SOUVENIR

# 85th Annual Session of Indian Ceramic Society
## 73rd Annual Session of All India Pottery Manufacturers' Association
## 47th Annual Session of Indian Institute of Ceramics

*And*

## International Virtual Conference on

# "Advances in Ceramics & Cement Technologies: Materials & Manufacturing"

## (IvaCCT- 2021)

**13th -14th December, 2021**

*Organized by*

Indian Ceramic Society, Karnataka Chapter
Bengaluru, Karnataka

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*In association with*

Dept. of Ceramic & Cement Tech.
HKE Society's PDA College of Engineering, Kalaburagi, Karnataka

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*This Conference and the Souvenir is dedicated to*

**Late Prof. M D Narasimhan**

Founder Head of Department, Ceramic & Cement Technology

HKES, PDA College of Engineering, Kalaburagi (Karnataka), India

&

Former Head of Department, Ceramic Engineering

Institute of Technology, Banaras Hindu University, Varansai (UP), India

# About Prof. M D Narasimhan

Prof M D Narasimhan born in 1925 at Coimbatore. He obtained his B.Sc 1946 from Presidency College, Madras. Then he completed B.Tech in Ceramics in 1949 from BHU on a State Scholarship from Nizam of Hyderabad. He started his professional career in 1950 at RRL Hyderabad and proceeded to the United States of America (USA) in 1954 on a research assistantship in the Metal Ceramic Project sponsored by the US Atomic Energy Commission at the Massachusetts Institute of Technology (MIT) acting as the group leader of the Project and was awarded the Doctor of Science degree in 1958. At MIT he studied under Prof. F H Norton and along with Prof. W D Kingery he postulated a new theory on Liquid Phase sintering.

After returning from the USA in 1959, he joined IIT Mumbai as Assistant Professor-in-Charge of the Silicate Technology Division and continued till 1963 organising and conducting Post Graduate course in Ceramics. He left IIT Mumbai to serve in Industry, first as Laboratory Manager at the Indian Firebricks and Insulation Company Ltd, Marar, Hazaribagh during 1963 to 1965 and then at EID Parry (India) Ltd Madras upto 1971. In both these Ceramic companies he established and organised modern Laboratories for R & D as well as testing and quality control of Ceramic products.

He came back to the academic profession and joined the Banaras Hindu University in 1971 as Professor and head of the Dept of Ceramic Engineering and continued to serve till his retirement in 1985. He later joined Gulbarga University (Karnataka) on invitation as Professor and Head of the Ceramic and Cement Technology at PDA College of Engineering at Gulbarga where he set up and organised the department and retired in 1994. Thereafter he served as President of IBM Consultancy Services Madras till February 1996. He breathed his last at Bangalore on 8th April 1996.

Prof Narasimhan was a life member of the Indian Ceramic Society and served as its Hony. Jt. Secretary (1972-75). He was a Founder member of Indian Institute of Ceramics and also its Vice-President (1980-81). He was a fellow of the Institure of Ceramics (UK) and was also a member of the Society of Sigma-Xi(USA) as well as of the Indian Institute of Metals and the Indian Institute of Chemical Engineers. He had several awards and research publications to his credit. He visited USA, Canada, UK and Many other European countries on various assignments.

Prof M D Narasimhan with CCT students, Kalaburagi


At 43rd Annual session of InCers at BHU

## Prof. M D Narasimhan Memorial Award

Indian Ceramic Society - Karnataka Chapter (ICSKC) jointly with Department of Ceramic & Cement Technology, PDA College of Engineering, Kalaburagi, during this occasion, instituted an Award named as **Prof. M D Narasimhan Memorial Award to** be given to an eminent Ceramist during the annual session of Indian Ceramic Society.

The First award will be presented during the 85th Annual session of InCerS & IvaCCT at Kalaburagi on 13th Dec2021. This award is bestowed to **Dr R G Shah**, former Chairman & founder secretary of Indian Ceramic Society, Bangalore Chapter (currently Karnataka chapter) and a close associate of Prof M D Narasimhan.

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# FOREWORD

**Dr. C. D. Madhusoodana**
*BE (Ceramics), MS (IISc), PhD (Tokyo Tech), MBL (NLSIU), FICeram, FIE*
Ceramic Technological Institute, Corp R & D, BHEL, Bangalore

***ಸ್ವಾಗತ !*** ***स्वागत !!*** ***WELCOME !!!***

The organizing committee welcomes you all for the 85th Annual session of Indian Ceramic Society (InCerS) in conjunction with 47th Annual Session of IIC and 73rd Annual Session of AIPMA and International Virtual Conference on **"Advances in Ceramics & Cement Technologies: *Materials & Manufacturing- IvaCCT*"** being held at HKE Society's PDA College of Engineering, Kalaburagi, Karnataka, India during 13th-14th, December, 2021.

Indian Ceramic Society - Karnataka Chapter (ICSKC) is one of the most active Chapters and takes pride in organizing this important event jointly with Department of Ceramic & Cement Technology, PDA College of Engineering, Kalaburagi. Due to COVID-19 pandemic situation, except for the inaugural and valedictory events all the other technical sessions are being held in virtual/hybrid mode. We have received overwhelming response for this event from Researchers, Scientists, Professors, Students and Industry personnel from different parts of the country and abroad. This event has 2 Awards lectures, 8 Plenary Lectures, 28 invited lectures, 25 Contributory (oral) presentations, 76 Flash (poster) presentations and 16 Virtual exhibitions.

In this conference, the 8 technical sessions are organized with invited and contributory lectures by eminent speakers in their respective fields like glass, cement & ceramic materials. There are two special sessions viz: (1) Manufacturing & material issues in Cement Industries (2) Entrepreneurship & Startups in Ceramic field. We have received excellent support from industries and organizations as well. There are two title sponsors viz: RAK Ceramics & Prism Johnson Limited, 4 gold sponsors and 9 silver sponsors on board. 16 companies will showcase their products & services in virtual exhibition, which is the

highlight of this event. American Ceramic Society-India Chapter and Institute of Engineers-Kalburgi centre have endorsed this event.

Technical committee has brought out this souvenir giving some glimpses of the event along with the abstracts of all presentations. The manuscripts submitted will be published in a special issue/ regular issue of "Transactions of the Indian Ceramic Society" or other SCI journals– after peer review.

On behalf of Organising Committee, we wish to thank all the Sponsors, Exhibitors, Advertisers, Speakers and Participants for their active participation and support. Finally, we wish to express our heartfelt thanks to all our colleagues on the different committees for their untiring efforts in making 85th Annual session and IvaCCT so very eventful & successful.

*जय हिन्द !*

*With Best Regards,*

For, *Team IvaCCT*

**C D Madhusoodana**
**Conference Chair**

**Convener**
**Prof. Baburao N Sherikar**
HoD, PDACEK

**Convener**
**Shri. S Chandrashekar**
Chairman- ICSKC
Convener - IvaCCT

**Chairman (Technical Committee)**
**Dr. Dinesh Rangappa**
VTU, Bangalore
Vice Chairman- ICSKC

# MESSAGE

**INDIAN CERAMIC SOCIETY**

Care: CSIR-Central Glass & Ceramic Research Institute
196, Raja S. C. Mullick Road, Jadavpur
Kolkata – 700 032, India
Tel : +91 (33) 2413 8878
E-mail : icers1928@gmail.com • Web : www.icers.org

**Dr L. K. Sharma**
President, Indian Ceramic Society

November 17, 2021

## MESSAGE

*It gives me an immense pleasure to know that the 85th Annual Session of the Indian Ceramic Society along with International webinar on "Advances in Ceramics & Cement Technologies: Materials & Manufacturing" will be organized by the Indian Ceramic Society, Karnataka Chapter in association with Department of Ceramic & Cement Technology, HKE Society's PDA College of Engineering, Kalaburagi, Karnataka during 13th-14th December, 2021 at PDA College of Engineering, Kalaburagi, Karnataka. This event will be in hybrid manner; - limited presence and virtual participation.*

*The objective of the conference is to share and exchange ideas on research and development in the fields of glass, cement & ceramic materials and its applications in industries.*

*As President of the Indian Ceramic Society, I take this opportunity to thank all the members of the conference organizing committee for their outstanding efforts in preparing for this event.*

*I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations that will lead to a better, healthier, merrier world. I strongly believe that this conference will result in concrete output in support of its topics.*

*I extend my best wishes for great success of the conference and congratulate the organizers on this timely initiative.*

*(L. K. Sharma)*
**President, Indian Ceramic Society**

Registered under Lift Societies Registration Act XXI of 1860 : Registration no. 52 of 1945-46

# MESSAGE

**President**
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**Vice President**
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**Hony. Treasurer**
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ALL INDIA POTTERY MANUFACTURER'S ASSOCIATION
76, B. B. GANGULY STREET (BASEMENT)
ROOM NO. - 9, KOLKATA - 700 012
MOBILE : +91 9831084445, +91 9830810881
Email : aipma.kol@rediffmail.com

**In The 73rd ANNUAL SESSION Held ON 13-14th December 2021, Kalaburagi, Karnataka**

Honorable Chief Guest, Distinguished Guests, Fellow Delegates, Representatives of Business Houses , Respectable Ladies And Gentlemen, I hereby welcome you all in the73rd Annual Session of All India Pottery Manufacturers' Association, 85th Annual Session of Indian Ceramic Society and 47th Annual Session of Indian institute of Ceramics.

The Session will be organizing International Virtual Conference on "Advances in Ceramics & Cement Technologies, Materials & Manufacturing". This is also a platform to exchange our views and opinions and up gradation of Technology with new innovative ideas by us which will add New Dimension to The Ceramic Industries countrywide and abroad. All India Pottery Manufacturers' Association will play a key role in this scenario which I strongly believe.

All India Pottery Manufacturers' Association was established in the year 1948, the year after our independence by a group of eminent industrialists in the field of pottery and ceramic. The concept of this Association was basically to promote the ceramic industry of our country.

The first President of AIPMA was Late Madan Gopal Bhagat and the office of the Association was established in Ilaco House, Central Gate, Ground Floor, 1 &3 Brabourne Road, Kolkata – 700 001.

The said office is shifted at 76 B.B. Ganguly Street ,Kolkata-700012 from June 2020 onwards..

All India Pottery Manufacturers' Association is working relentlessly for last seventy years for the development of entrepreneurs through different programmes of awareness like seminars, meetings, journals etc. INDOCERAM, the quarterly journal of AIPMA is well known in the field of ceramic because of its technically enriched article wherein we do publish the write up of eminent professors, industrialists in this field. Progress of any Industry depends on research & development and innovation. AIPMA will be instrumental to establish coordination between the research institutes such as CGCRI, NML and different laboratories and our member units to get benefits of latest technological development.

I once again convey my heartiest thanks to all present in this session. I am also thankful to the organizing committee for organizing such a splendid session.

**Shri G.G. Trivedi**
President
25th November, 2021

Alternative correspondence – Ganguli Ceramics, P-22, Bondel Road, Kolkata - 700019. Ph. : (033) 2287-3146

# MESSAGE

INDIAN INSTITUTE OF CERAMICS
(Registered under West Bengal Societies Registration Act XXVI of 1961)
Care: CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
KOLKATA – 700032 ☎ (033) 2413 8879
E-mail: liceramkolkata@gmail.com ● Website: www.liceram.org

*Dr. H. S. Tripathi*
*President*

**MESSAGE**

I am extremely happy to note that the Indian Ceramic Society, Karnataka Chapter in association with the PDA College of Engineering is organising an International virtual conference on "Advances in Ceramics and Cement Technology: Materials & Manufacturing" along with the Annual Sessions of The Indian Ceramic Society, Indian Institute of Ceramics and All India Pottery Manufacturers' Association. The quality of the product is strongly interlinked with starting materials and manufacturing techniques. With the advent of time, due to the shortage of good quality raw materials, the use of synthetic materials is increased to a large extent. Adoption of newer technologies not only helps in increased productivity it is also immensely helpful for quality improvement of the product, and reduction in environmental impact. In an industry like ceramics, looking for less energy-intensive manufacturing technology becomes imperative. In this context, the topic of this conference is very much relevant and timely.

I wish the conference and the associated events all success.

Date: 3rd December 2021

(H. S. Tripathi)

# MESSAGE

**Indian Ceramic Society - Karnataka Chapter**
*Ceramics Section, Sri Jayachamarajendra (Govt.) Polytechnic*
*KR Circle, Bangalore 560 001.* Ph : 080 22260508 Extn: 229/230
E-mail : icerskc@gmail.com www.icskc.in
**Society Registration No: SOR/GNR/393/2014-15 Dated. 28/3/2015**

## MESSAGE

It is my pleasure to welcome all of you to the 85th Annual session of the Indian Ceramic Society along with 73rd annual session of All India Pottery Manufacturers' Association and 47th Annual session of Indian Institute of Ceramics and international webinar ***"IvaCCT -2021" ADVANCES* IN CERAMICS & CEMENT TECHNOLOGIES: Materials & Manufacturing** scheduled on 13th and 14th of December 2021 at PDA college of Engineering, Kalaburagi in Karnataka.

This conference is designed to provide a platform to address the impact of advancements in research and developments of materials and manufacturing specifically related to cement and ceramic industries contributing to a better future.

The conference is also aimed at bringing together the best in research and industry to share and learn, connect, and grow. The deliberations will enhance the quality of connect between all stake holders like industries, academic institutions, entrepreneurs, consultants, scientists, students, etc.,

More than 60 experts from various countries have consented to share their expertise vide a technical presentation at the conference in a hybrid mode. There are parallel sessions, physical and E-exhibitions scheduled with live streaming of conference to interested audience world over.

I thank all the sponsors, exhibitors, advertisers and speakers for their support and delegates for their active participation.

Appreciating each member of the various organizing committees for their untiring efforts, we look forward to your participation and support for a successful conduct of the conference.

S CHANDRASHEKAR
Joint Secretary – ICS
Chairman- ICSKC
Conference Convener

# MESSAGE


**Dr. Bhimashankar C. Bilgundi**
President

## Message

I feel pleasure to note that International Conference on "Advances in Ceramic and Cement Technologies: Materials and Manufacturing" being organized at Department of Ceramics and Cement Technology, PDA College of Engineering on 13th & 14th December 2021. This conference is being organized both in online/offline mode that facilitates many professionals from industry, researchers, scientists, academicians, research scholars and engineering students belonging to the field of ceramic engineering and cement technology. Further, this conference proves beneficial towards exchange of information about latest innovation techniques.

It is matter of pride to our college and organization that eminent scientists and researchers from different parts of the world will be participating in this conference.

I appreciate the efforts being put by our faculty and staff along with executive members of Indian Ceramic Society Karnataka Chapter to jointly organize this International Conference at our institution.

I welcome all the delegates and wish the organizers for a grand success of this conference

**Dr. Bhimashankar C. Bilgundi**
Chairman, Governing Body,
PDA College of Engineering &
President, HKE Society, Kalaburagi

Behind PDA Engg. College - Aiwan-E-Shahi Area - Kalaburagi-585 102 - Karnataka
Phone : +91-8472-220337 - Email : ao@hkes.edu.in - Website : hkes.edu.in

# MESSAGE

I am very glad that Department of Ceramic and Cement Technology, PDA College of Engineering, Kalaburagi Karnataka is organizing "**International Conference on "Advances in Ceramic and Cement Technologies: Materials and Manufacturing**" from 13th to 14th December 2021 in our college campus. In the present scenario considerable amount of research and development is going on in the field of materials engineering particularly in ceramics and cement technology. Advanced ceramics are most potential materials for big industries such as iron and steel, electronics devices, electrical insulators, defence etc.. Advances in cement technology play a vital role for construction of new building structures also.

This International conference proposes to cover different themes in the field of ceramics and cement technology. In addition, this conference will facilitate an interaction of present scientific research and innovations in newer ceramics and cement materials by eminent scientists, engineers from Industries and academician active in research and development activities.

I welcome the delegates from all over the world to our organization to participate in this conference and wish the organizers all the best for grand success of this International Virtual Conference.

**Dr. Shivanand S. Hebbal**
Principal,
PDA College of Engineering,
Kalaburagi

# MESSAGE

The motivation behind the conduct of this conference (IvaCCT-2021) is to meet and exchange technical knowledge with experts and industry peers from ceramic field. Being an alumnus of IIT Kharagpur and IISc Bengaluru, I had the opportunity of meeting national and international scholars from ceramic sciences. It was my dream to bring together such people at least once when I get a chance. When I took over charge as Head of the Dept. of Ceramics and Cement Technology at PDA College of Engineering, Kalaburagi, I started executing my dream. My work was made easy by our motivated Principal, faculty and staff of the department as well as by the cooperation of the ICSKC members. Four months of hard work and coordination has lead to a great success and the conference received very good response by way of contributed papers and overwhelming sponsorship. About 120 papers were received out of which 28 papers will be presented in four parallel technical sessions. About 80 flash presentations are also scheduled. Seventeen companies also have sponsored the conference which indicates the extent of reach of the conference among the industry. I am happy that my efforts have not gone in vain, and I owe this success to my colleagues and ICSKC members. Hope this conference will set a model, and will be very useful to the participants. I thank especially our HKE Society's President, Dr. Bhimashankar C. Bilagundi, our college governing body member Ar. Basawaraj J. Khanderao, and other council members of HKE Society for their wholehearted support in organizing this conference.

**Dr. Baburao N. Sherikar**
Head, Dept. of Ceramics and Cement Technology
Convener – IvaCCT - 2021
PDA College of Engineering, Kalaburagi

# INDIAN CERAMIC SOCIETY- KARNATAKA CHAPTER


## Indian Ceramic Society-Karnataka Chapter

*Ceramics Section, Sri Jayachamarajendra (Govt) Polytechnic.*
*KR Circle, Bangalore 560 001.*Ph: 080 22260508 Extn: 229/230
E-mail: incersksc@gmail.com www.icskc.in
**Society Registration No: SOR/GNR/393/2014-15 Dtd. 28/3/2015**




### ABOUT INDIAN CERAMIC SOCIETY

www.incers.org

The Indian Ceramic Society (ICerS) a non-profit organization was established in 1928 with the blessings and active support of Pandit Madan Mohan Malaviyat at BHU in Varanasi.
The objective of the society was to promote advancement of ceramic science, arts and technologies by bringing together concerned resource people, publishing scientific and technical books and journals, holding annual sessions, meetings, discussions, symposia and exhibitions on the related subjects.

InCerS has more than 2000 members including foreign members and comprises individuals and groups that include scientists, engineers, researchers, manufacturers, faculty, students, marketing and sales professionals as well as others in ceramic materials related disciplines.

### ABOUT INDIAN CERAMIC SOCIETY –KARNATAKA CHAPTER

www.icskc.in

Indian Ceramic Society –Karnataka Chapter (ICSKC) a registered non-profit body under the aegis of INDIAN CERAMIC SOCIETY with a membership of 200 Ceramic and Advanced Materials professionals drawn from Academics, Industries, R&D Institutes, Defence, Space organisations is a very active chapter and has won the coveted best chapter awards 10 times in the last 20 years and every year for last 3 three years in a row. ICSKC members were also awarded Young Scientist Award, Refractory Technologist Award, RL Thakur Memorial Award, Sasadhar Ray Memorial Award, Malaviya Award including GN Agarwal Award for life time achievement in Glass and Ceramics.

ICSKC regularly organizes Seminars, Technical workshops, Industry visits, Annual Foundation day with a family get-together and distributes Awards to meritorious Ceramic students, etc.

In the recent past ICSKC has organized events like :Nanosec 2011, Refractories for CFBC boilers (Re2012) and Materials technologies for cement industry (CemSem2014), International conference-CAMEE2015, ACeND-2018.
**One day workshops on :**
Steel Plant Refractories at JSW- Tornagallu,
Advanced Materials for Space Applications (CAMSA 2018 at ISRO-ISAC),
Advanced Ceramics and Refractories for Foundry Industry in Bangalore

ICSKC for the first time conducted **65 on-line webinars** during the pandemic with support from experts from various parts of the world on subjects like Glass, Refractories, Ceramic Tiles, Wear resistant tiles, Refractory Installations Practice, Thermography –for online refractory condition monitoring, optimizing burner operation for brick kiln operation, etc.,

ICSKC members also contributed towards
1. Revamping of Ceramic Education and Infrastructure for the benefit of students.
2. Chief ministers covid relief fund
3. Sponsoring Oxygen Concentrator for the benefit of the needy during Covid pandemic.

As resource persons ICSKC team has conducted technical lectures to support PDA college in various activities like placement, internship, skill development, job placement, etc.

With best wishes for a successful conduct of the 85th Annual session of Indian Ceramic Society and International virtual conference IvaCCT

S Chandrashekar
9448061681
CHAIRMAN –ICSKC
JT. SECRETARY –ICS
CONFERENCE CONVENER

# PDA COLLEGE OF ENGINEERING, KALABURAGI

The Hyderabad Karnataka Education (HKE) society has been established in the year 1958, by Late Shri. Mahadevappa Rampure, founder president, a great visionary and educationist. Poojya Doddappa Appa (PDA) College of Engineering, Gulbarga is the first institution established by the society in 1958 with three basic engineering degree like Civil, Mechanical and Electrical Engineering with as intake 120 students. At present the college has 13 undergraduate program, 10 PG program and 13 research centers with an intake 980 students for UG, 197 students for PG under VTU Belagavi. The college received about 32 crores of funds from TEQIP, World Bank assisted Project under MHRD New Delhi. The college has been granted academic autonomous status in the year 2007 affiliated to VTU Belagavi. The college has been granted NBA for the first time in the year 2006. Further, the NBA team granted accreditation under Washington accord (Tier-I) from the academic year 2019-20 to 2021-22. The college celebrated its golden jubilee in the year 2010, setting new standards in the field of education and achieving greater heights for Diamond Jubilee celebration. The college campus is spread over 71 acres of land on either side of Mumbai-Chennai railway track and has a sprawling complex with gardens and greenery all around. Around 46 educational institutions, hospitals run under HKE Society.

**Department of Ceramics and Cement Technology:**

The department has been started in the year 1981, under the headship of Late Prof. M.D. Narasimhan, a globally renowned ceramist, with a vision to produce skilled engineers and to provide an exciting learning environment in the field of Ceramic and Cement

Technology. Since its inception department have produced more than 500 ceramic engineering graduates who are serving in reputed organization and industries, to name a few BHEL, Corning glass, Jindal, ACC, Ultratech, Shree Cements, Saint-Gobin, H & R Johnson, Hindustan Sanitary wares, etc.

Late Dr. M. D. Narasimhan

From Left to Right: Faculty and Staff of Dept. of Ceramic and Cement Technology
1)Prof. Pavan Rangdal, 2)Prof. Hansraj Sahu, 3)Dr Veeresh P. Mallapur, 4)Dr Amaresh R., 5) Dr Baburao N. Sherikar 6) Dr John U. Kennedy 7) Dr Mahadevappa Gadge 8) Dr S. B. Patil 9) Mr Mallikarjun Kumne 10) sharankumar Jagte 11) Prof. Gundu R. Kolkur

The department is well equipped for the laboratories like Clays & Potteries, Ceramic Processing Lab., Glass making & testing, Refractories testing lab., Nanomaterials synthesis lab. and sophisticated instruments analysis Lab with equipment such as BET surface area analyzer, FTIR, AAS station, high temperature furnaces.

The faculty members have completed their higher education such as M.Tech., PhD from institutes of national importance like IISc, IIT and NIT. Department has been accredited by NBA for the first time for 5 years in the year 2006. Once again during 2019-2020 the department has been accredited by NBA under Tier-1. A PG program on Materials Science and Technology is also being run from the academic year 2014-2015. In addition the department is also recognized as research centre by VTU, Belagavi. The department has received research grants worth Rs. 70 lakhs and presently.

Most alumni of our department are working in key positions in multinational industries and research organizations in India and abroad. A few known alumni are Dr C. D. Madhusoodana, Additional General Manager, CTI, BHEL, Dr. B. S. Patil, Chief Technical Officer, RAK Ceramics, Mr. Harsh Joshi, DGM Refractories, JSW Steel Ltd., Mr Shivakumar Kadur, Owen Corning USA, Mr Vivek Kumar Katagi, AGM (Technical), Ultratech Cements, Mr Arun Barad, Mr. Arvind Patil, Vice-President, Shree cements, Mr Basawaraj Shiggavi, FL Smidth etc.

# ORGANISING COMMITTEE

## International Vitrual Conference on

## "Advanced Ceramics & Cement Technologies : *Materials & Manufacturing*" (IvaCCT- 2021)

**December 13th-14th, 2021**

**Venue: PDA College of Engineering, Gulbarga, Karnataka**

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Mr Muneesh Nagpal
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Mr Ramaiah
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Mr Sujay Kumar
Mr Uday Mugali
Mr Vivek Kumar Katagi
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# IvaCCT-2021 Inaugural Programme

## Inauguration: 13th Dec 2021 9:00 AM to 10:30 AM

1. Invocation
2. Welcome address : **Dr. S. S. Hebbal,** Principal, PDACEK & Patron -IvaCCT
3. Lighting of the lamp
4. Welcome & Genies of the Conference: **Dr. C. D. Madhusoodana,** Conference Chair
5. Indian Ceramic Society- Presidential address: **Dr. L. K. Sharma,** President of Indian Ceramic Society
6. Indian Institute of Ceramics- Presidential address: **Dr. H. S. Tripathi,** President of Indian Institute of Ceramics
7. All Indian Pottery Manufactures Association (AIPMA)-Presidential address: **Dr. Sabyasachi Roy,** Vice-President AIPMA
8. Presentation of Indian Ceramic Society Awards
9. Presentation of ICSKC-PDACEK Awards
10. Releasing of Souvenir & Address: **Dr. Bhimashankar C Bilagundi** President HKE Society
11. Address by Chief Guest **: Sri. S. C. Vishwanath, JSW**
12. Felicitation to Guests by: **Sri. S. Chandrashekar**, Convener-IvaCCT & Chairman-ICSKC
13. Vote of thanks: **Dr. Baburrao Sherikar**, HoD- CCT, PDACEK & Convener-IvaCCT

# IvaCCT-2021 Valedictory Programme

## 14th Dec 2021 5:15 PM to 6:00 PM

1. Welcome address : **Dr. S. S. Kalashetty,** Vice-Principal, PDACEK & Co Chair - IvaCCT
2. Summary of the proceedings: **Dr. Dinesh Rangappa,** Chairman-Technical Committee
3. Presentation of Best Flash Talk Awards : by Guest of Honour **Ar. Basawaraj J. Khanderao**
4. Address by Chief Guest **: Prof. A. M. Umarji**
5. Open discussion:
6. Concluding Remarks by **Dr. L. K. Sharma,** President of Indian Ceramic Society
7. Presentation of Mementos:

   By **Dr. S. S. Hebbal, Principal,** PDACEK & Patron –IvaCCT

   & **Dr. C. D. Madhusoodana** , Conference Chair
8. Vote of thanks: **Dr. Veeresh Mallapur**, Organizing Secretary-IvaCCT
9. National Anthem

# SESSION PLAN- DAY 1

| 85th Annual Session of InCerS | DAY 1: 13th DECEMBER 2021 MONDAY | | | IvaCCT-2021 |
|---|---|---|---|---|
| 09.00 AM - 10.20 AM | INAUGURATION & PRESENTATION of AWARDS ( Venue: Auditorium) Link | | | |
| 10.20 AM - 11.00 AM | HIGH TEA | | | |
| | AWARD Lectures : Venue: Auditorium Link | | Session Chair: Dr L K Sharma | |
| 11.00 AM - 11.45 AM | M G BHAGATH MEMORIAL LECTURE<br>**Prof. Palani Balaya**, NUS, Singapore<br>Title: *Nanostructured Materials and Their Impact on Developing Safe Battery Technologies* | | | |
| 11.45 AM - 12.30 PM | SAHAJ MEMORIAL LECTURE<br>**Dr. B S Patil**, RAK Ceramics, Dubai<br>Title: *Digitalization of Ceramic Manufacturing with Industry 4.0* | | | |
| 12.30 PM - 01.30 PM | LUNCH BREAK ( Exhibition Stalls) | | | |
| 01.30 PM - 02.10 PM | Venue: Auditorium Link | | Session Chairman: Prof AM Umarji Co-Chair: Prof Mahadevappa Gadga | |
| | Plenary Lecture - 1 | | **Mr. Srinivasan Natarajan** Prism Johnson Ltd, India<br>Title: *Cost Effective Products & Technologies for Cement Industry from Prism Johnson Ltd* | |
| 02.10 PM - 02.50 PM | Plenary Lecture - 2 | | **Dr. Manabu Fukushima** AIST, Japan<br>Title: *Solution forming process for advanced engineering porous ceramics* | |
| 02.50 PM - 03.30 PM | Plenary Lecture - 3 | | **Dr. Anne Leriche Valenciet** Université Polytechnique Hauts-de-France, CERAMATHS – Valenciennes (France)<br>Title: *Comparison of different methods of making microporous honeycomb ceramics* | |
| 03.30 PM - 04.00 PM | TEA BREAK (Advertisements) | | | |
| | **Seminar Hall 1: Link** | **Seminar Hall 2: Link** | **Auditorium: Link** | **Seminar Hall 3: Link** |
| | **Technical Session 1: Innovative Processing of Ceramic Materials & Glass** | **Technical Session 2: Refractory Materials & Applications** | **Technical Session 3: Special session on Cement (Materials & Manufacturing issues** | **Technical Session 4: Engineering Ceramics, Structural Ceramics and Coatings** |
| | Session Chair: Prof. Parag Bhargava | Session Chair: Dr B S Tripathi | Session Chair: Prof. Amaresh Raichur | Session Chair: Prof. L M Manocha |
| 04.00 PM - 04.20 PM | Invited Talk - S101 | Invited Talk - S201 | Invited Talk - S301 | Invited Talk - S401 |
| | **Mr. Sitendu Mandal**<br>CSIR-CGCRI<br>Title: Specialty Glass: Sustainable Development for Strategic Applications and Technology Commercialization | **Mr. Harsh Joshi**<br>JSW<br>Title: Reduction in Carbon Pick-Up from Refractory for Producing Special Steel | **Mr. Basavaraj Shiggavi**<br>FLSmidth India<br>Title: Sustainability -Zero Emission for cement industry | **Dr. Arjun Dey**<br>ISRSC, ISRO<br>Title: Reversible Phase Transition of Vanadium Oxides-Titanium Oxide Thin Films for Smart Radiative Device (SRD) for Spacecraft Application |
| 04.20 PM - 04.40 PM | Invited Talk - S102 | Invited Talk - S202 | Invited Talk - S302 | Invited Talk - S402 |
| | **Dr. Saurabh Kapoor**<br>Starlite Technologies, Ltd, Aurangabad<br>Title: Indentation Behavior Of Soda Glasses Densified at Elevated Temperature | **Mr. Surendra Mishra**<br>Dhirubhai Refractories (Arabian) Co. Ltd<br>Title: Rotary slag corrosion tests on cement bricks for high Sulphur AFR | **Prof. Balaram Sahoo**<br>Indian Institute of Science<br>Title: Effect of Fly Ash and CNT on Setting Mechanism and Strength of Cementitious Composite: A Chemical Approach | **Mr. Shivashuranappa V Gubbevvad**<br>PDA college of engineering Kalaburag<br>Title: Analysis of experimental wear data of materials and ceramic based composites from literature for validation of wear model equations |
| 04.40 PM - 05.00 PM | Invited Talk - S103 | Invited Talk - S203 | Invited Talk - S303 | Invited Talk - S403 |
| | **Dr. Roy Johnson**<br>ARCI<br>Title: Transparent Polycrystalline Ceramics: Processing & Applications | **Mr. Rajeev K Laharia**<br>Calderys<br>Title: Calderys Innovative Solution For Cement Plants using AFR – Nano Bonded "Supracem" | **Prof. Pranab Das**<br>ACS College of Engineering, Bangalore<br>Title: Preparation and properties of GdLiPO4:Yb3+,Er3+ | **Dr. V Aarudi**<br>Siddaganga Institute of Technology, Tumakuru<br>Title: Influence of Ceramic B4C Particulate Additives on Characterization, Tensile Fractography and Wear Behavior of GD(Al Alloy Matrix |
| 05.00 PM - 05.15 PM | Oral Presentation - S101 | Oral Presentation - S201 | Invited Talk - S304 (05.00 PM - 05.20 PM) | Oral Presentation - S401 |
| | **Prof Santanu Das**<br>Indian Institute of Technology (BHU)<br>Title: Ceramic Fiber Manufacturing Processes: Present Indscenario and future prospect | **Abdur Rauf**<br>HDCIS Banquet Centre, HDCIS, SAIL<br>Title: Performance Improvement of Hot Metal Ladle Lining With AlZrO-SiC-C Refractory in BF | **Mr. Biswajit M Patra**<br>TATA Steel<br>Title: Utilization of LD Slag in Portland Slag Cement Manufacturing | **Dr. Madeva Nagaral**<br>Aircraft Research and Design Centre, HAL<br>Title: Influence of Ceramic Reinforcement Particle Size on the Mechanical Behavior and Fractography of AZ91D-B4C Aerospace Metal Composites |
| 05.15 PM - 05.30 PM | Oral Presentation - S102 | Oral Presentation - S202 | | Oral Presentation - S402 |
| | **Indrajeet Mandal**<br>CSIR-CGCRI<br>Title: Influence of Na2SiO4 in structure and conductivity of Na-ion conducting NASICON based glass electrolyte | **Ranjeeth Ravi**<br>Indian Oil Corporation, R&D, Haryana<br>Title: Analysis of Refractory Failure & Hot Spots in the Riser Section of FCC Unit of a Refinery | Invited Talk - S305 (05.20 PM - 05.40 PM)<br>**Mr. M Kadhirvelu**<br>Murugappa Morgan Thermal Ceramics Ltd<br>Title: Sustainability through Advanced Insulation in Cement Industry | **Kommuri Kirana**<br>Osmania University<br>Title: An insight study into the Compositionally Induced Normal to Diffuse Ferroelectric transitions in NKN ceramics |
| 05.30 PM - 05.45 PM | Oral Presentation - S103 | Oral Presentation - S203 | | Oral Presentation - S403 |
| | **S Mamatha**<br>ARCI Hyderabad<br>Title: 3D Printing of Clay Bonded Silicon Carbide for Kiln Furniture | **Pawan Rangdal**<br>P D A College of Engineering, Gulbarga<br>Title: Synthesis of Alumina Sol Binder To Be Used In High Alumina Castable And Its Comparison With Commercially Available Binders | Invited Talk - S306 (05.40 PM - 06.00 PM) | **Kripasindhu Sardar**<br>National Chung Hsing University, Taiwan<br>Title: Non-aqueous synthesis of silicon nitride ceramics |
| 05.45 PM - 06.00 PM | Oral Presentation - S104 | Oral Presentation - S204 | **Mr. Vivekkumar V Kaigi**<br>Ultratech Cement<br>Title: The sustainable Refractory solutions- Key need of Cement Industry | Oral Presentation - S404 |
| | **Abinash Kumar**<br>National Institute of Technology, Rourkela<br>Title: Fabrication and Characterization of 5-1 type Porous (Ba0.85Ca0.15)(Zr0.1Ti0.9)O3 (BCZT) Lead-free Piezoceramics by Novel Ice Templating Process | **Arshad Hussain**<br>Kerneos Arabia (Dominion Global), UAE<br>Title: Refractory Installation | | **Shriraag M. Pathak**<br>CSIR-National Aerospace Laboratories, Bengaluru<br>Title: Solid Particle Erosion Performances of Ceramic Nanoparticles Reinforced Polyurethane Coatings |
| 06.00 PM - 09.00 PM | Virtual Exhibitions ( VE-1 to VE-10) Chairman: Dr M G Anandkumar Co Chair: Pawan Rangdal LINK | | | |

# SESSION PLAN- DAY 2

| 85th Annual Session of InCerS | DAY 2: 14th DECEMBER 2021 TUESDAY | | | IvaCCT-2021 |
|---|---|---|---|---|
| 09.00 AM - 09.40 AM | Venue: Auditorium Link | | Session Chairman: Prof Bhaskar Das Co-Chair: Prof John U Kennedy | |
| | Plenary Lecture - 4 | | **Dr. Amitabha Kumar** Boral IP Holdings LLC, USA<br>Title: *Pathways for Sustainable Cement Material* | |
| 09.40 AM - 10.20 AM | Plenary Lecture - 5 | | **Dr. Sarojit Gupta** South Dakota Univ, USA<br>Title: Greening of Ceramics and Materials Manufacturing – An Analysis on Different Case Studies | |
| 10.20 PM - 11.00 AM | Plenary Lecture - 6 | | **Mr. Aakarsh Naidu** The Startupreneur ®, UK<br>Title: Start-ups & Entrepreneurship in ceramics | |
| 11.00 AM - 11.15 AM | TEA BREAK (Advertisements) | | | |
| | **Seminar Hall 1: Link** | **Seminar Hall 2: Link** | **Auditorium: Link** | **Seminar Hall 3: Link** |
| | **Technical Session 5: Advanced Functional Ceramics, Nanomaterials & Biomaterials** | **Technical Session 6: Ceramics for Energy and Environment** | **Technical Session 7: Special session on Entrepreneurship & Start-up** | **Technical Session 8: Raw Materials & Manufacturing** |
| | Session Chair: Dr. KGK Warrier | Session Chair: Dr Dinesh Rangappa | Session Chair: Mr Galjeet Singh Mathur | Session Chair: Dr Chandresh Agarwal |
| 11.15 AM - 11.35 AM | Invited Talk - SI01<br>**Prof. Bikramjit Basu**<br>IISc, Bangalore<br>Title: Biomaterials and Implants in India: Current Status and Recommendations | Invited Talk - SI11<br>**Dr. Thomas Kadenkandath**<br>Bloom Research, Inc, USA<br>Title: Improved Manufacturing Method for the Production of Ni-rich NMC Cathodes for Advanced Li-Batteries | Invited Talk - SI21<br>**Mrs. Jeyalakshmi Venkatanarayanan**<br>Universe Power Systems<br>Title: Dream big & grow with MSME schemes | Invited Talk - SI31<br>**Mr. Gary Laymath**<br>IMERYS Performance Minerals Asia Pacific<br>Title: Kaolin – A story beyond whiteness and particle size |
| 11.35 AM - 11.55 AM | Invited Talk - SI12<br>**Dr. Rishi Gupta**<br>ANTON PAAR<br>Title: Characterization of various attributes in ceramic and cement samples" | Invited Talk - SI12<br>**Dr. Aruna S T**<br>CSIR-NAL<br>Title: Reversible Solid Oxide Fuel Cells for Green Hydrogen Generation: Present Status and Future Prospects | Invited Talk - SI22<br>**Mr. Sathish Chitwadgi**<br>Sister Cera Kraft LLP<br>Title: Entrepreneurship opportunities in Ceramic Tile Industry | Invited Talk - SI32<br>**Mr. Shankha Chatterjee**<br>ALVATS Alumina Pvt Ltd, India<br>Title: Developments in synthetic alumina towards sustainable growth in coming decades |
| 11.55 AM - 12.15 AM | Invited Talk - SI13<br>**Prof. J Manjanna**<br>Rani Channamma University, Belagavi<br>Title: Smart bio clay minerals in the geological disposal of high level waste and conventional applications as solid acids | Oral Presentation - S601<br>**Dr. Soumya Shankar Ghosh**<br>IIT Roorkee<br>Title: Conductive nanostructured coating on graphite for new generation anodes of lithium ion batteries | Invited Talk - SI23 (11.55 AM - 12.15 PM)<br>**Mr. Sabyasachi Roy**<br>ANTS Ceramics<br>Title: Lab to Production Scale-up story of ANTS Ceramics | Invited Talk - SI33<br>**Dr. Shyam S Rao**<br>CUMI<br>Title: Advanced Ceramics - Manufacturing Processes and Applications |
| 12.15 PM - 12.30 PM | Oral Presentation - S501<br>**Omprakash Hebbal**<br>P D A College of Engineering Kalaburagi<br>Title: Performance, Emission and Combustion Characteristics of a MMC coated Low Heat Rejection Engine Using Mahua Biodiesel | Oral Presentation - S602<br>**Shahensha Mohammed M**<br>CSIR-NIIST, Thiruvananthapuram<br>Title: Removal of Mixed Azo Reactive Dyes from Aqueous Solution Using Mixed-Oxidants-based Tertiary Re Process Backed-up by Hybrid Ultrasonic Cavitation and Ozonation Technique | **Dr. Prakash Mugali**<br>Bharat Systems, Belagavi<br>Title: How do you start your Tech company ? | Oral Presentation - S811<br>**Dr.Prabhu Ramanujam**<br>Hindalco Industries Limited, Belagavi<br>Title: Effect of particle morphology on the wear resistance mechanism of Alumina Ceramics |
| 12.30PM - 12.45 PM | Oral Presentation - S502<br>**Payal Roy**<br>CSIR-CGCRI<br>Title: A Novel Homeostatic Dressing Material Impregnated With Mesoporous Antibacterial Bioactive Glass For Profusely Bleeding Condition | Oral Presentation - S603<br>**Susmita Bera**<br>CSIR-CGCRI<br>Title: Enhanced Photocatalytic Activity of Mixed Doped $BiVO_4$ for Water Splitting under Visible Light | Invited Talk - SI35 (12.30 PM - 12.55 PM)<br>**Mr. Mahesh Shastri**<br>Re-Batt Energy Solutions Pvt.Ltd.<br>Title: Innovative Start-up on Lithium Ion Battery Processing and Assembly | Oral Presentation - S812<br>**Vivek Narayan**<br>Imerys Ceramics<br>Title: Viscosity and Gelation of Ceramic Slips – An Industrial Perspective |
| 12.45 PM - 01.00 PM | Oral Presentation - S503<br>**Prabhakar N Patil**<br>Dept. of Physics, Gulbarga University<br>Title: Mechanistic insights into the synthesis of $CuFe_2O_4$ and $Fe_2(MoO_4)_3$ by sol-gel method | Oral Presentation - S604<br>**G Thiruvathi**<br>CTI- BHEL<br>Title: Synthesis of Lithium Nickel Cobalt Aluminium oxide (NCA) type cathode material for lithium ion batteries | Invited Talk - SI36 (12.55 PM - 01.15 PM) | Oral Presentation - S815<br>**Sanjukta Roy**<br>CSIR-CGCRI<br>Title: Ceramic-based photocatalytic membrane reactors for wastewater treatment |
| 01.00 PM - 01.15 PM | Oral Presentation - S504<br>**Kaustubh Ramesh Kambale**<br>College of Engineering Pune<br>Title: Sintering and Electrical Properties of ABN-BN and ABN-ASTNO Ceramics | Oral Presentation - S605<br>**Manjunath Shetty**<br>Manipal Institute of Technology<br>Title: One-Pot supercritical fluid Synthesis of Reduced Graphene Oxide hybrid $BiVO_4$ nanostructures For Dye to Battery to Anode | OPEN DISCUSSION | Oral Presentation - S816<br>**Aiswarya Anil**<br>CSIR-NAL, Bangalore<br>Title: A comparative study on solid state and sol-gel synthesis of Lithium Aluminium Silicate |
| 01.15 PM - 02.10 PM | LUNCH BREAK & Virtual Exhibition: (VE-11 to VE-16) Chairman: Dr Veeresh Mallapur Co Chair: B K Mahantkran Link | | | |
| 02.10 PM - 03.10 PM | Venue: Auditorium Link | | Session Chairman: Prof S S Kulkarni Co-Chair: Prof Sridhar Pandey | |
| | Plenary Lecture - 7 | | **Prof. R Moreno,** Institute of Ceramics and Glass, Spain<br>Title: *Synthesis and colloidal processing of bi-shape lanthanum manganite sublimated by a citrate route* | |
| 03.10 PM - 04.00 PM | Plenary Lecture - 8 | | **Prof. Bala Vaidhyanathan,** Loughborough Univ, UK<br>Title: *Field Assisted Processing of 3D Printed Advanced Ceramics* | |
| 04.00 PM - 04.15 PM | TEA BREAK (Advertisements) | | | |
| | **Flash Talk: Session 1 Link** | **Flash Talk: Session 2 Link** | **Flash Talk: Session 3 Link** | **Flash Talk: Session 4 Link** |
| 04.15 PM - 05.15 PM | Chairman : Dr Nagesh Kini<br>Processing & Engineering Ceramics & Coating, Nanomaterials & Structural Ceramics, Refractory Materials & Application<br>FTS1-01 to FTS1-20 | Chairman : Prof. H D Prasanna<br>Advances in Glass, Ceramics for Environment & Advanced Functional Ceramics & Bio-materials<br>FTS2-01 to FTS2-21 | Chairman : Dr Purushotham Jheld<br>Ceramics in Energy<br>FTS3-01 to FTS3-17 | Chairman : Prof. S H Patil<br>Other Materials & Manufacturing<br>FTS4-01 to FTS4-18 |
| 05.15 PM - 06.00 PM | VALEDICTORY FUNCTION (Venue: Auditorium) Link | | | |
| 06.00 PM - 06.30 PM | HIGH TEA | | | |

## Award 1: M G Bhagath Memorial Lecture

**Prof. Palani Balaya (FACerS)**
Department of Mechanical Engineering, Faculty of Engineering, National University of Singapore, Singapore

**Title: *Nanostructured Materials and Their Impact on Developing Safe Battery Technologies***

Nanostructured materials have triggered a great excitement in the area of energy applications due to both fundamental interest as well as technological impact. Size reduction in nanocrystals leads to a variety of unexpected exciting phenomena due to enhanced surface-to-volume ratio and reduced length for the transport. In the first part of this memorial lecture, we will consider some of those phenomena restricting our discussions to the nano-size effects on (a) transport, (b) thermodynamics and (c) storage behaviour with a few examples to illustrate material challenges for advanced energy storage devices.

(a) Mesoscopic electrical conduction occurs due to overlap of space charges at reduced interfacial spacings. Unlike microcrystalline materials, having both bulk as well as semi-infinite interfacial contributions to the electrical conduction, nanocrystalline materials exhibits only interfacial conduction. We highlight two illustrations: (i) Fe-doped $SrTiO_3$ where interfacial contribution is predominated by hole depletion throughout the nano-grains, (ii) $TiO_2$ where accumulated electrons fully dominate within the nanograins resulting in enhanced electronic conduction.

(b) Size reduction of materials affects thermodynamic properties and hence their energetics due to excess surface contributions causing stabilization of meta-stable phases at nano-size.

(c) The benefit of narrowly spaced boundaries in nanomaterials also results in efficient energy storage due to the reduced effective diffusion path for both ions and electrons. Thus, in the context of storage behaviour, nanocrystalline electrodes exhibit high capacity as well as coulombic efficiency (reversible storage). We will consider few case studies on lithium and sodium storage.

Second part of the lecture will address various safe battery technologies for electric vehicles. Several Li-ion battery chemistries have been introduced successfully by the industries including $LiFePO_4$/graphite (LFP), $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$/graphite (NCA), $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$/graphite (NMC) etc., Despite enormous efforts made on Li-ion cells of oxide chemistries which use micron-size positive electrode materials ($LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$, $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ etc.,) most of the industries at this moment prefer using LFP chemistry which uses carbon coated nano-sized $LiFePO_4$ in view of the excellent safety features despite its low energy density. In this presentation, we will analyze various causes for improved safety of LFP cells. The storage performances of a few selected 18650 type Na-ion cells will also be

presented. Various strategies using nanostructured materials will be discussed to minimize heat generation and the associated total internal resistances of these Li-ion and Na-ion cell chemistries for improving their safety features.

## Profile

Just after graduating from Hyderabad University, India (1993) in the area of Solid-State Ionics, Dr. Palani Balaya joined IISc, Bangalore as a Research Associate (1994-1996) and worked on insulating materials. He later joined the Inter University Consortium Mumbai, as a Scientist (1996-2001) before moving to Max Planck Institute for Solid State Research, Stuttgart as a Guest Scientist (2001-2006) to work in the area of Nano-ionics. Dr. Palani Balaya joined the Faculty of Engineering, NUS as an Assistant Professor in 2007. Since 2014, he works as an Associate Professor at NUS. His research area includes developing lithium-ion battery and sodium-ion battery. He served as a Topical (Battery, Fuel Cell, Capacitor) Editor for Journal of Solid-State Electrochemistry (2013-2017). Elected as an Academician by the World Academy of Ceramics, Italy (2019) and elected as a Fellow of the American Ceramic Society (ACerS) in 2019. Recognized as an ACerS Global Ambassador in 2016, recipient of Global Star Award (2015) from ACerS, Late Shri Har Mahandar Singh Chhatwal Memorial Award (2015) from Indian Ceramic Society etc. He served in Inter-governmental Panel on Climate Change as a Co-ordinating Lead Author for preparing a Special Report on Renewable Energy Sources and Climate Change Mitigation, in 2011. Published 106 articles with h-index of 45 and citations of 9479 (GS).

## Award 2: Sahaj Memorial Lecture

**Dr. Basavaraj S Patil**
Chief Technical Officer, Tiles Division (UAE, India, and Bangladesh)
RAK Ceramics, Dubai

### Title: *Digitalization of Ceramic Manufacturing with Industry 4.0*

In the global economy, ceramic industry is expected to grow at a compound rate of 6.5% by 2025. Across the international markets, Asia Pacific (APAC) countries are subjected to have the bigger role in the growth rate. Further drilling down, as the second largest exporter of the world, India is known to have increased its presence over the course, exporting for first time less than ten years ago.

RAK Ceramics is the leading ceramic solutions provider which is one of the largest manufacturers in the world. Latest products and technologies have always been the priority in enhancing the traditional ways of manufacturing. Digitalizing and automating many manual processes, along with the focus of technology implemented in the products gives a varied portfolio, not only limited to RAK Ceramics but all around the world. Traditional way of manufacturing is currently converted to modern solutions with the help of industrialization and data connection with the upgradation of the machinery to gather the information which in turn helps in decision making. Ceramic Tile manufacturing have variety of processes involved, which consume an high amount of energy which is unavoidable. Hence, to reduce the environmental impact as well as to reduce the cost impact, many energy saving initiatives are implemented around the world, out of which most of them are implemented in RAK Ceramics. Reducing the energy consumption by Co-generation, Energy Waste reduction, Heat recovery and various Machinery Optimization by the team are the areas to name a few.

Further to the latest innovations, trends and energy conservations, another major area of focus is the sustainability factor. Ceramic industry's scope is vast, where majority of the wastes generated can be recycled with proper technology and process improvements in place. In RAK Ceramics, it is an important aspect which we led in recycling almost around ten types of wastes generated from the used water to the damaged fired tiles (whose recycling product can be recycled and reused very minimally).

## Profile

Dr. Basavaraj Patil currently leads the Tiles division as Chief Technical Officer in RAK Ceramics for UAE, India and Bangladesh. Dr. Patil has graduated as a Bachelor of engineering in ceramics and cement technology from Gulbarga university. During his course he worked on "Sintering of Zirconia in Advanced Ceramics" for his academic project. He has begun his career at Modern Insulators as an engineer. He has then joined RAK Ceramics as ceramist and worked in various positions for 14 years and finally positioned himself as Senior Production Manager. He played a vital role in starting porcelain production in RAK ceramics and introduced many innovative products like double layer tiles, biggest size slabs, salt and pepper, soluble salts, double charge, roll feed, chroma and ink jet technology, etc.

In 2010, he completed his master's in M.B.A from Bolton University, U.K, while parallelly working for RAK Ceramics. Later, he joined Kajaria Ceramics as an assistant vice president in India. In his tenure of five years, Dr. Patil's contributions include, introduction of vitrified tiles with digital printing and polishing in several sizes, which were at the time were the defining moment in the industry's market. He is also responsible for significantly introducing larger size and wide range formats in GVT. Led the renovation and modernizing adverse production facilities to profitable units by producing glaze porcelain tiles.

He joined back RAK Ceramics as Vice President in 2016. With the value Dr. Patil has added to the company, he was made the Chief Technical Officer for Tiles. Since his rejoining, he has achieved more appreciation as he was leading in implementing alternative solutions to replace high cost raw materials and zirconium. Under his leadership, RAK Ceramics production facilities as well provides numerous SKUs which are nascent to market with the help of enhanced technologies to produce products like 3d veins, Translucent slabs, Komfi tiles, Anti-microbial tiles under RAK Sanit and new GP products through multiple feeding system producing marble tech product for the first time in the region to name a few. Focussing on circular economy by recycling GP fired tiles through Fired tile crusher. Dr. Patil is also keen on implementing industry 4.0 through IOT, initiated for energy management in one of the plants to go completely digital.

# List of Plenary Lectures

| Number | Name & Affiliation | Title of the Paper |
|---|---|---|
| Plenary Lecture - 1 | Shri Srinivasan Natarajan<br>Deputy General Manager (Sales & Marketing) Prism Johnson Ltd, India | Cost Effective Products & Technologies for Cement Industry from Prism Johnson Ltd |
| Plenary Lecture - 2 | Dr. Manabu Fukushima<br>National Institute of Advanced Industrial Science and Technology (AIST), Japan | Gelation freezing process for advanced engineering porous ceramics |
| Plenary Lecture - 3 | Dr. Anne LericheValencien<br>Université Polytechnique Hauts-de-France, CERAMATHS - Valenciennes (France) | Comparison of different methods of making microporous bioceramic scaffolds |
| Plenary Lecture - 4 | Dr. Amitabha Kumar<br>Boral IP Holdings LLC, USA | Pathways for Sustainable Cement Material |
| Plenary Lecture - 5 | Dr. Suojit Gupta<br>North Dokota University, USA | Greening of Ceramics and Materials Manufacturing: An Analysis via Different Case Studies |
| Plenary Lecture - 6 | Mr. Aakarsh Naidu<br>The Startupreneur ®, London, UK | Start-ups and Entrepreneurship in Ceramics |
| Plenary Lecture - 7 | Prof. R Moreno<br>Institute of Ceramics and Glass, Spain | Synthesis and colloidal processing of Sr-doped lanthanum manganite synthesized by a citrate route |
| Plenary Lecture - 8 | Prof. Bala Vaidhyanathan<br>Loughborough University, UK | Field Assisted Processing of 3D Printed Advanced Ceramics |

## Plenary Lecture- 1

**Shri Srinivasan Natarajan**
Deputy General Manager (Sales & Marketing)
Prism Johnson Ltd, India

### Title: *Cost Effective Products & Technologies for Cement Industry from Prism Johnson Ltd*

Indian cement industry is having a vast growth potential in terms of capacity, production and consumption. In FY 22 the production is expected to increase by approximately 12% or up to 381 MT (million ton). H&R Johnson (India) is offering cement performance enhancer, cement waterproofing chemical and ceramic membrane as a cost-effective solution for growth and better quality of cement.

HRJ make Cement performance enhancer can effectively increase the cement quality, productivity of the cement and significantly decrease the clinker factor which ultimately reduce the $CO_2$ emission. HRJ make cement waterproofing chemical can significantly decrease the water permeability which ultimately improves the durability of the cement structure. HRJ make ceramic membrane can significantly minimise the liquid effluent problem generated in cement industry.

**Profile:**

Mr. Srinivasan in working in Prism Johnson Ltd since last 3 years. He has obtained his B. Tech in Chemical Technology from Anna University and obtained his MBA from Madras University. He has total of 20 years of experience in construction chemicals in India and Abroad. He has worked for Sika, Fosroc and Chryso earlier.

## Plenary Lecture- 2

**Dr. Manabu Fukushima**
Research Scientist (Structural Materials Research Institute)
National Institute of Advanced Industrial Science and Technology (AIST)
Japan

**Title:** ***Gelation Freezing Process for Advanced Engineering Porous Ceramics***

This presentation reviews our advanced gelation freezing process for macroporous ceramic components, that can achieve wide range of porosity from 50 to 98 vol% and various pore configurations such as unidirectional, bridging, bamboo-like, spherical and gradient porosities. This presentation intends to give an overview of distinctive characteristics such as mechanical strength, thermal conductivity, electrochemical performance, and piezoelectric property of the macro-porous components with varied morphology and compositions. In addition, the relationship between the microstructure and mechanical/thermal properties has been discussed using a multiscale modeling technique, in which a homogenization method has been conducted with microscopic models created from three dimensional images, collected by X-ray computed tomography (CT) and stress or temperature distributions in macroscopic samples by finite element method. The simulation results have been well consistent with the experimental results, suggesting that this modeling technique can be thus confirmed to become a strong tool for the prediction of the mechanical or thermal properties of porous ceramics.

**Profile:**

Manabu Fukushima is a group leader at Multi-Materials Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Nagoya, Japan. He has published over 80 papers in peer-reviewed journals, 6 book chapters, holds 34 patents and edited or co-edited 9 books. He has received awards including first prize of ECD ICACC best paper awards (2011), ECD Global Star Award (2014) and Global Ambassador (2017) from the American Ceramic Society, and 21st Century Takayoshi Iseki Award (2015) from the Ceramic Society of Japan, Lee Hsun Young Scientist Award (2017) from Chinese Academy of Sciences, and Minhas Memorial Award (2018) from Indian Ceramic Society.

## Plenary Lecture- 3

**Dr. Anne Leriche-Valencien**
Université Polytechnique Hauts-de-France
CERAMATHS : Valenciennes
France

### Title: *Comparison of Different Methods of Making Microporous Bioceramic Scaffolds*

For many years, bone substitutes have been manufactured from calcium phosphate powders by different methods allowing the production of porous scaffolds having a porosity architecture aimed at being close to the natural bone skeleton. Several processing methods for the preparation of porous ceramics have been tested in our laboratory such as the addition of PMMA sacrificial porogens, freeze casting and 3D fabrication methods. The physical characteristics of the porous scaffolds obtained by such different techniques and the biological responses will be presented and compared. Finally, an original process combining heat treatment assisted by microwaves with an additive manufacturing technique allowing rapid manufacture of customized bioceramics will be presented.

**Profile:**

Professor Anne Leriche received her PhD degree based on thesis work in Engineering ceramics at Mons (Belgium) and at Leeds (UK) universities, with "*summa cum laude"* in 1986. After a brief spell of 1.5 years as a research leader at a ceramic start-up company, specializing in oxide ceramics, she joined the laboratory advanced ceramic materials and processes from the University of Valenciennes ("University Polytechnic of Haut-de- France") and received diploma "Habilitation à Diriger des Recherches" in 1992. She became full professor in 2005. She led the lab from 1999 to 2016, leading numerous researches sponsored by European Union. In her distinguished career, she advised 20 PhD students, authored 208 peer-reviewed research papers and had been co-inventors of 3 patents.

Prof. Leriche's contribution to the National and International ceramic societies started from her early career, as she organized 3 "Ceramic Conferences" in Mons. She served as President of French Ceramic Society (2006-2016), President of ECerS (2013-2015) and President of JECS Trust (2010-2011; 2015-2017). During her Presidency at ECerS, she introduced real breakthrough policies, involving young researchers and industry professionals. She also widened the relationship with other international ceramic societies. She organized a series of ECerS summer schools, since 2013. Prof Leriche is an elected Fellow of the European Ceramic Society and of the American Ceramic Society and World Academy of Ceramics. She also received ECerS Stuijts Award (2017).

## Plenary Lecture- 4

**Dr. Amitabha Kumar (FACerS)**
Vice-President, Innovation and R&D
Boral IP Holdings LLC Dry Creek Way, San Antonio, Texas
USA

### Title: *Pathways for Sustainable Cement Materials*

International efforts are in progress to address reduction in carbon dioxide emissions from cement production and use. The lecture describes various pathways in production and use of cement materials that may result in decreased total $CO_2$ emissions. Strategies to decrease $CO_2$ emissions emanating from Portland cement, by far the most ubiquitous binding material used in construction, are discussed. Use of alternate fuels, raw materials, cement phases, grinding fineness, reaction with water and gases, chemical and mineral admixtures, and concreting practice is described. Concretes derived from known admixtures such as fly ash, slag, and calcined clay is discussed. The potential of new cement materials based on limestone, clay, gypsum and Portland cement clinker based mineral binders is described. Pathways for absorption of carbon dioxide to form non-conventional cementing materials and sequestration in Portland cement concretes, and though use of new cement materials is outlined. Use of packing theories in concrete aggregate and mortar formulations could result in reduced use of Portland cement. Combined use of polymeric materials and fibrous reinforcements to generate new materials could influence the lowering of CO2 emission per unit of built area. Many challenges remain but the excitement of discovery provides inspiration to journey through the search for elusive solutions.

**Profile:**

Amitabha Kumar, has a Ceramics and Materials Science background with an engineering degree from BHU and a doctorate from Pennsylvania State University. In a career spread over 35 years, Amitabha has worked in refractories, building, and food packaging materials, focusing on innovative developments for betterment of environment and sustainability.

## Plenary Lecture- 5

**Dr. Suojit Gupta**
Associate Professor
Department of Mechanical Engineering, University of North Dakota
USA

### Title: *Greening of Ceramics and Materials Manufacturing – An Analysis via Different Case Studies*

Ceramics based materials are important for different types of structural and functional applications. For manufacturing perspective, ceramics manufacturing is often time consuming and energy intensive. There is a critical need for "greening" of ceramics manufacturing. In this presentation, I will discuss different approach of greening of ceramics manufacturing via different case studies. We will also have a discussion on these methods from entrepreneurship perspective as well which underlies the importance of valorisation of different types of underutilized resources. A comparison of different types of manufacturing technologies will be presented. It is expected that these novel technologies can be commercialized for further development.

**Profile:**

Dr. Gupta is an Associate Professor of Mechanical Engineering in the University of North Dakota. Dr. Gupta has published over 50 technical papers, 5 patents, and has given over 20 invited/keynote talks and over 70 contributed presentations in several international, national and local conferences. Previously, Dr. Gupta was employed in The Rutgers University. Prior to that, he was a postdoctoral fellow in The Pennsylvania State University. Earlier, Dr. Gupta finished his doctoral studies from Drexel University. Dr. Gupta also has MBA from University of Massachusetts, Amherst. Dr. Gupta has won several awards like Dean's Award for the Best Faculty (2016), Dean's Teaching Professorship (2-18-20), Global Young Investigator (ECD, ACerS, 2016), ASM/IIM Lectureship (2016), Du Co Ceramics Award (2019), TMS Functional Materials Division Young Leaders Professional Development Award (2019) etc. Dr. Gupta is also a passionate educator and has supervised several graduate theses.

## Plenary Lecture- 6

**Mr. Aakarsh Naidu**
The Startupreneur ®
(London School of Economics & Political Science)
London, United Kingdom

### Title: *Start-ups and Entrepreneurship in Ceramics*

The Ceramics and Cement industry has traditionally been driven by manufacturing and distribution. With the emergence of startups, there has been a rise of new business models and advanced manufacturing techniques. In this session, we will uncover startup opportunities in the ceramics and cement industry and how to tap them.

**Profile:**

Aakarsh Naidu is an alumnus of the London School of Economics (LSE), Global Startup Enabler, and Founder of the UK based venture Startupreneur®. He has been in charge of one of India's Top Startup Incubators - NSRCEL at IIM Bangalore and briefly led the Startup Programs for Facebook in India and South Asia before starting his venture. Aakarsh has been on the advisory/jury panel of the Global Startup Awards, Small Enterprise Business Awards, Startup Karnataka's Elevate 100 and also participated in the unveiling of the Startup India Action Plan in Delhi. He is a mentor at The Founder Institute, World Resources Institute (WRI), IB Hubs and Catalyst for Women Entrepreneurs (CWE). His venture Startupreneur has been selected as one of the Innovative Startups under the London Mayor's International Business Programme - 2021.

## Plenary Lecture- 7

**Dr. Rodrigo Moreno**
Research Professor
Institute of Ceramics & Glass (CSIC), Madrid
Spain

**Title:** ***Synthesis and Colloidal Processing of Sr-doped Lanthanum Manganite Synthesized by a Citrate-route***

Sr-doped lanthanum manganites (LSM) have being largely studied due to their excellent electrical and magnetic properties, which make them suitable for applications in surgery, energy, chemistry and magnetism. One extended application of LSM is as cathode material in solid oxide fuel cells (SOFCs). Some effort has been done to develop accurate synthesis methods to obtain homogeneous powders with tailored shape, size and surface area. However, not always the controlled synthesis is accomplished by a reliable processing strategy. The aim of this work is twofold. Firstly, the study of the synthesis parameters to produce nano-meter sized particles of $La_{0.80}Sr_{0.20}MnO_3$ by a citrate route, and secondly, the preparation and optimization of LSM aqueous suspensions for the manufacture of semi-cells of LSM onto YSZ substrates. In addition to the complete characterization and thermal behaviour of the starting powders, their colloidal processing and the co-sintering of the semi-cells is studied. Porous LSM layers of 60-85 nm were obtained by dipping onto YSZ substrates produced by tape casting. Sharp interfaces were obtained without diffusion of Zr and Y and slight diffusion of La and Mn in the YSZ layer.

**Profile:**

Rodrigo Moreno is Research Professor at the Institute of Ceramics & Glass (CSIC, Spain). PhD in Chemistry (1988). He has co-authored more than 400 papers (320 in ISI journals), 9 patents, several book chapters, and two books. He is member of the Spanish, the Portuguese and the American Ceramic Societies, Fellow of the European Ceramic Society and member of the World Academy of Ceramics. He is Vice-president of the Spanish Society of Materials and member of the Executive Board of FEMS.

## Plenary Lecture- 8

**Prof. Bala Vaidhyanathan**
Department of Materials
Loughborough University
United Kingdom

**Title: *Field Assisted Processing of 3D Printed Advanced Ceramics***

The processing of advanced functional ceramic powders and suspensions into useful engineering components has been investigated via a series of research projects each focusing on a different stage of the manufacturing route viz., (i) the ability to control the agglomerates present in the ceramic powder resulting in the production of a free-flowing and crushable powders, (ii) the formation of low viscosity but high solids content nanoceramic suspensions suitable for 2D and 3D additive layer manufacturing (3D printing) and (iii) the use of novel field assisted sintering techniques (FAST). This holistic approach helped to transfer the developments achieved in each stage of the manufacturing process to the next and resulted in the ability to form fully dense advanced ceramic components whilst restricting the grain growth to a minimum. The methodology has been employed to develop various advanced functional ceramic components such as 3D printed $BaTiO_3$ based light-weight PTCR heaters for automotive and aerospace applications that surpasses existing commercial counterparts, ultra-low loss microwave dielectrics for beyond 5G communication devices, additively manufactured (AM) zirconia based biomedical components exhibiting vastly superior hydrothermal ageing resistance and mechanical performance suitable for use in biomedical implants (eg., hip/knee prosthesis, finger joints, dental and jaw repairs), petro-chemical valve parts as well as for ballistic armour applications. Significant sustainability advantages were noted with AM compared to conventional subtractive manufacturing methods in terms of reduction in material wastage and process efficiency. 3D printing of hydrothermally immune nanostructured dental implants was regarded as one of the six best modern technological developments in materials science by a BBC documentary (Materials of the Modern Age: The Secret Story of Stuff). These novel advancements are covered by a series of patents and papers and this talk will provide an overview of some of these developments.

**Profile:**

Vaidhyanathan is a Professor of Advanced Materials and Processing, current Associate Dean for Enterprise (ADE) of the School of Aeronautical, Automotive, Chemical and Materials Engineering at Loughborough University (LU), member of the School Senior Management Team (SSMT), and member of the advisory team of university's research challenges. Previously he has been a member of the research staff at the Pennsylvania State University, USA, and a Lead Scientist at General Electric-Global Research Corporation. He specializes in nanostructured functional materials and non-conventional field assisted processing. He has published over 200 peer-reviewed articles, 6 book chapters, and holder of 17 patents. Vaidhyanathan has pioneered the development of additive manufacturing of advanced ceramics, energy efficient microwave, hybrid and flash methods for the advanced processing of functional ceramic materials.

# List of Invited Talks

| ID | Name & Affiliation | Title of the Paper |
|---|---|---|
| **Technical Session 1: Innovative Processing of Ceramic Materials & Glass** | | |
| Invited Talk– S1I1 | Mr. Sitendu Mandal<br>CSIR-CGCRI, Kolkata<br>India | Specialty Glass: Sustainable Development for Strategic Applications and Technology Commercialization |
| Invited Talk– S1I2 | Dr. Saurabh Kapoor<br>Sterlite Technologies Ltd.<br>Aurangabad, India | Indentation Behavior Oxide Glasses Densified at Elevated Temperature |
| Invited Talk– S1I3 | Dr. Roy Johnson<br>ARCI, Telangana<br>India | Transparent Polycrystalline Ceramics: Processing & Applications |
| **Technical Session 2: Refractory Materials & Applications** | | |
| Invited Talk– S2I1 | Mr. Harsh Joshi<br>JSW Steel, Mumbai<br>India | Reduction in Carbon Pick-Up from Refractory for Producing Special Steel |
| Invited Talk– S2I2 | Mr. Surendra Mishra<br>Marvel Refractories (Anshan) Co Ltd. | Rotary slag corrosion tests on cement bricks for high Sulphur AFR |
| Invited Talk– S2I3 | Mr. Rajeev K Laharia<br>Caldreys, Paris<br>France | Calderys Innovative Solution For Cement Plants using AFR - Nano Bonded "Supramon" |
| **Technical Session 3: Special session on Cement: Materials & Manufacturing issues** | | |
| Invited Talk– S3I1 | Mr. Basavaraj Shiggavi<br>FLSmidth<br>Chennai, India | Sustainability -Zero Emission for cement Industry |
| Invited Talk– S3I2 | Prof. Balaram Sahoo<br>Materials Research Centre<br>IISc- Bangalore, India | Effect of Fly Ash and CNT on Setting Mechanism and Strength of Commercial Cements: A Chemical Approach |
| Invited Talk– S3I3 | Prof. Pranab Das<br>ACS College of Engineering<br>Bangalore, India | Preparation and properties of Geopolymer |

| | | |
|---|---|---|
| Invited Talk– S3I4 | Mr. Biswajit M Patra<br>TATA Steel | Utilization of LD Slag in Portland Slag Cement Manufacturing |
| Invited Talk– S3I5 | Mr. M Kadhirvelu<br>Murugappa Morgan Thermal Ceramics Ltd., Tamilnadu | Sustainability through Advanced Insulation in Cement Industry |
| Invited Talk– S3I6 | Mr. Vivek Kumar Katgi<br>Ultratech Cement | The sustainable Refractory solutions- the need of Cement Industry |
| **Technical Session 4: Engineering Ceramics, Structural Ceramics and Coatings** | | |
| Invited Talk– S4I1 | Dr. Arjun Dey<br>URSC, ISRO<br>Bangalore, India | Reversible Phase Transition of Vanadium Oxides-Titanium Oxide Thin Films for Smart Radiative Device (SRD) for Spacecraft Application |
| Invited Talk– S4I2 | Dr. Shivasharanappa V Gubbewad<br>PDA College of Engineering<br>Gulbarga, Karnataka | Analysis of experimental wear data of materials and ceramic based composites from literature by validation of wear model equations |
| Invited Talk– S4I3 | Dr. V Auradi<br>Siddaganga Institute of Technology,<br>Tumkur, Karnataka | Influence of Ceramic B4C Particulate Addition on Characterization, Tensile Fractography and Wear behavior of 6061Al Alloy Matrix |
| **Technical Session 5: Advanced Functional Ceramics, Nanomaterials & Biomaterials** | | |
| Invited Talk– S5I1 | Prof. Bikramjit Basu<br>IISc- Bangalore, Karnataka<br>India | Biomaterials and Implants in India: Current Status and Recommendations |
| Invited Talk– S5I2 | Dr. Rishi Gupta<br>Application Specialist<br>Anton Paar | Characterization of various attributes in ceramic and cement samples |
| Invited Talk– S5I3 | Prof. J Manjanna<br>Rani Channamma University,<br>Belagavi, Karnataka | Smectite clay minerals in the geological disposal of high-level waste, and conventional applications as solid acids |
| **Technical Session 6: Ceramics for Energy and Environment** | | |
| Invited Talk– S6I1 | Dr. Thomas Kodenkandath<br>Hazen Research Inc., USA | Improved Manufactring Method for the Production of Ni- rich NMC Cathodes for Advanced Li-Batteries |
| Invited Talk– S6I2 | Dr. Aruna S T<br>NAL, Bangalore<br>India | Reversible Solid-Oxide Fuel Cells for Green Hydrogen Generation: Present Status and Future Prospects |

| Technical Session 7: Special session on Entrepreneurship & Start-up | | |
|---|---|---|
| Invited Talk– S7I1 | Mrs. Jayalakshmi<br>Universe Power Systems | Dream Big & Grow with MSME Schemes |
| Invited Talk– S7I2 | Mr. Sathish Chitwadgi<br>Sinter Cera Kraft LLP | Entrepreneurship opportunities in Ceramic Tile Industry |
| Invited Talk– S7I3 | Mr. Sabyasachi Roy<br>Director<br>ANTS Ceramics Pvt. Ltd. | Lab to Production: Scale up story of ANTS Ceramics |
| Invited Talk– S7I4 | Dr. Prakash Mugali<br>Enerzi Systems | How do you start your Tech Company? |
| Invited Talk– S7I5 | Mr. Mahesh Shastri<br>Co-founder, CFO<br>Re-Batt Energy Solutions Pvt. Ltd. | Innovative Start-up on Lithium-ion Battery Processing and Assembling |
| **Technical Session 8: Raw Materials & Manufacturing** | | |
| Invited Talk– S8I1 | Mr. Gary Laymath<br>IMERYS- Performance Minerals Asia Pacific | Kaolin- A story beyond whiteness and particle size |
| Invited Talk– S8I2 | Mr. Shankha Chatterjee<br>ALMATS Alumina Pvt Ltd<br>Kolkata, India | Developments in synthetic alumina towards sustainable growth in coming decades |
| Invited Talk– S8I3 | Dr. Shyam S Rao<br>CUMI | Advanced Ceramics- Manufacturing Processes and Applications |

## Invited Talk- S1I1

**Mr. Sitendu Mandal**
Chief Scientist & Head
CSIR-CGCRI, Kolkata
India

**Title: *Specialty Glass- Sustainable Development for Strategic Applications and Technology Commercialization***

Two important technologies on Specialty glasses namely high density (5.2 g/cc) Radiation Shielding Window (RSW) glass derived from $PbO$-$SiO_2$-$K_2O$ ternary system and Specialty Borosilicate Glass Beads comprising $SiO_2$-$B_2O_3$-$Na_2O$-$Fe_2O_3$-$TiO_2$ with minor impurity of chloride and sulphate (< 200 ppm) have been successfully developed in CGCRI with an aim to meet the growing requirement under Nuclear Energy Programme in the country.

**Profile:**

Mr. Sitendu Mandal, currently the Chief Scientist and Head, Specialty Glass Division, CSIR-Central Glass and Ceramic Research Institute, Kolkata obtained his B. Sc and M. Sc Degree in Chemistry from VISVA BHARATI, Santiniketan, Bolpur, West Bengal. He has more than 32 years of research experience in different fields of specialty glass technology and ceramics. His major research area is to develop specialty glasses to meet the strategic need of the nation and study glass chemistry. He is the key person for indigenous production of Radiation Shielding Window (RSW) Glasses and Specialty Borosilicate Glass Bead for nuclear waste immobilization in DAE's three stage waste disposal programme in the country. He has taken an ambitious target to produce the whole ranges of utilizing the specialty refractory crucible technology through bottom pouring flow cast technique.

He has successfully completed many research projects as principal investigator sponsored by Govt. agencies as well as leading industries. He has published 15 papers in national and international journals and conference proceedings and filed 4 patents in India.\ He is the recipient of many awards of National Repute such as NESA Fellowship of the Year Award 2021 by National Environmental Science Academy, D. N. Agrawal Memorial Award – 2021 by The Indian Ceramic Society, Gopal Chandra Bhattacharyya Memorial Award by the Science Association of Bengal in 2021, the prestigious CSIR-Technology Award (2018), "Certificate of Merit – 2017 under CSIR Technology Award from Honorable President of India, SKOCH Order of Merit Award (2017), NRDC Meritorious Innovation Award 2013, Malaviya Award (2004) by The Indian Ceramic Society, CSIR-DAAD Fellowship for the year 1994-95, Institutional Best Technology Awards, Fellow of Indian Institute of Ceramics (IIC), Fellow of West Bengal Academy of Science and Technology (WAST).

## Invited Talk- S1I2

**Dr. Saurabh Kapoor**
Head, Glass Research- Optical Fibers
R & D, Sterlite Technologies Ltd., Maharashtra
India

### Title: *Indentation Behavior Oxide Glasses Densified at Elevated Temperature*

Densification of oxide glasses at elevated temperature (so-called hot compression) offers a novel route to develop glasses with tailored properties for emerging applications and to acquire better understanding of the pressure-induced changes in the glass structure and densification mechanisms during deformation, e.g., during sharp contact loading. Here, we will focus on the insights gained in the understanding of the influence of hot compression on the composition–structure–property relationships of oxide glasses. The structural response of oxide glasses is analyzed through both Raman and NMR spectroscopy, while the mechanical properties are investigated using Vickers micro-indentation. The magnitude of the changes in all macroscopic properties (e.g., density, hardness, and crack resistance) is found to correlate well with the pressure induced structural changes in the glasses. We show that the structural changes depend largely on the type of network former, the coordination number distribution of network formers, the number of non-bridging oxygens, and the packing efficiency in the glasses.

**Profile:**

Dr. Saurabh Kapoor received his B.S. (Hons.) Physics in 2009 and M.S. (Hons.) in Physics in 2011 from Department of Physics, GNDU. He obtained his Ph.D. in Materials Science and Engineering from University of Aveiro, Portugal in 2014. At present he heads glass research – Optical fibers at Sterlite Technologies Ltd., Aurangabad, Maharashtra. Prior to joining Sterlite Technologies Ltd, Dr. Kapoor has worked as a postdoctoral researcher at Aalborg University, Aalborg, Denmark and at Rutgers University, New Jersey, USA. Dr. Kapoor is an author/Co-author of 25 research articles in the field of glass science. Dr. Kapoor is also a member of TC-04 (Biomedical Glasses) and TC-20 (Photonic glasses and optical fibers), at International Commission on Glass (ICG).

## Invited Talk- S1I3

**Dr. Roy Johnson**
Scientist G & Associate Director
ARCI, Telangana
India

**Title: *Transparent Polycrystalline Ceramics: Processing & Applications***

Transparent ceramic materials are a new class of advanced materials exhibiting excellent optical and mechanical characteristics attracting much attention in strategic and civilian applications especially in harsh environments. Recent advances in defect free ceramic processing techniques offer the flexibility in engineering the optical properties of transparent ceramics with tailored microstructures of achieving close to theoretical transparency. Currently, the demand for the poly crystalline ceramics is also growing due to their versatility in fabrication and lower cost of production in comparison to single crystals. The candidate ceramic systems, which are in use, for applications includes polycrystalline submicron alumina ($Al_2O_3$), aluminium oxynitride (AlON), spinel ($MgAl_2O_4$) and zinc sulphide (ZnS) ceramics. The experience of the author, at ARCI in the development of Zinc sulphide through chemical vapour deposition (CVD) and spinel though powder metallurgy (PM) route followed by hot isostatic pressing (HIP) will be during the proposed presentation.

**Profile:**

Dr. Roy Johnson was awarded the PhD degree from university of Nagpur for the research carried out on "Ceramic Honeycomb Structures for Air Pollution Control" at National Environmental Engineering Research Institute, (CSIR-NEERI) Nagpur. He has joined ARCI, in 1994 and worked in various capacities and led several research projects in the area of advanced ceramics, transparent ceramics, cellular ceramics chemical vapour deposition and Isostatic Pressing. Currently, He is Associate Director, ARCI, for three major centers of excellence namely ceramic processing, non-oxide ceramics and sol-gel based nano-composite coatings. He has 104 research publications in international Journals and 11 Indian patents for his credit and co-authored one book and two book chapters. He is a Fellow of Indian Institute of Ceramics and Fellow of Institution of Chemists and also a member of several Indian and International professional bodies. He is also the recipient of awards including MRSI medal 2012 (Materials Research Society), ARCI Technology award 2012 and Pandit Madan Mohan Malaviyaji award (Indian Ceramic Society- 2011).

## Invited Talk- S2I1

**Mr. Harsh Joshi**
Deputy General Manager (Refractory), JSW Steel Ltd.
Toranagallu, India

**Title: *Reduction in Carbon Pick-Up from Refractory for Producing Special Steel***

IF & Electrical Grade Steel are special category steels having high cleanliness & extreme low carbon requirement (<30 ppm). Steel making process involves various additions, changing of vessels, mixing & prolonged contact with refractory surfaces which results in inclusions & carbon pickup during the process, which result in higher composition diversions & lower yield. Many process changes introduced helped in improving the cleanliness of Steel but the carbon pickup of 7-10 ppm between RH & cast slab was perennial issue in these grades. Detailed study was carried out to map the carbon variation in process & all process variables where characterized to identify the source of carbon pick-up. It was found that pick-up is primarily from ladle refractory, tundish refractory & casting powders. Ladle refractory was changed from MgO-C to Alumina Spinel zonal wise. Tundish spray was changed & low carbon casting was used for Ultra low carbon steel. These changes resulted in carbon pick up by 6-8 ppm & diversions from 10 to 1% in these grades.

**Profile:**

Mr Harsh Joshi is graduated from PDA college of Engg under VTU in Ceramics and Cement technology in the Year 2003 .He got campus selected in M/s NITCO Tiles. From 2003 Dec to till date he is working in M/s JSW steel Ltd Bellary. Presently working as DGM Refractory In JSW steel Ltd. Over 18 years of rich exp Mr Harsh Joshi did many technical contribution in the field of refractory .Some of important contribution in the field of refractory were the Steel ladle new product development of Alumina Spinel instead of MgO C and RH Refractory life enhancement .Over 17 National Level papers was published and 2 international Level papers were published by Mr Joshi . Very active Member of ICS K in Sub regional committee also in IIM vijaynagar Chapter. Harsh Joshi has been awarded as “MAN OF STEEL AWARD from M/s Boston Consulting group in project Leap” also “Young Metallurgist of the year 2019” under IIM Vijay agar Chapter.

## Invited Talk- S2I2

**Mr. Surendra Mishra**
MARVEL Refractories (Anshan) Co Ltd. (MRL)
China

**Title:** ***Refractory Products for Cement Industry***

Presentation introduces MRL products for Cement Industry. Presentation talks about the different types of magnesia, Spinel Flexibilizers, addresses the issue of refractory selection in view of ever-increasing use of AFR usage. Presentation also focuses on Quality Management System used in MRL to ensure the best quality refractory products are supplied to its customers.

**Profile:**

Value oriented, customer-focused global sales executive with over three decades of sales, marketing, product management experience with leading refractory producers. Keen understanding of refractory needs for cement, steel, nonferrous and other high-temperature processing industries. Mr. Mishra has Master of Sciences in Metallurgical Engineering from Georgia Institute of Technology in Atlanta and undergraduate degree from BITS Pilani.

## Invited Talk- S3I1

**Mr. Basavaraj Shiggavi**
Head of project services Cement & Mining
FLSmidth
Chennai, India

### Title: *Sustainability - Zero Emission for cement Industry*

Cement is one of the most consumed products globally – second only to water. And the demand will only increase in the future as a consequence of rapid urbanisation and growing populations. The industry would increase its direct emissions by 4% globally, with a corresponding increase of 12% in global cement production by 2050.

Producing approximately 7% of the world's $CO_2$ emissions, the sector can significantly contribute to the ambition of the Paris Agreement to limit global warming to well below 2 °C. With limited alternatives to cement that currently can reach significant scale, a key focus is to accelerate the ongoing sustainable transition of the cement industry through innovation in low-emission technologies. As a technology leader, FLSmidth have always been in the business of helping our customers produce cement more productively and sustainably. And with the launch of MissionZero, FLSmidth are accelerating solutions to help our cement customers towards the zero-emission cement plant.

With Mission Zero, we will deliver solutions that make it possible to operate zero-emissions cement plants and manage zero-emissions mining processes. Achieving the goals by 2030 requires a paradigm shift in collaboration, innovation and adoption of new technology in the industries.

## Invited Talk- S3I2

**Prof. Balaram Sahoo**
Materials Research Centre
IISc- Bangalore, India

**Title:** ***Effect of Fly Ash and CNT on Setting Mechanism and Strength of Commercial Cements: A Chemical Approach***

The phase transformations in Portland cement, before and after hydration, will be discussed in detail by using a full Rietveld refinement of the X-ray diffraction (XRD) patterns, Fourier Transformed Infra-Red (FTIR) spectroscopy, Thermogravimetric Analysis (TGA) and Mössbauer spectroscopy at room temperature. From the Rietveld refinement of XRD data, alite, belite, celite, brownmillerite and low quartz phases were detected and quantified as major phases in dry cement powder. After hydration, calcium carbonate, portlandite and ettringite phases were found to form. A large reduction in the amounts of alite and belite phases were observed suggesting the formation of amorphous C–S–H phase and emphasizing the role of alite phase in flash setting of cement, as justified by the XRD and FTIR spectroscopy. Mössbauer spectra of all the unset samples showed quadrupole split doublets corresponding to the brownmillerite phase which remains unchanged even after about one week of hydration, suggesting that brownmillerite did not transform to other phases during initial stage of hydration process. Furthermore, the chemistry and mechanism of mechanical strength development at different setting-times in different weight-ratios of proclaimed commercial-cement and fly-ash mixture is studied. The main content of fly-ash is quartz (SiO2). According to our results, as the setting time increases, the quartz present in fly-ash gets utilized during the setting of the cement to form the well-known C-S-H gel ($3CaO.2SiO_2.3H_2O$). Our analysis suggests that the addition of fly-ash reduces the water requirement for the hydration process. Furthermore, the fly-ash inhibits the formation of $CaCO_3$ phase from portlandite ($Ca(OH)_2$) through atmospheric $CO_2$, and more importantly, it promotes the transformation of portlandite to form the C-S-H network, which provides strength and long term stability to the set cement. As the commercial cement already contains the optimum amount of fly-ash, any further addition of fly ash leaves the fly-ash partially unreacted, which drastically decreases the compressive strength. Further studies on the effect of CNT addition, on the strength and long term stability to the set cement will be discussed.

**Profile:**

Dr. Balaram Sahoo obtained his M. Sc. (Physics) degree from Utkal University, Bhubaneswar, and M. Tech (Met. Engg.and Mat. Sc.)degree from IIT Bombay, Mumbai. He received his Ph.D. (Natural Sciences) in the year 2006, from University of Duisburg-Essen, Duisburg, Germany. He worked as a post-doctoral scientist (Environmental Science) at the Swiss Light Source, Paul Scherrer Institute, Villigen PSI, Switzerland. He, also, worked as a post-doctoral scientist (Photon Science) at PETRA III, in Hamburg Synchrotron Radiation Laboratory (HASYLAB), Hamburg, Germany. He has been a faculty member of MRC, IISc., since 2012. His Research area broadly focuses on: Nanomaterials synthesis, properties and devices, Nanoparticles, thin films, multilayers and hybrid structures, Structural, magnetic, electronic, electrical transport, optical, vibrational, thermal, mechanical and the coupled properties, Data storage devices, magnetic sensors, piezoelectric sensors and actuators, Thermoelectric and magnetoelectric devices, Surface and interface science, nanomagnetism, Photon Science.

## Invited Talk- S3I3

**Prof. Pranab Das**
Visiting Professor, ACS College of Egineering
Bangalore, India

**Title: *Preparation and Properties of Geopolymer***

High performance concrete (HPC); the durability and strength of such concrete have been discussed widely in many forums. However, due to the restriction of the manufacturing process and the raw material qualities, along with some inherent disadvantages of Portland cement, it is costly. The environmental issues associated with the production of OPC with release of carbon dioxide during manufacture of OPC resulting from calcination of limestone, clay and combustion of fossil fuel is in the order of one ton for every ton of OPC produced and the extent of energy required to produce OPC is only next to the energy required to produce steel and aluminum. In geopolymer preparation. when used as a partial replacement of OPC, in the presence of water and in ambient temperature, fly ash and granulated blast furnace slag(GGBS) reacts with the calcium hydroxide during the hydration process to form complex calcium silicate hydrate (C-S-H) gel. Abundant availability of fly ash worldwide creates opportunity to utilize this by-product produced from burning coal, as a substitute for OPC to manufacture green cement products. The geopolymer technology proposed by Davidovits gives considerable promise for application in concrete industry as an alternative binder to the Portland cement. In terms of reducing the global warming and carbon footprint the geopolymer technology can reduce the $CO_2$ emission in the atmosphere around 80%. In this technology, the source material that is rich in silicon (Si) and Aluminum (Al) is reacted with a highly alkaline solution through the process of geopolymerisation to produce the binding material. The term “geopolymer describes a family of mineral binders that have a polymeric silicon-oxygen-aluminum framework structure, similar to that found in zeolites,. The polymerization process involves a substantially fast chemical reaction under highly alkaline condition on reaction with Si-Al containing minerals that result in a three dimensional polymeric chain and ring structure consisting of Si-O-Al-O-H bonds. Geopolymer concrete is emerging as a new environmentally friendly construction material for sustainable development, using flash and alkali in place of OPC as the binding agent. To bring down the cost use of calcium in place of alkali is tried which is a subject of research as regards development of strength and other associated properties This attempt results in two benefits. i.e. reducing $CO_2$ releases from production of OPC and effective utilization of industrial waste such as flash, slag, mines waste etc. Research on utilization of uther si-al containing waste materials like mines waste municipal waste inceranation , rice husk ash etc are being tried in various research articles.

**Profile:**

Dr. Pranab Das is a material scientist and holds Ph.D from University of Mumbai while working at Bhaba Atomic Research Center, India from 1967-1982. From 1983-2003 he worked in Research and Development Center, Steel Authority of India in R&D Division Later he joined educational institutes and presently with ACS College of Engineering, Bangalore, India.

## Invited Talk- S3I4

**Mr. Biswajit M Patra**
Technologist, Process Technology Group
TATA Steel

**Title: *Utilization of LD Slag in Portland Slag Cement Manufacturing***

LD slag is a by-product of steel making process. Ensuring 100% utilization of LD slag in a green and sustainable way has been a major challenge for the steel industries. Cement manufacturing by using natural resources is also a major sustainability challenge in terms of CO2 emission and rampant use of natural resources. To address these challenges LD slag is explored as a blending material for PSC manufacturing.

To achieve this objective exhaustive study conducted on manufacturing of Portland slag cement by utilizing LD slag as partial replacement of BF slag in (8-15) % range satisfying all the conditions of IS 455:2015. This composite slag is used maximum up to 60% in the PSC making. The prepared PSC samples are characterized in terms of all the property requirement as per IS 455. The PSC samples are used to prepare M20 and M40 grade concrete and fresh properties, hardened properties and durability properties of concrete mixes are evaluated. It was found that PSC samples prepared using LD slag are satisfying all the standard and are compared to control samples where only BF slag is used as a blending material.

The study concluded that LD slag can be used for making PSC as one of the blending materials along with granulated blast furnace slag. The composite slag (LD+BF slag) can have LD slag up to 15% of total slag and such composite slag can be used up to 60% in PSC manufacturing. Successful implementation of this work will lead to reduction in greenhouse gas emission and conservation of natural resources.

**Profile:**

Working as Technologist, Process Technology Group, Tata Steel. Currently working on ensuring sustainability and value maximization in the areas of by-products generated by steel industry. Previously also worked in the areas of development of new materials etc. He holds a bachelor's degree in Ceramic Engg. From NIT Rourkela and master's degree in Materials Science & Engg. from IIT Kharagpur.

## Invited Talk- S3I5

**Mr. M Kadhirvelu**
Murugappa Morgan Thermal Ceramics Ltd.
Chennai, Tamilnadu
India

**Title: *Sustainability through Advanced Insulation in Cement Industry***

Two major challenges faced by every industry to sustain their operations is Conserving the energy and Preserving the environment. Selection of proper thermal insulation addresses the above challenges. This paper gives the advantages of using environment friendly bio persistence–Superwool range of products and Microporous insulation for Cement Industry. This will help the industry to reduce the energy consumption and reduce emission of green house gases to preserve the environment in their waste recovery boiler and other equipments.

**Profile:**

Mechanical Engineer having over 29 years of experience in Project Management, Business Development, Sales & Marketing in Refractories and Thermal Insulation field. Out of 29 Years, 26 Years with Morgan India handling key and challenging furnace projects related to Core Industries – Iron & Steel from Coke Ovens to Galvanising/Special furnaces), Ceramics (Shuttle & Tunnel Kilns), Power (HRSG/Pipe Insulation) right from Design Engineering to Execution.

## Invited Talk- S3I6

**Mr. Vivek Kumar Katgi**
AGM, TPMC- Refractory Planning and Budgeting
Ultratech Cement, Mumbai

**Title:** ***The Sustainable Refractory Solutions- The Need of Cement Industry***

This presentation mainly focuses on the following objectives

(i) What is suitability & why it is important?
(ii) About global & India's cement market
(iii) About UltraTech cement
(iv) Brief introduction of cement manufacturing
(v) Refractory selection & application for cement industry
(vi) Refractory wear phenomena in cement industry
(vii) UltraTech's actions towards sustainable refractory solutions

**Profile:**

Mr. Vivekkumar V Katgi, AGM(TPMC), UltraTech Cement Ltd, Mumbai Presently heading Group's Refractory and responsible for Refractory planning & budgeting, refractory life enhancement by new innovations, cost optimisation and to improve plants reliability by minimising refractory issues.

## Invited Talk- S4I1

**Dr. Arjun Dey**
URSC, ISRO
Bangalore, India

### Title: *Reversible Phase Transition of Vanadium Oxides-Titanium Oxide Thin Films for Smart Radiative Device (SRD) for Spacecraft Application*

Thermal management of spacecraft is an essential part in spacecraft performance and its life duration. Generally, spacecrafts encountered with large temperature variation in space from +150 to -150 °C. Hence, efficient thermal control system is necessary to maintain the temperature of all the internal components such as battery, electronic packages etc to desired temperature limits. At present various thermal control elements are used in spacecraft for this purpose, these systems includes both active elements and passive elements. The active elements generally required electric energy to perform its function, these includes heaters, coolers. Passive elements like radiating surface etc. to regulate the radiation heat transfer at space. However, the new demands in advance satellite such as higher functional densities, longer mission life, more-efficient, cost-effective, reliable etc resulting in requirement of more advance thermal control systems. In this perspective passive smart radiative device (SRD) represents very promising approach to achieve an energy-efficient thermal control of satellite because its variable emittance passively adapts to the external temperature. Vanadium oxides are one of the best candidates for thermochromic applications like SRD, which undergo smart transition at transition temperature near to room temperature. Aforesaid smart reversible phase transition results in favourable alter in properties such as optical transmittance, IR emittance and electrical resistivity. These changes in functional properties are primarily due to an insulator/semiconductor to metallic transition (IMT or SMT). In the present work, RF magnetron sputtering technique is utilized to grow vanadium oxide-titanium oxide nano-composite thin films of various thicknesses. Thin films are grown on both optically opaque + low emittance and transparent+high emittance substrates such as aluminized quartz and bare quartz glass substrates respectively. The thicknesses of deposited films were measured by profilometry technique. X-ray diffraction (XRD) analysis revealed crystalline peaks of various phases of vanadium oxides ($VO_2$, $V_2O_3$, $V_2O_5$) and titanium oxides. Further, X-ray photo election spectroscopy (XPS) studies are carried out to analyze the oxide states of the films. XPS shows the quantity measurement of the oxides phases present in the thin films. Phase transitions of the deposited films were investigated by the differential scanning calorimetric (DSC) technique. The reversible i.e. smart transition for thin films was observed in the region of 45 to 50 °C.

**Profile:**

Dr. Arjun Dey is presently working as Scientist at U. R. Rao Satellite Centre, Indian Space Research Organisation (ISRO), Bangalore. As CSIR-SRF, he had completed the doctoral research works from CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata and received the formal PhD degree in Materials Science and Engineering from Indian Institute of Engineering Science and Technology (IIEST), Shibpur. The research work of Dr. Dey culminated about 128 in Peer Reviewed SCI & Scopus indexed journals publications including from 'Nature Group'. He has Co-authored 3 books from CRC Press/Taylor & Francis. He has already co-guided 3 PhD. (one of the PhD students received prestigious 'Humboldt Fellowship'), 4 ongoing PhD and 14 M.Tech. students. Dr. Dey serves as the 'Guest Editor' for 'Ceramics International' Journal for twice the reviewer of more than 60 different peer reviewed SCI journals. He obtained many prestigious awards such as: "N. S. Satya Murthy Memorial Award" from Indian Physics Association in 2019, "Satellite Technology Day Award-2018" (2 Categories-Technical Paper and Innovative Idea - 'Spark') from URSC/ISRO in 2018,, Dr. R. L. Thakur Memorial Award" from The Indian Ceramic Society in 2012, "DST-Fast Track Young Scientist Scheme Project Grant Award" from DST, Govt. of India in 2011, "Young Engineers Award" from The Institution of Engineers (India) in 2011, Metallurgical and Materials Engineering Division Prize from The Institution of Engineers (India) (2 times) in 2015 and 2011 and "CSIR-Senior Research Fellowship" from GoI in 2009.

## Invited Talk- S4I2

**Dr. Shivasharanappa V Gubbewad**
Department of Automobile Engineering
PDA College of Engineering
Gulbarga, Karnataka

**Title: *Analysis of Experimental Wear Data of Materials and Ceramic-Based Composites From Literature by Validation of Wear Model Equations***

Ceramic Based composites generally consist of ceramic fibers, bonding agents, filler materials in a matrix. Typically, ceramics are made metal oxides such as alumina (aluminum oxide) as well as carbides such as silicon carbide. The application of ceramics based composites in performance engineering components like brake pads, bearings, aerospace turbine blades, nuclear reactor, fuel rods, sealant etc have major advantages of ceramic based composites over other materials in wear applications, because of their ability to withstand higher hardness, corrosive environments high strength to weight ratio. However, widespread acceptance has been limited by inherent brittleness and scatter in their strength data, an attempt is made to quantitatively represent wear of ceramic composites and allied materials by fitting the prediction model equations to experimental wear data.

Large numbers of papers are published to describe wear behavior to experimental variables that affect wear. In majority of the papers published analyze wear volume loss due to un-lubricated sliding wear of solids in contact. Most of the experimental setup is similar to pin on disc type configuration. Wear volume loss is quantitatively represented by wear rate and sliding distance and then correlated implicitly to experimental variables and material properties. Various analytical models are proposed in literature to predict wear behavior assuming different variables. Archard model, Evans and Wilshaw model, Kato model, Wang and Hsu model are validated with wear data of metallic alloys, ceramic based composites.

However, gaps in literature are observed in literature in analysis and validation of models proposed with experimental data. Further, it is observed that there is a gap in systematic experimental data for validation with wear model equations. The present presentation/paper aims to understand tribological behavior of various wear data published in literature by interpreting with analytical model equations proposed in literature.

**Profile:**

Shivasharanappa. V.Gubbewad completed B.E. (Automobile Engineering) in April 1991 at P.D.A. Engineering college Kalaburgi and completed M.Tech (Maintenance Engineering) in June 1994 at S.J.C. Engineering college Mysore. Presently working as an Associate Professor at P.D.A. Engineering college Kalaburgi. Areas of interest Maintenance Engineering and Composite Materials.

## Invited Talk- S4I3

**Dr. V Auradi**
Siddaganga Institute of Technology
Tumkur, Karnataka

### Title: *Influence of Ceramic $B_4C$ Particulate Addition on Characterization, Tensile Fractography and Wear behavior of 6061Al Alloy Matrix*

In the present work Al6061 alloy reinforced with B4C particulate composites are synthesized by optimizing various parameters like size, addition level, preheating temperature of $B_4C$ particulates and temperature of processing the composite. Ceramic $B_4C$ particulates are added with an addition level of 5, 7 and 11 wt. %. In the present work a novel two stage mixing combined with preheating of the reinforcing particles along with $K_2TiF_6$ are adopted to accomplish better dispersion. The prepared composites are characterized by XRD and SEM/EDAX studies. Further, the mechanical and wear properties of all the composites are evaluated at room temperature. Novel procedure adopted to improve distribution of $B_4C$ particulates in liquid Al. Also addition of ceramic $B_4C$ particulates to 6061Al shows improvement in both mechanical and wear properties.

## Invited Talk- S5I1

**Prof. Bikramjit Basu**
Materials Research Centre
IISc- Bangalore, Karnataka
India

### Title: *Biomaterials and Implants in India: Current Status and Recommendations*

Medical devices are a major part of healthcare costs. Nearly 80 percent of devices come from outside the country: the USA, Germany, France, Singapore, China and the Netherlands, and healthcare costs are not affordable to many Indians. Also, a large number of patients come to India for treatment from the Middle East, Africa and neighbouring countries (Bangladesh, Sri Lanka, Nepal, Bhutan etc.). The translational research ecosystem in India has evolved to address this chain of high healthcare costs and unmet clinical needs. A key challenge for innovation is the manufacturing of affordable biomedical devices without compromising on quality.

Against the above perspective, this talk will describe a few case studies illustrating the most recent research findings from our group and other leading research groups based in India, to illustrate how to take labscale research to biomedical device development through collaborative efforts of Academia and National laboratories with intensive-interactive inputs from Clinicians and Industries. In particular, the translational research on acetabular liner, dental implants and the multicentric pilot studies using patient-specific bone flaps for cranioplasty surgery will be particularly highlighted.

Towards the end of the presentation, I will discuss a set of policy-related recommendations for the accelerated growth of biomaterials science and implants in the next decade and beyond. The recommendations discussed should help to establish India as a global market leader for a new generation of bioimplants, whose predictive clinical performance would be closely tracked by “digital twins”. It is the speaker’s vision that such a discussion would not only encourage young researchers to be passionate about understanding the current challenges, and those of the end-user, but also inspire them to form strong collaborations for adaptive problem solving, thereby making significant contributions to the field. Given the right support, the key recommendations of the speaker can be highly transformative to the field and are ideas that can carry forward both people's wellbeing and the nation's economy in their energy and momentum.

**Profile:**

Bikramjit Basu is currently a Professor at the Materials Research Center, with joint appointment at the Center for Biosystems Science and Engineering, Indian Institute of Science (IISc), Bangalore. He also serves as Visiting Professor at University of Manchester, UK (2018-2023) and at the European Centre for Functional and Surface Functionalized Glass, Alexander Dubček University of Trenčín, Slovakia (2020-2021). He is currently President of the Society for Biomaterials and Artificial Organs, India. After his undergraduate and postgraduate degree in Metallurgical Engineering from NIT Durgapur (1995) and IISc (1997) respectively, he earned his PhD in the area of Engineering Ceramics at Katholieke Universiteit Leuven, Belgium in March, 2001. Following a brief post-doctoral stint at University of California; he served as a faculty in Materials Science and Engineering at Indian Institute of Technology Kanpur (2001-2011) and moved to IISc in May, 2011.

Bikramjit's contributions in Engineering Science have been globally recognised. He received Government of India's most coveted science and technology award, Shanti Swarup Bhatnagar Prize in 2013 for his significant contributions to the field of Biomaterials Science. A Chartered Engineer of the UK, he is an elected Fellow of the International Union of Societies for Biomaterials Science and Engineering (2020), Indian Academy of Sciences (2020), American Ceramic Society (2019), American Institute of Medical and Biological Engineering (2017), Institute of Materials, Minerals & Mining, UK (2017), National Academy of Medical Sciences, India (2017), Indian National Academy of Engineering (2015), Society for Biomaterials and Artificial Organs (2014) and National Academy of Sciences, India (2013). He is the recipient of the Richard Brook Award from the European Ceramic Society in 2021.

## Invited Talk- S5I2

**Dr. Rishi Gupta**
Application Specialist, Characterization Division
Anton Paar, India

**Title:** ***Characterization of various attributes in ceramic and cement samples***

**Profile:**

Dr. Rishi Gupta has done his Doctorate and Post-doctorate from University of Delhi. He has more than 12 years of experience in the field of catalytic reactions and analytical instrumentations, and has more than 40 publications to his credit. Dr. Gupta has rich experience in material characterization and he has conducted several training programs on the related topics. Currently he is working as an Application Specialist in the Characterization Division of Anton Paar India.

## Invited Talk- S5I3

**Prof. J Manjanna**
Department of Chemistry, Rani Channamma University
Belagavi, Karnataka

**Title: *Smectite clay minerals in the geological disposal of high-level waste, and conventional applications as solid acids***

Bentonite is the candidate buffer (backfill) material in the engineered barrier system for deep geological disposal of high-level waste (HLW). Montmorillonite (Mt, 2:1 smectite group clay) is the major clay mineral of bentonite with high capacity for swelling and adsorption, low hydraulic conductivity and self-healing properties. The interaction of Mt with the carbon steel (Fe), an overpack material of engineered barrier system, the corrosion products provide potential pathways for the alteration of Mt. Apart from small fraction of Fe-rich clay minerals, the conversion of Na-Mt to Fe(II)-Mt and Fe(III)-Mt.

The (III)-Mt was prepared by conventional cation exchange of Na-Mt with $FeCl_3$. It was converted to Fe(II)-Mt through the reduction of interlayer and adsorbed Fe(III) ions with ascorbic acid. Also, pure Fe(II)-Mt was obtained by using weak Fe(II)-L complexes for cation exchange. This new method enabled us to routinely prepare this redox sensitive Fe(II)-Mt under ambient conditions. The basic properties viz., sorption and diffusion characteristics of radionuclides relevant to geological disposal of HLW were studied using Fe(II)-Mt and Fe(III)-Mt. The sorption behavior and apparent diffusion coefficients obtained for Fe-Mt are found to be marginally different from that of original clay mineral, Na-Mt. The effect of gamma irradiation and temperature on the redox behavior of interlayer iron was also studied.

Furthermore, organo-modified Fe-Mt was prepared through solid state reaction by in-situ complexation of interlayer Fe(II) ions with suitable chelating agent (1,10-phenanthroline). These intercalated compounds were converted to solid acid catalysts and used for the reduction of nitroarenes and Biginelli type of organic reactions. Also, they are used for the adsorption of molybdenum from highly acidic solution towards HLLW.

**Profile:**

Prof. J. Manjanna is working in the Dept. of Chemistry, Rani Channamma University (RCU), Belagavi, Karnataka, India. He is also a Director, School of Basic Sciences & Deputy Registrar. Before joining to RCU in 2013, he was at Kuvempu University as Assistant Professor in the Dept. of Industrial Chemistry & Coordinator for Nanoscience & Technology (M.Tech.) programme since Jan 2010. He obtained M.Sc. (1995) and Ph.D. (2001) in Chemistry from Kuvempu Univ. He worked in BARC, Mumbai for his Ph.D. degree and then as K S Krishnan Research Associate (2002-2004). Later he moved to Japan as a Postdoctoral researcher (2004-2010) under JSPS and JST fellowship at Hokkaido University., Iwate Univ., and Univ. of Tokyo. He has published over 85 Int. Journal papers & 03 patents (one Japanese and two Indian). He received 'Young Scientist' award twice – by Indian Council of Chemists in 2000 and by Vision Group on Science and Technology, Govt. of Karnataka in 2012. He has received best paper award (6 times) in national conferences. As of Nov-2021, the google scholar citations are 2400 & h-index: 28. Recently, his name appeared among the world's top 2% scientists.

## Invited Talk- S6I1

**Dr. Thomas Kodenkandath**
Hazen Research Inc.
USA

**Title:** ***Improved Manufactring Method for the Production of Ni- rich NMC Cathodes for Advanced Li- Batteries***

Hazen Research, Inc., has developed, demonstrated and scale-up a simpler, lower cost and environmentally more benign production process for of high-performance Ni- rich NMC cathodes for advanced Li- batteries. Our three-step process uses new type of single-source precursors, spray pyrolysis for the decomposition of the precursors and rotary kiln reaction for the crystallization of the NMC cathodes. Our NMC-622 cathodes demonstrated electrochemical performance with initial capacity >200 mAh/g, voltage stability in the range of 3.0–4.2 V, energy density > 800 Wh/kg, coulombic efficiency > 95%, and capacity retention >85 % over 100 cycles. The process has been scaled-up and high-performance >1Ah full pouch cells have been demonstrated. The presentation will discuss the process, characterization and electrochemical properties of the NMC-622 cathode powders.

**Profile:**

Dr. Thomas Kodenkandth, earned his Ph.D in Solid State Chemistry from Indian Institute of Technology, Madras. He was selected as a Promising Young Scientist by UNESCO and spent 3 years at ICTP-Trieste and CNR-Parma, Italy. Thomas was a EPSRC Fellow and Imperial College, London and served a Scientist at Advanced Materials Research Institute, University of New Orleans, USA. His industrial career include stints at American Superconductors, MA, ITN Energy Systems and Ascent Solar Technologies, CO and currently at Hazen Research, CO. Hazen Research, Inc. an employee owned company based in Golden, CO have been serving materials, metallurgy and mining industries from around the world for over 60 Yrs. Thomas has extensive experience on functional materials and their advanced manufacturing process as devices for energy (generation, storage and efficiency) technologies. Under US-DoE project with Natl. Renewable Energy Lab. (NREL), he has developed a new, simpler and environmentally benign process for the production of high-performance Ni- NMC cathodes. With Argonne National Laboratory (ANL) and DoE, he has developed a new method for the direct recycling of NMC cathodes.

## Invited Talk- S6I2

**Dr. Aruna S T**
Sr. Principal Scientist (Surface Engineering Division)
CSIR-NAL, Bangalore

**Title: *Reversible Solid-Oxide Fuel Cells for Green Hydrogen Generation: Present Status and Future Prospects***

To address the daunting issues of energy and the environment, the production of green hydrogen from renewable resources that are intermittent in nature is emerging as a potential and promising solution. This has led to the development of highly efficient electrolyzers such as solid oxide electrolyzers (SOECs), which use 30% less power than polymer electrolyte membrane (PEM) electrolyzers to generate the same volume of hydrogen. SOECs can also be used in the co-electrolysis of $CO_2$ to generate syngas. This can be used in chemical industries and also to synthesize methane and other hydrocarbons that are easy to store and easy to transport. Solid oxide electrolyzers are advantageous due to their higher electrical efficiency, higher conversion efficiency, availability of raw materials and lower raw materials cost. Solid oxide fuel cells can be operated in fuel cell mode and electrolyzer mode and hence it is referred to as reversible solid oxide fuel cells (RSOFC). Although SOFC and SOEC utilize the same cell materials, their operating modes and reaction mechanisms are different. Also, the conventional electrode materials are prone to delamination issues due to higher steam concentration at the fuel electrode and high oxygen partial pressures at the oxygen electrode. To address these issues, there is a need to develop novel materials and improve cell performance and economic feasibility to further realize the commercialization of RSOFC. In the present talk, the importance of green hydrogen, the basic working principle of RSOFC, the material requirements, the research progress on RSOFCs and the challenges to be addressed to commercialize this technology will be presented.

**Profile:**

Dr. S.T. Aruna is currently working as a Senior Principal Scientist at the Council of Scientific and Industrial Research - National Aerospace Laboratories (CSIR-NAL), Bangalore, India. She has 27 years of research experience. She received her Ph.D. in the year 1998 from the Indian Institute of Science and she was a postdoctoral fellow at Bar-Ilan University, Israel before joining CSIR-NAL in 2001. Dr. Aruna's research interests are in the area of nanomaterials synthesis, ceramic processing, plasma spray coatings and fabrication of high temperature electrochemical devices. She is well versed in the design and development of plasma sprayed thermal barrier coatings and coatings for bio-medical and wear resistant applications. She is the pioneer of the concept of the mixture of fuels approach and synthesis

of plasma sprayable powders by solution combustion method. Her other contributions in various disciplines include the development of ground-based cloud seeding materials, electrodeposited composite coatings, high emissivity paint coatings, thermal and environmental barrier coatings, solid oxide fuel cells, oxygen sensors, superhydrophobic coatings and sol-gel based corrosion resistant coatings. Her team has successfully transferred the tapecasting technology for alumina and zirconia ceramic substrates to M/s. Carborundum Universal Ltd. (CUMI), Hosur.

She has authored 110 research papers in international peer-reviewed journals, 6 review articles, 10 patents, co-authored a book and written 11 book chapters and 4 encyclopedia chapters. Her research papers have been well-cited and her publications have an h-index of 40. One of her review papers published in Current Opinion in Solid State and Materials Science, has received the best cited paper award twice. She has guided 5 Ph.D. students and 25 Masters and B.Tech students. She has completed almost 20 R & D projects sponsored by various agencies. She is on the editorial board of the Surface Engineering Journal. Her name was featured in the list of the top 2 % of the world scientists. She has received the Pavan Nagpal Memorial award from the Indian Ceramic society, Karnataka chapter; N.M Sampat award from The Electrochemical society of India, CSIR-NAL`s best woman scientist award for the year 2011-2012, CSIR-NAL`s best innovation award for the year 2014-15, and 2017-18; CSIR-NAL`s best research award-2016, and many more.

## Invited Talk- S7I1

**Mrs. Jeyalakshmi Venkatanarayanan**
Universe Power Systems
India

**Title: *Dream Big & Grow with MSME Schemes***

**Profile:**

Jeyalakshmi Venkatanarayanan is the founder and proprietor of Universe Power Systems. Her educational background is in Electronics and Telecommunication Engineering. She is also a qualified teacher, trained dancer, choreographer, and Carnatic singer. Her first entrepreneurial venture was the dance school 'Nruthya Kendra' that she started in 1984. Jeyalakshmi is also the founder of Universe Business Solutions, where she dons the role of Growth Consultant for both emerging and established entrepreneurs. The 'Smart Scaling Up' workshop series, designed by Jeyalakshmi to help small businesses rapidly scale up their enterprises, has been extremely successful, and been offered by Universe Business Solutions numerous times. She has also designed and offered several workshops on topics like business continuity and growth, and efficiently leveraging MSME schemes from the government, under the umbrella of Universe Business Solutions.

She was awarded the Rashtriya Rattan Award on the occasion of Indira Gandhi's birthday in the year 2000 by the Global Economic Council for exceptional achievements in business. In 2009, she was selected among 10000 women entrepreneurs across the world by Goldman Sachs, and her management education at ISB was sponsored. She was awarded the First Generation Women Entrepreneur Award by Acharya Institute of Management, and was inducted as a member of their Advisory Board Council in 2011. In 2012, she received the Mother Teresa Excellence Award. In 2017, she received the Shrama Sadana Award by Abhinandana. In the same year, she also became the first woman Vice President of the Association for Information Technology (AIT) in 21 years, and a Vice President for FITDAK (the Karnataka IT Association). Under Jeyalakshmi's leadership, Universe Power Systems was selected as the emerging SME of Bangalore from 'the Talk' in 2019. She also received the Power Woman of the Year award from 'Indian Affairs', and the Social Entrepreneurship Award from eMerg in 2019.

## Invited Talk- S7I2

**Mr. Sathish Chitwadgi**
Founder and Business Consultant
Sinter Cera Kraft LLP, Thane

### Title: *Entrepreneurship opportunities in Ceramic Tile Industry*

Construction is the core demand driver for any economy. Growth in construction and economy throws up many business opportunities based on manufacturing & services, supply chains and innovation aided by new age technologies. The objective of this interaction is to elaborate the ways and means to create sustainable businesses, contribute to nation-building, create wealth and provide employment.

The discussion covers various entrepreneurial opportunities in the ceramic and related industry. It deals with identifying markets and opportunities, products, technologies & technology suppliers, basic economics and scales of operations, importance of networking and collaborating with industry bodies and research institutions, innovation in materials and energy / fuel efficiency, foresight and building capability to take risks and overcome hurdles, capital requirements and funding, innovation in products & services among others. It also briefly dwells on demographics, income levels & development and macro-economic factors influencing businesses, global ceramic tiles manufacturing, new growth markets and future prospects.

**Profile:**

Satish Chitwadgi, founder and partner of Sinter Cera Kraft LLP leads the business consulting and minerals business of the company. He specialises in Manufacturing, Product Development, Project Management, Procurement, Operations and Supply Chain. Sinter Cera Kraft LLP has successfully concluded several consulting assignments in Ceramic Tiles and Engineered Quartz Stone sectors in India, Turkey, Vietnam, Uganda and West Africa. The company also deals in several value added minerals suitable for the Ceramic Industry. He graduated from PDACEG in 1994 specialising in Ceramic & Cement Technology and has completed his Senior Management Program from IIMC, Kolkata in 2013. His professional exposure encompasses various industry functions including Research & Development, Project Management, Manufacturing Management, Supply Chain Management in Ceramic Tiles, Engineered Stones and Mineral Processing Industries. He has worked for almost 2 decades with H&R Johnson (India) Ltd (Prism Cement Ltd) in various capacities and has been responsible for various research projects, CDM projects, greenfield & brownfield Tile projects.

## Invited Talk- S7I3

**Mr. Sabyasachi Roy**
Director
ANTS Ceramics Pvt. Ltd.

**Title:** ***Lab to Production: Scale up story of ANTS Ceramics***

In this discussion our primary focus will be in sharing entrepreneurship experience in Ceramic manufacturing industry. The learning of business, market aspect, ceramic manufacturing aspects, financial aspect for ceramic business will be discussed. We will share project formulation, scale up and execution process. Our learning in scale up from concept to production will be discussed.

**Profile:**

Mr. Sabyasachi Roy is a Ceramic Technologist with more than 16 years of experience in the field of Technical Ceramics and advanced ceramic materials. AAer compleBng his B.Tech. in Ceramic Engineering & Technology from Govt. College of Engineering and Ceramic Technology in 2003, he did his Masters in Materials Science and Engineering (with Ce-ramics as a major) from Indian InsBtute of Technology, Kharagpur in 2005. He has co-founded ANTS Group (ANTS Ceramics Pvt Ltd , ANTS InnovaBons Pvt Ltd and ANTS Lab and Equipments Private Limited) which is innovaBon based Ceramics and advanced materials manu-facturing high growth organizaBon. ANTS Ceramics Pvt Ltd., the first company of ANTS group was founded with IncubaBon support of STEP, IIT Kharagpur and CIIE, IIM Ahmedabad in 2006 with mis-sion of commercializaBon of lab scale indigenous technology.

He is also associated with several organisaBons as an acBve member like ASM India, Indian Ceramic Society, Powder Metallurgical AssociaBon of India, Alumni network of Govt. College of Ceramic Tech-nology etc. He is acBve member of Industrial Advisory board of Metallurgical Engineering Depart-ment, College of Engineering Pune. He is also Vice President of All India Pofery Manufacturer Asso-cia Bon ( 2020-2022) and Elected member of Indian Ceramic Society in Western Zone, India. He has received Sasadhar Roy Memorial Award from Indian Ceramic Society in 2018 and M G Bhagat Memorial Award in 2020 for his contribuBon in Ceramic Field. He also has received Young Alumni Acheivers Award 2021 from Indian InsBtute of Technology Kharagpur ( IIT -Kharagpur).

## Invited Talk- S7I5

**Mr. Mahesh Shastri**
Co-founder, CFO
Re-Batt Energy Solutions Pvt. Ltd.
Bangalore, Karnataka

**Title:** ***Innovative Start-up on Lithium-ion Battery Processing and Assembling***

Past few decades of Indian Battery industries were mainly focused on lead acid, nickel and alkaline technology for major power storage devices, even the first EV's introduced in India were used to have lead acid battery. But, in the Last few years Indian battery market is showing huge interest towards Lithium-ion batteries due to its compact size, less weight, more efficiency along with increased battery life and Zero maintenance. There are several battery technologies considering only Lithium-ion, one of the prominiet is LFP(Lithium iron Phosphate) batteries due its safety and long cycle life. In the last 5years there are several startups which solely depending on the demand of LFP batteries. With EV's entering the Indian market there is a huge scope for Lithium-ion based startup to meet the demand of LFP assembling plants. LFP battery is not only used for EV's but also for energy storge in day to day life like Home ups, Portable power bank, solar energy storage dervices, etc.

**Profile:**

(Dr.) Mahesh Shastri was awarded his Bachelors of Engineering in Electronica & Communication and M.Tech in Nanotechnology from Visvesvaraya Technological University Belagavi. He submitted his Doctoral degree Ph.D. (Nanotechnology) from Visvesvaraya Technological University Belagavi. He has worked as Senior Research Fellow at VTU, Muddenahalli, and then he also worked as a Student member in the DST-JSPS project. At present he is working as Director and CFO, Re-Batt Energy Soutions Pvt. Ltd.

(Dr.) Mahesh Shastri has worked to develop a novel process for producing electrode nanomaterials for energy storage applications. He has extensive working on high capacity Li-ion and Li-S battery electrode materials and device fabrication. He has also visited Tohoku University Sendai, Japan, under the DST-JSPS project at Adschiri Lab and worked on Next Generation electrode materials for battery applications. He has published 13 papers in national and international journals, Co-author in 2 book chapters. He has also got best poster and oral presentation in several national and international conferences.

## Invited Talk- S8I1

**Mr. Gary Laymath**
Technical Support & Development Manager
IMERYS Performance Minerals Asia Pacific
UK

### Title: *Kaolin- A story beyond whiteness and particle size*

Kaolin is a versatile raw material used in a multitude of industrial applications, some of the more familiar of which are paper coating and filling, plastic, paints, rubber, ceramics, fiberglass and refractories. Whilst all require a certain degree of purity, the end users typically focus on whiteness, particle size distribution, surface area and rheology. However, the paint and coatings industry also pay particular attention to the aspect ratio and shape of the kaolin particles in order to influence surface flatness, opacity and flow. This presentation introduces the general effects of aspect ratio to whiteware ceramics and demonstrates more specifically how this applies to ceramic glazes.

**Profile:**

Gary is a UK national who graduated in applied chemistry in the UK with additional supplementary studies in chemical engineering. Gary has 42 years' experience in a technical capacity with ECC International and Imerys including 30 years within the Ceramics division. His experience includes kaolin processing and application in paper and ceramics, development of synthetic zeolites from calcined clays, production of precipitated calcium carbonates, processing and development of white bentonites in household products and personal care industry (heading a development team cooperating with Procter and Gamble, Unilever etc.), development of ball clay solutions for Ceramics markets in Europe, technical support to ceramic customers in Scandinavia, Iberian Peninsula and the Middle East. Gary fully supports Indian Ceramics, having attended the inaugural exhibition and most exhibitions since. He, along with his team, has provided seminars to the tiles and sanitaryware producers since 2014 on an approximately biannual basis. In 2020, due to the pandemic, Gary and the team utilised video conference facilities to stay engaged with both customers and the Ceramics industry in general; and was honoured to give a video presentation on the basics of ceramic raw materials to 150 members of the Indian Institute of Ceramics. Gary remains committed to provide resources to support the growth and sustainability of the Indian Ceramics dream.

## Invited Talk- S8I2

**Mr. Shankha Chatterjee**
Technical Manager (India, China and SEA)
ALMATS Alumina Pvt Ltd
Kolkata, India

**Title:** ***Developments in synthetic alumina towards sustainable growth in coming decades***

Specialty synthetic alumina is a niche segment in the big ocean of commodity alumina market. The specialty alumina is used in three distinctly different markets e.g. refractories, ceramics and polishing. The developments of specialty alumina is driven by the demands and growths in all these three markets. Refractory industry is mainly driven by steel production driven by construction and manufacturing sectors, rapid urbanization and structural reforms, although there are several other markets such as cement, petrochemical, non-ferrous metals and glass which also require specialty alumina products for value added refractories. In ceramics, most of the products use calcined aluminas, but with a large variety of customized products are necessary for the individual applications and customer needs in many ceramic applications such as wear protection, automotive, LCD glass, LED applications, environmental ceramics, waste water treatment, thermal filler, semiconductor and substrates etc like both conventional structural alumina ceramics and electrical cum electronics applications. Alumina is also one of the most important abrasive materials for polishing and lapping of a wide range of surfaces and applications. In spite of the growth potentials, a specialty alumina manufacturer is observing a typical commodity market regime, being more volatile over years from the viewpoints of feedstock raw materials costs, energy costs, logistics costs etc. In spite of all such barriers, a specialty alumina manufacturer has to focus on product quality, process technology and continual innovations with newer materials to sustain market competitiveness and remain market leader by providing better solutions to the end users. This presentation highlights the value chain links of specialty alumina manufacturing, its applications and their growth potentials and newer synthetic specialty alumina material solutions so as to provide better value addition to end users.

**Profile:**

Mr Shankha Chatterjee is a member of ALMATIS technical team and responsible for product and market developments in India, China and South-East Asian and Middle East countries. He is based in Kolkata. Shankha is with ALMATIS since last 10 years. Prior to that he worked about 12 years in different refractory manufacturing companies in India, China and Poland and experienced in areas like production, quality control, process control, research & development, technical services etc. He holds bachelor engineering degree in Ceramic Technology from the College of Ceramic Technology in Kolkata, completed Senior Management Program from the Indian Institute of Management Calcutta. Shankha authored and presented several technical papers and presentations in various national and international conferences.

## Invited Talk- S8I3

**Dr. Shyam S Rao**
Executive Vice President (Industrial Ceramics)
Carborundum Universal Ltd. (CUMI)
India

**Title: *Advanced Ceramics – Manufacturing Processes and Applications***

**Profile:**

Currently Dr. Shyam S Rao is Executive Vice President in Industrial Ceramics Division in Carborundum Universal Ltd. (CUMI). Dr. Shyam S Rao holds a bachelors in Metallurgy and a Masters in Material Science. He also holds a PhD in in Materials Science from Rutgers University, New Jersey, USA (1986-1992). He has over 25 years of experience and is associated with the Company since 1999.

# List of Contributory Presentations

| Presentation ID | Author Details | Title of the Paper | Abstract ID |
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| **Technical Session 1: Innovative Processing of Ceramic Materials & Glass** | | | |
| S1O1 | Prof Santanu Das | Ceramic Fiber Manufacturing Processes: Present lookout and future prospect | IvaCCT21-ABS057 |
| S1O2 | Indrajeet Mandal | Influence of $Na_2SO_4$ in structure and conductivity of Na-ion conducting NASICON based glass electrolyte | IvaCCT21-ABS040 |
| S1O3 | S Mamatha | 3D Printing of Clay Bonded Silicon Carbide for Kiln Furniture | IvaCCT21-ABS039 |
| S1O4 | Abinash Kumar | Fabrication and Characterization of 3-1 type Porous $(Ba_{0.85}Ca_{0.15})(Zr_{0.1}Ti_{0.9})O_3$ (BCZT) Lead-free Piezoceramic by Novel Ice Templating Process | IvaCCT21-ABS087 |
| **Technical Session 2: Refractory Materials & Applications** | | | |
| S2O1 | Abdur Rouf | Performance Improvement of Hot Metal Ladle Lining With $Al_2O_3$-SiC-C Refractory at ISP | IvaCCT21-ABS024 |
| S2O2 | Ranjeeth Ravi | Analysis of Refractory Failure & Hot Spots in the Riser Section of FCC Unit of a Refinery | IvaCCT21-ABS070 |
| S2O3 | Pawan Rangdal | Synthesis of Alumina Sol Binder To Be Used In High Alumina Castable And Its Comparison With Commercially Available Binders | IvaCCT21-ABS080 |
| S2O4 | Arshad Hussain | Refractory Installations | |
| **Technical Session 4: Engineering Ceramics, Structural Ceramics and Coatings** | | | |
| S4O1 | Dr. Madeva Nagaral | Influence of Ceramic Reinforcement Particle Size on the Mechanical Behaviour and Fractography of Al2618-$B_4C$ Aerospace Metal Composites | IvaCCT21-ABS051 |

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| S4O2 | Kommuri Kirana | An insight study into the Compositionally Induced Normal to Diffuse Ferroelectric transitions in NKN ceramics | IvaCCT21-ABS088 |
| S4O3 | Kripasindhu Sardar | Non-aqueous synthesis of silicon nitride ceramics | IvaCCT21-ABS099 |
| S4O4 | Shrirang M. Pathak | Solid Particle Erosion Performances of Ceramic Nanoparticles Reinforced Polyurethane Coatings | IvaCCT21-ABS102 |
| **Technical Session 5: Advanced Functional Ceramics, Nanomaterials & Biomaterials** | | | |
| S5O1 | Omprakash Hebbal | Performance, Emission and Combustion Characteristics of a MMC coated Low Heat Rejection Engine Using Mahua Biodiesel | IvaCCT21-ABS112 |
| S5O2 | Payal Roy | A Novel Haemostatic Dressing Material Impregnated With Mesoporous Antibacterial Bioactive Glass For Profusely Bleeding Condition | IvaCCT21-ABS029 |
| S5O3 | Prabhakar N Patil | Mechanistic insights into the synthesis of $CuFe_2O_4$ and $FeCo_2O_4$ by sol-gel method | IvaCCT21-ABS058 |
| S5O4 | Kaustubh Ramesh Kambale | Sintering and Electrical Properties of AlN-BN and AlN-$Si_3N_4$ Ceramics | IvaCCT21-ABS076 |
| **Technical Session 6: Ceramics for Energy and Environment** | | | |
| S6O1 | Dr. Soumya Shankar Ghosh | Cementitious nanostructureds coating on graphite for new generation anodes of lithium ion batteries | IvaCCT21-ABS002 |
| S6O2 | Shahansha Mohammed M | Removal of Mixed Azo Reactive Dyes from Aqueous Solution Using Mixed-Oxidants-based Fenton-like Process Backed-up by Hybrid Ultrasound Cavitation and Ozonation Techniques | IvaCCT21-ABS004 |
| S6O3 | Susmita Bera | Enhanced Photocatalytic Activity of Metal Doped $Bi_2WO_6$ for Water Splitting under Visible Light | IvaCCT21-ABS025 |
| S6O4 | G Thirupathi | Synthesis of Lithium Nickel Cobalt Aluminium oxide (NCA) type cathode material for lithium ion batteries | IvaCCT21-ABS075 |

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| S6O5 | Dr. Manjunath Shetty | One-Pot supercritical fluid Synthesis of Reduced Graphene Oxide hybrid $BiVO_4$ nanostructures for Li-ion Battery as Anode | IvaCCT21-ABS092 |
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| S8O1 | Dr.Prabhu Ramanujam | Effect of particle morphology on the wear resistance mechanism of Alumina Ceramics | IvaCCT21-ABS033 |
| S8O2 | Vivek Narayan | Viscosity and Gelation of Ceramic Slips – An Industrial Perspective | IvaCCT21-ABS005 |
| S8O3 | Sanjukta Roy | Ceramic-based photocatalytic membrane reactors for wastewater treatment | IvaCCT21-ABS094 |
| S8O4 | Aiswarya Anil | A comparative study on solid state and sol gel synthesis of Lithium Aluminium Silicates | IvaCCT21-ABS074 |

***Note:** Presentation ID **S1O1** means Season 1 oral presentation 1(**O is an alphabet in S1O1**)

Contributory Paper S1O1

# Ceramic Fiber Manufacturing Processes: Present lookout and future prospect

**Sabyasachi Roy[1,2] and Santanu Das[1*]**

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Ceramic Fiber plays a consequential role in high strength modified structural applications, composite manufacturing, in wide range of functional and exceptional engineering application in various fields including aerospace, automobile, energy and specially in insulation application. Insulation application is dominated by different grade of ceramic fiber. There are extensive future applications of piezo-ceramic fibers and bio-ceramic fibers in atypical functional applications. Majority of ceramic fiber manufacturing units are following the typical melting and spinning route for ceramic fiber production. The advantage of melting route is to enhance the productivity and ease of formation of continuous fiber. However, the disadvantages of melting route are high energy consumption, high set up cost, less flexibility in composition variation and difficulties in operation for extreme high temperature. Sol-gel synthesis route and slurry spinning are the most industry viable options for ceramic fiber processing with desired properties and improved productivity. Non-oxide fibers are being made through polymeric precursor route and in-depth research and scale-up is required to take up these processes for easy operation and flexibility of making different functional compositions. In this presentation we will be focusing on processing of ceramic fiber, alternative routes of manufacturing, and their advantages and disadvantages.

**Key Words:** *ceramic fibers, manufacturing, sol-gel synthesis, slurry spinning, melt-spinning.*

Contributory Paper S1O2

# Influence of $Na_2SO_4$ in Structure and Conductivity of Na-ion Conducting NASICON Based Glass Electrolyte

**I. Mandal,[1] M. Ghosh,[2] K. K. Dey,[3] K. Annapurna,[4] J. Mukhopadhyay,[1] A. D. Sharma,[1] A. R. Allu[1,*]**

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One of the main reasons for the inability to commercialize high sodium conducting glass as an electrolyte for sodium battery application is the vague knowledge of the factors governing the Na-ion dynamics. In the present study, we have attempted to establish a relationship between the structure and conductivity of $37.5Na_2O–37.5P_2O_5–15Al_2O_3–10NaF$ (FS-0; mol.%) glass systems with changes in different $Na_2SO_4$ concentrations. We have used MAS-NMR (Magic Angle Spinning-Nuclear Magnetic Resonance), Raman Spectroscopy, and Impedance Spectroscopy here to evaluate the structural and ionic conductivity of FS-0 glasses along with the variation of $Na_2SO_4$ concentration. From the Raman spectra and MAS-NMR analysis, we infer that the number of P – O – Na bonds and sulfate ($SO_4^{2-}$) units surrounded by sodium increases with increasing Na2SO4 concentration. Impedance spectra analysis of FS-0 glasses with different $Na_2SO_4$ concentrations reveals that adding 6 mol% $Na_2SO_4$ to FS-0 glass gives maximum conductivity compared to other glasses. We identify from the ac-conductivity spectral analysis and Mean square displacement (MSD) that the concentration of charge carriers, critical hopping length, and the no of the shallower potential of sodium cations increase with the addition of 6 mol% Na2SO4. Overall, we assume that the structural changes, the Na-ion concentrations, and the shallow potential wells that are formed due to the interaction with the nearest neighboring cations of sodium play a major role in influencing the Na-ion dynamics. The information from the present study will certainly be a guide to optimizing the chemical composition of glasses exhibiting high ionic conductivity.

**Key Words:** *NASICON; phosphate glass; NaF; conductivity.*

## Contributory Paper S1O3

# 3D Printing of Clay Bonded Silicon Carbide for Kiln Furniture

**S. Mamatha[1]*, Papiya Biswas[1], Y. Srinivasa Rao[1], Roy Johnson[1]**
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Kiln furniture plays an important role in space and thermal management of the furnaces leading to increased energy saving during production runs. During servicing conditions kiln furniture are subjected to thermo-mechanical stresses due to the load of the charge and elevated temperatures. In view of this, thermo-mechanical properties are very critical to avoid the deformation of parts and to avoid the failure of the furniture itself. Further, the furniture also allow homogeneous heat flow throughout the hot zone and the products should not interact with the surface of the furniture to avoid the rejections. Material and configuration are the critical attributes to achieve the best performance of the kiln furniture. In the current study the clay-bonded silicon carbide has been 3D printed into complex configurations on laboratory scale. Clay bonded silicon carbide is well known for its high thermal conductivity and low thermal expansion, which provide it excellent thermal shock resistance. Effect of 3D printing parameters with respect to clay bonded silicon carbide and property evaluation will be discussed during the presentation.

## Contributory Paper S1O4

# Fabrication and Characterization of 3-1 type Porous $(Ba_{0.85}Ca_{0.15})(Zr_{0.1}Ti_{0.9})O_3$ (BCZT) Lead-free Piezoceramic by Novel Ice Templating Process

**Abinash Kumar, Manoj Kumar Sahoo, R. Mazumder***
*Department of Ceramic Engineering, National Institute of Technology, Rourkela*
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Porous piezoelectric ceramics have gained a significant interest for application like low frequency hydrophone because of higher hydrostatic figure of merit and lower acoustic impedance in comparison to the dense ceramics. $BaTiO_3$ ceramics with Ca and Zr co-doping has offered a significant impact on the development of lead-free piezo ceramics. The high saturation polarization ($17\mu C/cm^2$) and piezoelectric properties ($d_{33}$> 400pC/N) of BCZT make it a potential material for piezoelectric applications. However, generation of randomly oriented porosity by adding a polymeric pore-forming agent that burns out during solid-state sintering results significant degradation of piezoelectric properties. It has been reported that oriented channel pore with decreasing pore size enhances the $d_{33}$ values in 3-1 type

piezoceramics. However, there is no report available on preparation of 3-1 type BCZT porous ceramics.

The present work explores the fabrication of BCZT piezo-ceramic having 3-1 connectivity using ice templating process. Ice templating process ensures formation of aligned pores which favours enhanced piezoelectric properties due to proper aligning of dipoles in the casted samples. Slurry stabilization prior to freeze casting is one of the most essential steps for attaining homogeneous and isotropic casting. Different dispersants namely, PAA, BYK-154, Anti-Tera and Castament were explored and suitable dispersants and concentration were optimized. The freeze casting was performed at -70$^{o}$C. After the removal of ice via freeze drying the sample was sintered at 1400$^{o}$C for 2 h. The microstructural evolution along the freezing direction and density was studied. Finally, the electrical and piezoelectric properties were analyzed where permittivity ($\varepsilon_r$), dielectric loss, $d_{33}$ and acoustic impedance of the porous ceramic were found to be 1245, 0.03 (at 1 kHz), 190 pC/N at a poling field of 2kV/mm and 4.32 MRayl, respectively. Interestingly, higher piezoelectric property can be retained in ceramic with 45% porosity. Furthermore, acoustic impedance can be reduced by 600% compared to the dense bulk sample.

**Keywords:** *Ice templating; Porous piezoceramic; Figure of merit; Acoustic impedance.*

## Contributory Paper S2O1

# Performance Improvement of Hot Metal Ladle Lining with $Al_2O_3$-SiC-C Refractory at ISP

**A. Rouf[1], B. K. Sinhamahapatra[2], R. K. Singh[3], M. K. Kujur[3], A. Patel[2]**

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Refractory consumption in steel making is one of the major concerned areas for steel makers. Hot metal ladle acts as a transfer ladle as well as metallurgical vessel in steel making shop. Now days, hot metal ladle is not only holding and transferring the hot metal, but it also acts as a metallurgical vessel for desulphurisation of the hot metal. As a result, working lining refractory exposes to various types of corrosion, erosion and thermal shock. However, degradation of lining material results from the interactions with chemical, thermal and mechanical phenomenon.

Alumina based refractory are used as lining material in hot metal ladle at ISP. Sometimes, magnesia carbon refractory is also used as lining material. The performance of existing refractory was in the range of 900-1000 heats. Alumina silicon carbide carbon (ASC) refractory was applied in the working lining of few ladles and performance was monitored. Application procedure and repair practices were maintained same as in case of existing refractory. Comparative study on erosion pattern, corrosion behavior and properties of ASC refractory with existing alumina refractory or magnesia carbon refractory were carried out. Ladle life with ASC refractory was achieved up to 1354 heats.

Contributory Paper S2O2

# Analysis of Refractory Failure & Hot Spots in the Riser Section of FCC Unit of a Refinery

**Ranjeeth Ravi[1], Anil Kumar Gautam[1], Naga Vaartha[2], Dr S P Singh[1], K Boral[2], Dr Sova Bhattacharya[1], Debasis Bhattacharyya[1]**

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Fluid catalytic cracking (FCC) is one of the most critical and profitable conversion processes used in petroleum refineries. FCC riser reactor and regenerator are the two most essential parts of an FCC unit. The construction of the FCC riser consists of a steel shell lined with refractory materials. The function of the shell is to provide a rigid structure; the refractory lining takes the brunt of abrasion created by the powdered catalyst and provides resistance to heat loss from the riser inside to the atmosphere.

Recently, a problem of hot spots of various sizes with temperatures up to 454°C was observed on the riser of the FCC unit of one of our refineries. Some hot spots were transient and moving sideways. A heat transfer model was prepared, which indicated that hot spots of ~450°C can be formed only in case of refractory wall loss of more than 50%. Based on the heat transfer model and onsite observations, the formation of hot spots was attributed to cracks in the refractory lining and disbanding between steel shell and refractory. As there was no possibility of refractory repair during the process, a shutdown of the unit was taken. After the shutdown of the unit, visual observations and detailed laboratory analysis of failed refractory material confirmed the initial prediction of hot spot formation due to cracks in lining and disbanding between steel shell and refractory. The slippage between the anchor and refractory might have led to a gap between the lining and the shell. These types of openings allow hot gas to bypass and circulate behind the refractory, resulting in hotspots on the shell. The improper dry out of refractory might lead to a deep penetrating crack until the shell and aggravate during mishandling or transportation. Confirmation of catalyst backtracking and coke impregnation during operation could have been a reason for the movable hotspot.

**Key Words:** *Hot Spot, Refractory Failure, FCC.*

## Contributory Paper S2O3

# Synthesis of Alumina Sol Binder To Be Used In High Alumina Castable And Its Comparison With Commercially Available Binders

**Pawan Rangdal [1], Sharanbassappa B. Patil [2], Pruthivraj Biradar [3]**
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In the present study Alumina Sol was prepared using 1M aluminium nitrate solution and liquor ammonia as precursor. The synthesized alumina sol was characterized with XRD, SEM, and FTIR to identify the alumina phases formed. The solid content in the prepared alumina sol was found to be 3% after calcinations. A mixture of white tabular alumina (WTA) & white fused alumina (WFA) with different particle size was used as aggregate material to prepare refractory castables. The synthesized alumina sol and commercially available binders like calcium aluminate cement (CAC) and hydratable alumina which were procured from Almatis, India were used as binders. Properties of the refractory castables like green density, sintered density, cold crushing strength, bulk density, apparent porosity and thermal shock resistance were studied.

Cold crushing strength of alumina sol bonded castables was found to be greater than CAC binder and faintly less than hydratable alumina. Bulk density of the alumina sol bonded castable was 2.89g/cc which represents very well packing and compaction. Thermal shock resistance of Alumina sol and hydratable alumina bonded refractory castables was equivalent both retained more than 95% of the strength after undergoing 12 thermal shock cycles where as the CAC bounded refractory lost its crushing strength by 5% on 12 thermal.

**Key Words:** *Alumina sol, Calcium Aluminate Cement, Hydratable alumina*

## Contributory Paper S2O4

# Refractory Installtions

**Arshad Hussain**
*Kareena Gulf, UAE*

## Contributory Paper S4O1

# Influence of Ceramic Reinforcement Particle Size on the Mechanical Behavior and Fractography of Al2618-$B_4C$ Aerospace Metal Composites

**Veeresha G[1], Manjunatha[1], Madeva Nagaral[2], V. Auradi[3], Bharath V[4]**
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The size of the reinforcement particles plays an important role in determining the mechanical behavior of metal composites. Hence, in the current studies an investigation were made to know the impact of 20 micron and 44 micron sized $B_4C$ particles addition on the mechanical behavior of aerospace alloy Al2618 metal composites. Al2618 alloy with 2, 4 and 6 weight percentages of 20 and 44 micron sized $B_4C$ particles reinforced composites were produced by stir cast process. These synthesized composites were tested for various mechanical properties like hardness, compression strength and tensile behavior along with density measurements. Further, microstructural characterization was carried by SEM/EDS and XRD analysis to know the varying sized particles distribution and phases. Both 20 and 44 micron sized particles distributed uniformly in the Al2618 alloy composites. The comparison studies indicated that 20 micron sized boron carbide particles reinforced Al2618 alloy composites were exhibited superior mechanical properties over 44 micron sized particles reinforced composites. Fractography studies demonstrated with the help of SEM micrographs to know the various fracture mechanisms.

**Key words:** *Al2618 Alloy; B4C; Mechanical Behavior; Fractography;*

## Contributory Paper S4O2

# An insight study into the Compositionally Induced Normal to Diffuse Ferroelectric transitions in NKN ceramics

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Ecofriendly ferroelectric ceramics $Na_xK_{1-x}NbO_3$(NKN), combination of ferroelectric KNbO3 antiferroelectric $NaNbO_3$ compounds have an interesting property that they possess

a morpphotropic phase boundary when Na/K ratio is (52/48) generally taken as (50/50) formation .NKN samples with x = 0.0, 0.2,0.4, 0.5, 0.6, 0.8 and 1.0 are synthesized by solid state double sintering method are used as energy storage devices. Phase conformaton and grain morphology of NKNsamples are done by X-ray diffraction studies Scanning electron micrographs respectively.The formation of microfiber grains is observed for x=0.5 sample in which equal molar compositions of sodium and potassium atoms are present. Dielectric studies which include the variation of dielectric constant and dielectric loss from room temperature to 550$^{o}$C over a wide frequency range of 1kHz to 1 MHz have shown two peaks around 220$^{o}$C indicating the structural transitions and another peak around 420$^{o}$C indicating both structural & ferroelectric to paraelectric transitions respectively. Inorder to highlight the nature of structural transitons and phase transitions an attempt is made to find three parammeters that define the nature of transitions - Diffuse parameter 'γ', Degree of deviation from Curie's law 'δTm' and Degree of diffuseness 'D' are found. for all NKN samples. γ is measured from modified Curie -Weiss plots drawn between log (1/ε- 1/εmax) and log (T - Tc ) . γ is found to be less than one for x = 0.0 and greater than one for x=0.2,0.4,0.5,0.6,0.8 and1.0 samples, specifying their normal and diffuse ferroelectric natures respectively. Degree of deviation from Curie's law 'δTm' is determined from the plots of the inverse of dielectric constant (1/ε) as a function of temperatureand δTm has shown the same type of variaton as of γ ..The Degree of diffuseness 'D' is found from the plots of differential dielectric constant dε/dT versus temperature and obseved a certain amout of degree of diffuseness is present around both 220$^{o}$C and 400$^{o}$Cfor all NKN samples.Diffuse phase transition can be induced by factors such as microscopic composition flfluctuation and local disorder mode through the local strain.

**Key Words:** *Ferroelectrics, dielectric constant, diffuse parameter,Curie's law*

## Contributory Paper S4O3

# Non aqueous synthesis of silicon nitride ceramics

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We present synthesis and characterization of mesoporous silicon nitride ceramics by non-aqueous sol-gel based synthesis process. Silicon nitride was synthesized with the use of silicon amide and ammonia as precursor to form a gel. This gel was dried and calcined within 200- 1400 $^{o}$C temperature range under a flow of ammonia gas to obtain high quality mesoporous silicon nitride ceramics. The as prepared powders were characterized by TEM, BET, solid state NMR and synchrotron XRD analysis.

## Contributory Paper S4O4

# Solid Particle Erosion Performances of Ceramic Nanoparticles Reinforced Polyurethane Coatings

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In recent years, wind energy has gained widespread attention and has become the third-largest power source after hydroelectricity and thermal power. It is one of the sustainable energies to rely on for the future. However, maintenance of wind turbine blades becomes a great challenge in tropical countries like India. Solid particle erosion is one of the prominent causes of wind turbine blade damage. To address this issue, in the present work, various in-house synthesized ceramic nanoparticles are used as fillers for reinforcement of polyurethane coatings on GFRP substrates. Alumina, zirconia and ceria nanoparticles have been prepared by solution combustion method using urea, glycine and oxalyl dihydrazide, respectively, as fuels. They are found to crystallize in corundum, tetragonal and cubic structures, respectively, as confirmed by X-ray diffraction studies. The oxidation states of Al, Zr and Ce in the respective oxides are studied using X-ray photoelectron spectroscopy. Scanning electron microscopy shows porous structure of the oxide products due to the release of gases in course of preparation. The solid particle erosion resistance of coatings are studied at varied concentrations of ceramic particles at impinging angles of 30° and 90°. The coatings showed good adhesion and hardness as determined by cross hatch cut test and pencil hardness test.

**Keywords:** *Wind turbine blade; Erosion; Ceramic nanoparticles; Polyurethane; Coatings.*

## Contributory Paper S5O1

# Performance, Emission and Combustion Characteristics of a MMC coated Low Heat Rejection Engine Using Mahua Biodiesel

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A single cylinder diesel engine is converted into a Low Heat Rejection (LHR) engine by coating the piston face by Metal Matrix Composites (MMC), in which heat lost to the cooling water is conserved by this thermal barrier and part of that is converted into useful work by increasing the efficiency of diesel engine. Thermal barrier coating is made of 25% $ZrO_2$ +75% $Al_2O_3$ of 0.1 mm thick, 50% $ZrO_2$ + 50% $Al_2O_3$ of 0.1 mm thick and 100% $ZrO_2$

of 0.1 mm thick by using plasma coating method over the base of Ni-Cr bond coat of 0.150 mm thickness. The performance, emission and combustion characteristics of LHR engine is evaluated for Mahua biodiesel and the same is compared with that of diesel on normal engine. Experimentally it is observed that, the brake thermal efficiency of LHR engine increased with lower emissions.

## Contributory Paper S5O2

# A Novel Haemostatic Dressing Material Impregnated with Mesoporous Antibacterial Bioactive Glass for Profusely Bleeding Condition

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Haemostasis is a physiological progression that stops bleeding at injured site without fluctuation of normal circulation process. To avoid haemorrhage during critical situations, gauze sponges or else commercial haemostatic materials are applied. Although the market available material including Quick Clot, Hemcom, Celox etc are being used widely in defence purpose, there are several issues, still needs to be addressed: a.) the thermal injury due to the toxicity of zeolite, resulting from the exothermic reaction and poor biodegradability associated with QuickClot b.) Hemcon bandage is not sufficiently adjustable in deep wounds due to its hard consistency. However, bioactive glass can display better properties to overcome these problems, since bioactive glass is biocompatible, may support immune reactions, displays better stability and the haemostatic behaviour is incredible while treating with bioactive materials. Mesoporous bioactive glasses (MBGs) hold good promises in that they possess highly ordered mesoporous channels, large surface area, tunable pore surface and volume, well defined surface property. Herein the present research focuses on development of antibacterial bioactive glass microspheres impregnated nonwoven surgical cotton gauze (MABGmscg) dressing, and we have done a number of characterizations (XRD, FESEM, TG-DSC, FTIR) and experiments (In-vitro dissolution study, cytotoxicity study (both Bioactive glass and non-woven gauze coated with BAG), antibacterial activity study, in-vitro thrombus formation, Prothrombin time (PT) assay, in-vivo study- acute dermal toxicity study) related to our material, the result exhibits successful bioactive glass formation, showing no toxicity and importantly, 23% reduction in P time, in-vivo study shows no signs of local toxicity and complete hair coverage by 14 days, which exhibits excellent potential of the material to revolutionize the market, once the prototype is developed.

**Key Words:** *Hemostatic bioactive glass, XRD, Prothrombin time, acute dermal toxicity.*

## Contributory Paper S5O3

# Mechanistic insights into the synthesis of $CuFe_2O_4$ and $FeCo_2O_4$ by sol-gel method

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Understanding of the possible mechanisms that affect the crystal structure formation and properties of ferrites along with their applications in various fields is of prime importance in recent years. Synthesis conditions, cation distribution at tetrahedral and octahedral sites and their stability play important role in controlling phase-purity and physico-chemical properties of spinel ferrite and cobaltite compounds. In this work, an attempt is made to understand the role of synthesis conditions on progress of phase-formation and the structural properties of synthesized spinel ferrite and cobaltite compounds. $CuFe_2O_4$ nanopowders were synthesized by tartaric acid assisted sol-gel auto combustion method and were annealed up to 800 °C annealing temperatures. Similarly, $FeCo_2O_4$ was synthesized by tartaric acid assisted sol-gel auto combustion method and was annealed. The structural characterization was carried out by XRD technique. In case of $CuFe_2O_4$ annealed at 400°C, phase pure ferrite has been obtained and weak impurity phases appear with the increase of annealing temperature. While, in case of $FeCo_2O_4$ amorphous nature is observed and expected phase formation is not achieved. The synthesis parameters play a vital role in the formation of phase-pure compound. The present study provides a better understanding on the role of the synthesis mechanism involved in the preparation of spinel ferrite and cobaltite samples.

**Keywords:** *Ferrite, Cobaltite, Sol-Gel method.*

## Contributory Paper S5O4

# Sintering and Electrical Properties of AlN-BN and AlN-$Si_3N_4$ Ceramics

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Aluminium nitride ceramics are widely used for various applications such as substrate in electronic devices, single crystal piezoelectrics etc. However, its application as high temperature electrical insulator is relatively under-researched. As per the existing technology, h-BN is used in high temperature electrical insulation application, but it needs to be noted that h-BN being a soft material has low erosion resistance. Hence, in this study AlN and its composites were studied. In this investigation, AlN-BN and AlN-$Si_3N_4$ ceramics were

prepared with BN and $Si_3N_4$ content varying from 10 to 50 wt % respectively. These ceramics were sintered by pressure less sintering technique at 1675 ºC for 4 hours using $Y_2O_3$ as a sintering aid. It is observed that after sintering AlN with 10 wt % of each BN and Si3N4 were found to be well sintered. Relative density of AlN-BN was found to be 98.49% and for AlN-$Si_3N_4$, it was 78.86%. Relative density of AlN-$Si_3N_4$ ceramics compared to AlN-BN ceramics was found to be relatively low. Precision impedance analyzer was used for investigating dielectric properties and it was found that, as frequency is increased, the dielectric constant found to be decreased for both AlN-BN (90-10 wt %) and AlN-$Si_3N_4$ (90-10 wt%) compositions at room temperature. However, above 1 kHz frequency dielectric constant exhibited nearly frequency independent behaviour in both the systems. At a frequency of 1 MHz, dielectric constant of AlN-BN was about 8.3 and for AlN-Si3N4, it was about 7.15. The dielectric constant of these compositions is in agreement with that of h-BN ceramics reported in the literature.

***Key Words:*** *AlN, h-BN, $Si_3N_4$, dielectric constant*

**Contributory Paper S6O1**

# Cementitious Nanostructured Coating on Graphite For New Generation Anodes Of Lithium Ion Batteries

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Nanostructured sol gel thin coating of high alumina based cementitious dielectric phases on graphite has been developed by suitable precursors via chemical route. The evolution of selective thin film has been substantiated by atomic force microscopy (AFM), scanning electron microscopy (SEM) and X-ray diffraction (XRD) studies. Uncoated and coated graphite samples have been compared in terms of their application as anode materials in a representative lithium (Li) ion battery. The better anodic performance of coated graphite samples in rechargeable batteries have been explored in terms of cyclic voltammetry (CV) plot and voltage-current output plots after a few cycles. The specific charge and discharge capacity of those two have also been noticed. From this brief investigation, it is apparent that this coated graphite has good potential as a successful anode material in standard batteries.

**Keywords:** *graphite, coating, charge discharge capacity, nanostructure*

Contributory Paper S6O2

# Removal of Mixed Azo Reactive Dyes from Aqueous Solution Using Mixed-Oxidants-based Fenton-like Process Backed-up by Hybrid Ultrasound Cavitation and Ozonation Techniques

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Textile industries utilize azo reactive dyes which contribute to about 70% of all used dyes. These dyes possess intense color and higher chemical oxygen demand (COD). Moreover, their removal from an aqueous solution is intricate via the common physical processes such as the adsorption and coagulation-flocculation. Even though the Fenton-like advanced oxidation process (AOP) involving hydrogen peroxide ($H_2O_2$) as an oxidant is found to be effective for the degradation of azo reactive dyes, it is a highly expensive process . Nevertheless, by mixing the costlier oxidants (such as the $H_2O_2$) with the cheaper one (such as the persulfate (S2O82-)), it is possible to reduce the cost specifically during the scale-up operation while maintaining high dye degradation activity. Nevertheless, the Fenton-like process for the removal of mixed reactive dyes by using the mixed oxidants has not been reported in the literature. Hence, in this work, a non-magnetic Flyash (FA)-Pd and a magnetic FA-γ-Fe2O3-Pd composite particles have been synthesized via the combination of electroless and inverse co-precipitation techniques. The composite particles have been utilized as activators in the Fenton-like AOP for the degradation of two different industrial azo reactive dyes in an aqueous solution by using the $H_2O_2$ and $S_2O_{82}$- as a single and mixed oxidants. The values of different parameters of Fenton-like AOP such as the catalyst concentration, oxidant ratio and its dosage, and initial solution pH have been optimized for the degradation of individual azo reactive dyes. The pre-treated dye solutions have been subjected to a hybrid process consisting of ultrasound (US) cavitation and ozonation ($O_3$) techniques, to eliminate the residual color and to minimize the final COD levels. Most common optimized treatment conditions have been established which were subsequently utilized for the degradation of azo reactive dyes mixed in an aqueous solution with varying initial concentration ratios. The benefits of utilizing magnetic composite particles as activator have been revealed over those of utilizing the non-magnetic counterparts.

**Keywords:** *Advanced oxidation process; Fenton-like process; Chemical oxygen demand*

## Contributory Paper S6O3

# Enhanced Photocatalytic Activity of Metal Doped $Bi_2WO_6$ for Water Splitting under Visible Light

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Design and fabrication of artificial systems that can mimic natural photosynthesis to directly harvest and convert solar energy into usable or storable energy resources which may resolve the global energy crisis. In this regard, photocatalysis is an efficient approach to harness solar energy and utilize solar photons to drive the thermodynamic uphill reaction to generate chemical fuels. Bismuth tungsten oxide ($Bi_2WO_6$) is a typical Aurivillius double perovskite oxides has been received an increasing research interest in water splitting due to moderate bandgap, superior chemical and thermal stability. However, the solar light absorption of bare $Bi_2WO_6$ is not significant in visible region, and low charge separation efficiency limits the photocatalytic performance. In the present work, the problem of limited absorption and fast charge transfer may overcome through *in situ* doping of $Bi_2WO_6$ having assembled flower like microstructure (~6 to 8 µm) by metal (Mo, Fe, Zn). The metal doping effectively reduces the bandgap $Bi_2WO_6$ and enhance light absorption in visible region. Notably, photoelectrochemical water splitting efficiency highly improved after metal doping and for example, Mo doping showed highest photocurrent density which is seven times higher than bare $Bi_2WO_6$. The enhanced activity may originated due to presence of additional electronic states via doping and enhanced number of charge carriers at the electrode-electrolyte interface during water splitting.

**Key Words:** *Photocatalysis, Water Splitting, Metal doped Bi2WO6*

## Contributory Paper S6O4

# Synthesis of Lithium Nickel Cobalt Aluminium oxide (NCA) Type Cathode Material for Lithium-Ion Batteries

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Lithium Nickel Cobalt Aluminium oxide (NCA) type cathode material for lithium ion batteries is synthesized by calcining Ni–Co–Al hydroxide based precursors through hydrothermal process. Development focused on the constructive synthesis that led to microsphere structure of material has diameter of 2-5 µm. The effect of hydrothermal reaction

time on the morphologies and the crystalline quality of the NCA cathode material is investigated on the basis of scanning electron microscopy & X-ray diffraction method. The developed NCA materials showed a specific capacity of ~160 mAh/g at 0.1C rate, which is a notable property of this material and shows good promise for future exploitation. The hydrothermal process was frozen after carrying out a series of experimental trials with other processes by keeping specific capacity of the derived powders as the primary parameter in each of the experimented processes. Electrochemical analysis of the button cells prepared by using developed NCA sample is stable up to 100cycles with a discharge capacity of > 155mAh/g. The derived NCA powders are also characterized in terms of specific surface area by using Brunauer-Emmett-Teller (BET) Isotherms, thermal stability by Thermo-Gravimetric Analysis (TGA), impurity in the developed NCA material by X-Ray Powder Diffraction (XRD) Analysis and moisture content.

**Key words:** *NCA, Lithium-ion battery, hydro-thermal synthesis & coin cells battery*

**Contributory Paper S6O5**

# One-Pot supercritical fluid Synthesis of Reduced Graphene Oxide hybrid $BiVO_4$ nanostructures for Li-ion Battery as Anode

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Metal Vanadates have to attracted the attention of researchers due to their potential applications in energy storage devices. In this paper, we are presenting a one-pot synthesis of hybrid nanostructures of $Bi_2WO_6$/rGO. The obtained composite sample was characterized using X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Electron Dispersive Spectrometry (EDS), FTIR, BET, and TGA-DTA for its structural, morphological, compositional, organic-groups identification and thermal analysis respectively. XRD of the sample as shown the formation of the monoclinic crystal structure. TEM results revealed the formation of rGO coated $BiVO_4$ hybrid nanomaterial and rGO has wrapped the surface of $BiVO_4$. About 3 μm 1-D branches formed by smaller nanoparticles were observed under TEM. Electrochemical properties of the sample indicate a charge-discharge capacity of 800 mAh/g, with efficiency at 0.1 C rate. One-pot synthesis of $BiVO_4$ -RGO nanocomposite on the surface plays an important role in obtaining high capacity and performance.

## Contributory Paper S8O1

# Effect of particle morphology on the wear resistance mechanism of Alumina Ceramics.

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The wear resistance of alumina ceramics is determined by the particle size, shape, and distribution of the alumina powders. However, a detailed and systematic study on the characteristics of different types/grades of calcined/reactive alumina was not investigated. The chemical business of Hindalco Industries Limited (HIL) at Belagavi manufacturers have over 80 – 90 different grades of specialty alumina, which goes for Refractory and Ceramic applications. Hence, it was thought prudent to investigate the effect of particle morphology on the wear resistance properties of alumina ceramics. This paper presents the investigation made on the sintering studies with different alumina powders having different particle size, shape, and distribution leading to desired sintering characteristics of the alumina ceramics. The resultant alumina ceramics are further examined for their respective wear resistance properties and worn surface morphologies, to understand the underpinning mechanism for the wear resistance applications.

**Keywords:** *Alumina, Wear resistance, Wear Morphology*

## Contributory Paper S8O2

# Viscosity and Gelation of Ceramic Slips – An Industrial Perspective

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As we know much of the ceramic production process involves ceramic slips and slurries. An understanding of the slip rheological properties gives us a better control over the production yield. The article will help in selecting the right clays, deflocculant dosage and solid content of a ceramic suspension.This paper investigates the viscosity and gelation behaviour of kaolins, ball-clays and casting-slips (sanitaryware). The kaolins and ball-clays are Indian as well as imported in origin. Viscosity measurements were performed using Gallenkemp Torsion Viscometer, Brookfield Viscometer and Ford cup flow method. Gelation was measured by Brookfield viscometer by plotting Gel-curves at different durations. Effects of dispersants, salts and solid-content on viscosity and gelation-rate are also discussed.

**Key Words:** *Slip-Casting, Rheology, Gelation, Deflocculant*

## Contributory Paper S8O3

# Ceramic-Based Photocatalytic Membrane Reactors for Wastewater Treatment

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The ever-increasing global water stress has led researchers to focus on efficient water treatment techniques. Advanced oxidation processes applying photocatalysts have drawn attention due to their ability of degrading recalcitrant organic contaminants present in wastewater. Integrated membrane separation with photocatalytic degradation technology has been of particular interest recently for effective treatment of emerging complex pollutants which are otherwise difficult to treat by conventional technologies. Combining membrane filtration with photocatalysis enables the use of comparatively low-pressure membrane systems and also provides the advantage of degrading the contaminants rather than simply separating. This short review focuses on the application of ceramic membranes as photocatalytic membrane reactors (PMRs) in wastewater treatment and advantages thereof. Both suspended and immobilized catalyst type PMR configurations are discussed along with their respective advantages and limitations.

**Keywords:** *ceramic; membrane reactor; photocatalysis; wastewater treatment*

## Contributory Paper S8O4

# A comparative study on solid state and sol gel synthesis of Lithium Aluminium Silicates

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Lithium Alumino Silicate (LAS) is a glass ceramic material containing oxides of lithium, aluminium and silicon which are potential materials in various applications like anticorrosive and ware resistant, optical instruments, telescope mirrors, high temperature sealing, electromagnetic window etc. The two common compositions of LAS are spodumene ($LiAlSi_2O_6$) and eucryptite ($LiAlSiO_4$). Various methods like melt quenching, sol gel and solid state method have been already adopted for the synthesis of these compositions. In the present study we followed two synthesis methods: solid state method and sol gel method for

both spodumene and eucryptite compositions and the results obtained are compared. In the solid state method the precursors are wet milled in ethanol and calcined from 800°C to 1000°C. In the sol gel method the gel obtained is subjected to thermo-gravimetric (TG/DTG) analysis to find out the thermal effect on the gel composition and crystallization temperature of the LAS. Further the gel is subjected to calcinations from 600°C to 1000°C. The calcined powders are subjected to X-ray diffraction (XRD) to find out the phase evolution as a function of temperature. The final crystallized spodumen and eucryptite powders are characterized by IR spectroscopy, particle size analysis and morphology by scanning electron microscopy (SEM). The TG/DTG results showed that the crystallization of LAS (Spodumen and Eucryptite) begines at 600°C in the sol gel method, while the crystallization of LAS begins at 800°C in the solid state method. However completion of crystallisation takes place above 900°C in both cases.

**Key Words:** *Spodumen, Eucryptite, Solid state, Sol-Gel*

# List of Flash Talks (ePosters)

| Flash Talk Session 1: Processing and Engineering Ceramics & Coating, Nanomaterials & Structural Ceramics, Refractory Materials & Applications | | | |
|---|---|---|---|
| **Flash Talk ID** | **Author Details** | **Title of The Paper** | **Abstract ID** |
| FTS1-01 | NAGARAJA T | Investigation on Diffuse Phase Transition through Raman and Dielectric Properties of $Pb(Fe_{0.5}Nb_{0.5})O_3 - Pb(Co_{0.33}Nb_{0.67})O_3$ Solid Solutions | IvaCCT21-ABS008 |
| FTS1-02 | Dhiraj kumar | Numerical Modeling and Drying Analysis of Kaolin in Deep Bed Dryer. | IvaCCT21-ABS011 |
| FTS1-03 | P RAJU | Comparative Wear Study of Pressure Slip Casting Sintered Alumina Solid Bodies | IvaCCT21-ABS050 |
| FTS1-04 | Dr.Preeti | Synthesis, Structural and Raman investigations of $PbNi1/3Nb_2/3O_3$ Ceramics | IvaCCT21-ABS073 |
| FTS1-05 | Kamalakar Reddy | Innovative Approach in Enhancing the Campaign Life of Blast Furnace Refractory & Hot Repair in Hot Blast Main | IvaCCT21-ABS012 |
| FTS1-06 | Kamal hossain Shaikh | Reaction sequence of the system Al-O-Si-N-C | IvaCCT21-ABS026 |
| FTS1-07 | Sanghamitra Bharati | Steelmaking Slag as Secondary Raw Material Source in a Castable for Low Temperature Applications | IvaCCT21-ABS066 |
| FTS1-08 | Paromita Das | Surface Engineering of Multi-Walled Carbon Nanotubes (MWCNTs) with Ceramic Oxide Coating | IvaCCT21-ABS045 |
| FTS1-09 | UMASHANKER L | Effect of Slurry erosive parameters on plasma sprayed Coatings on mild steel Substrate | IvaCCT21-ABS060 |
| FTS1-10 | UMASHANKER L | Sliding wear behavior of plasma sprayed coatings on mild steel | IvaCCT21-ABS061 |
| FTS1-11 | Mohammed Adnan Hasan | Development of Space-Environment worthy Protective Oxide Thin Films on Germanium Sun-Shield for Spacecraft Application | IvaCCT21-ABS103 |
| FTS1-12 | Srikrishna Manna | Silica based mesoporous antireflective (AR) cum hydrophobic coatings on solar cover glass for domestic and agricultural applications | IvaCCT21-ABS114 |
| FTS1-13 | Gauri Chavan | Novel ceramic nanocarrier for biomedical applications | IvaCCT21-ABS001 |

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|---|---|---|---|
| FTS1-14 | Mukesh Suthar | Facile Synthesis And Microwave Absorption Performance Of Paraffin Wax/BCZT/Activated Carbon-Based Composite Within Ku Band | IvaCCT21-ABS020 |
| FTS1-15 | Savan Kumar Sharma | Effect of Synthesizing Parameters towards the Evolution of Sol-Gel Derived Mesoporous γ-Alumina | IvaCCT21-ABS044 |
| FTS1-16 | R Divagar | Experimental / Practical Method of Finding Hoop Compressive Strength of Ceramic Cylinder | IvaCCT21-ABS069 |
| FTS1-17 | Dr. Hemalatha K.S | Relaxation mechanisms in Cerium Oxide doped Polyvinyl Alcohol nanocomposite films by using Impedance Spectroscopy | IvaCCT21-ABS081 |
| FTS1-18 | Mary Heleena | Studies on the Synthesis and Properties of Plasma Sprayed Yttrium Aluminum Garnet ($Y_3Al_5O_{12}$) Coating | IvaCCT21-ABS097 |
| FTS1-19 | Sharavan V | Effect of Alumina Nanoparticles on the Mechanical properties of Clay Brick | IvaCCT21-ABS108 |
| FTS1-20 | Harshit | Use of $SiO_2$ as Si-Source for Direct Single-Step Solution Combustion Synthesis of $CaMgSi_2O_6$ Ceramic Powder and Study of Their Compaction Behavior | IvaCCT21-ABS115 |

**Flash Talk Session 2: Advances in Glass, Ceramics for Environment and Advanced Functional Ceramics & Biomaterials**

| Flash Talk ID | Author Details | Title of The Paper | Abstract ID |
|---|---|---|---|
| FTS2-01 | Rupam Saha | In situ Radiopaque Bioactive Glass A Novel Composition For The Treatment Of Osteoporotic Vertebral Compression Fracture | IvaCCT21-ABS028 |
| FTS2-02 | T Sravan Rao | Synthesis and Characterization of Bismuth Borate-Barium titanate glasses | IvaCCT21-ABS034 |
| FTS02-03 | Sadashiv Bellubbi | Experimental Studies on Electro Chemical Discharge Machining Parameters for Silica Glass | IvaCCT21-ABS043 |
| FTS2-04 | Dr Sunanda Dadami | Influence of Electric Poling on $Pb_{0.9}Bi_{0.1}Fe_{0.55}Nb_{0.45}O_3$ Multiferroic | IvaCCT21-ABS049 |
| FTS2-05 | SATYENDRA KUMAR SINGH | Synthesis, Characterization, Mechanical and Machinability Behavior of Mg-PSZ Based 13-93 Bioactive Glass Composite | IvaCCT21-ABS010 |
| FTS2-06 | Akanksha Gupta | Effect of Sintering Temperature in Improving Hard Magnetism of $SrFe_8Al_4O_{19}$ for Permanent Magnet Applications | IvaCCT21-ABS016 |
| FTS2-07 | Dr. Mitun Das | Pressureless sintering of Fluorapatite – ZnO nanocomposite: Mechanical and biocompatibility study | IvaCCT21-ABS023 |

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|---|---|---|---|
| FTS2-08 | Monalisa Adhikari | Trace level formalin gas sensing by copper ferrite inverse spinel | IvaCCT21-ABS047 |
| FTS2-09 | Dr. Saravanan R | Microstructure and Mechanical Properties of TiC reinforced Al6063 Composites in Hot Extrusion | IvaCCT21-ABS053 |
| FTS2-10 | Rathina vel | Protein Encapsulated Sugar glass nanoparticles loaded nanofibrous patch for Tissue Engineering Applications | IvaCCT21-ABS055 |
| FTS2-11 | Dr. A.Rajani Malathi | Dielectric and Ferroelectric properties of CT and ST added NBT based composites | IvaCCT21-ABS056 |
| FTS2-12 | Subhajit Mojumder | Zinc Chromite Ceramic Spinel Nanoparticle Based Trace Acetone Sensor | IvaCCT21-ABS093 |
| FTS2-13 | V VEENACHARY | Electrical and Magnetic Studies on Promising Aurivillius Intergrowth Compound | IvaCCT21-ABS031 |
| FTS2-14 | P. Ramalingam | Thermal Calculations For Ceramic Engines - Prototype - 1 | IvaCCT21-ABS071 |
| FTS2-15 | V. Rajasekar | Evolution Of Ceramic Engines | IvaCCT21-ABS072 |
| FTS2-16 | Guddappa Halligudra | $Fe_3O_4$ nanoparticles supported $MoS_2$ nanoflowers ($MoS_2$-$Fe_3O_4$) as magnetically recoverable and reusable heterogeneous catalyst for reduction of organic dyes. | IvaCCT21-ABS077 |
| FTS2-17 | Pawan Rangdal | Synthesis Of Organic-Inorganic Porous Framework Using Locally Available Fullers Earth | IvaCCT21-ABS082 |
| FTS2-18 | K. Rudresha | UV light Assisted De-colorization of Dyes and Sensing of Arsenic and Lead by using 2-Dimensional CuO–ZnO Hybrid Nanocomposite | IvaCCT21-ABS101 |
| FTS2-19 | Ravi Mudike | CZTS Crystal growth by the slow vapor diffusion process | IvaCCT21-ABS105 |
| FTS2-20 | B. Uma | Synthesis of novel heterostructured Fe-doped $Cu_2O$/CuO/Cu nanocomposite: Characterization, enhanced Sunlight driven photocatalytic activity, efficient antibacterial agent and supercapacitor properties | IvaCCT21-ABS106 |
| FTS2-21 | Krushitha Shetty | Study of Green route Synthesis for Nano $MgFe_2O_4$ and its application as photocatalyst | IvaCCT21-ABS110 |

| Flash Talk Session 3: Ceramics in Energy | | | |
|---|---|---|---|
| **Flash Talk ID** | **Author Details** | **Title of The Paper** | **Abstract ID** |
| FTS3-01 | Mononita Das | "Paper Separator" with Improved Porosity, Thermal Stability and Electrochemical Performance for Application in Lithium-Ion Batteries | IvaCCT21-ABS027 |
| FTS3-02 | SHOROSHI DEY | Insights into the Redox Activity of La/Ba-Sr-Co-Fe-O-based Perovskite Oxides for Electrochemical Reactions in Solid Oxide Cells (SOC) | IvaCCT21-ABS032 |
| FTS3-03 | GOMASU SREENU | Structural and electrical characterizations of a novel lead-free ferroelectric bulk ceramics (1-x)$BiFeO_3$ –x$CaTiO_3$ for energy storage application | IvaCCT21-ABS038 |
| FTS3-04 | Koyel De | Effect of Co-Doping in $CeO_2$ Based LT-SOFC Electrolyte on Structural and Electrical Properties | IvaCCT21-ABS041 |
| FTS3-05 | Kuntal Ghosh | Engineered microstructure of $Li_7La_3Zr_2O_{12}$ Garnet Electrolyte derived from Water Hyacinth for All Ceramic Monolithic Lithium Batteries | IvaCCT21-ABS042 |
| FTS3-06 | Subhadeep Saha | Structural and Electrical Characterizations of $Nd^{3+}$ doped Bismuth Ferrite | IvaCCT21-ABS046 |
| FTS3-07 | Raveena R | Thermal Fundamentals of Ceramic Engine | IvaCCT21-ABS065 |
| FTS3-08 | Harish Sundara Raman | Concept of Using Ceramic Cylinders in IC Engines for Improving Efficiency | IvaCCT21-ABS067 |
| FTS3-09 | PR Lakshminarayanan | Futuristic Problems and Solutions | IvaCCT21-ABS068 |
| FTS3-10 | Naeemakhtar Momin | Effect of 20 mol % Doping of Gd on Ionic conductivity of Ceria Electrolyte for Intermediate Temperature Solid Oxide Fuel Cells | IvaCCT21-ABS091 |
| FTS3-11 | Vinay G | $MnFe_2O_4$ Synthesis and Characterization for Mg-Ion Battery Application | IvaCCT21-ABS104 |
| FTS3-12 | Vikas N. Thakur | Synthesis and Supercapacitive Study of CNT-Black $TiO_2$ | IvaCCT21-ABS100 |
| FTS3-13 | Akshay S | A Novel Aloe Vera mediated Solution Combustion Synthesis and Photoluminescence properties of $ZrTiO_4$ nanorods | IvaCCT21-ABS107 |
| FTS3-14 | Chetana S | Study of Charge Generation and Effect of the DC Supply on the Growth of Carbon Nanotubes and Their Electrochemical Properties | IvaCCT21-ABS095 |

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|---|---|---|---|
| FTS3-15 | K.M. Mamatha | Facile green synthesis of Molybdenum Oxide Nanoparticles using Centella Asiatica plant extract: Its photocatalytic and electrochemical Sensor applications | IvaCCT21-ABS096 |
| FTS3-16 | Mahesh Shastri | 2D Heterostructures based on Sulfur Nanosheets and educed Grphene oxide for Li-S batteries | IvaCCT21-ABS109 |
| FTS3-17 | Shiva Kumar Swamy | CZTS-rods/MXene Binary Heterostructure for the Application of Enhanced Photo-responsive Activities | IvaCCT21-ABS111 |

| **Flash Talk Session 4: Materials & Manufacturing** | | | |
|---|---|---|---|
| **Flash Talk ID** | **Author Details** | **Title of The Paper** | **Abstract ID** |
| FTS4-01 | Sanjana M | Study on Partial Replacement of E-plastic Waste as Coarse-Aggregate | IvaCCT21-ABS007 |
| FTS4-02 | Dr. Bharath V | Effect of Ceramic $Al_2O_3$ Reinforcement on Microstructure Evolution, Tensile Failure, Fracture and Fatigue Behavior of Aluminum Metal Composites: T-6 Condition | IvaCCT21-ABS009 |
| FTS4-03 | Guruchannabasavaiah N G | Microstructural Evolution in Ceramic $Si_3N_4$ Reinforced Al6082 Composites Subjected to SPD- ECAP Process | IvaCCT21-ABS013 |
| FTS4-04 | Rajanna.R | Fatigue Behavior of Ceramic $Si_3N_4$ Reinforced Al6082 Composites | IvaCCT21-ABS014 |
| FTS4-05 | GOPAL KRISHNA U B | Metallurgical and Mechanical characterization of Al7075-WC-Co composite manufactured by combined ball milling and stir casting | IvaCCT21-ABS015 |
| FTS4-06 | GURUPRASAD M J | “Studies on Removal of neutral red dye from it’s aqueous solution using water insoluble β-cyclodextrin polymers” | IvaCCT21-ABS018 |
| FTS4-07 | RAJESH G.L | Impact of Test Temperature on Wear Properties of 6061Al Reinforced with Ceramic B4C Micro-Composites Processed through Rheo Metallurgy | IvaCCT21-ABS019 |
| FTS4-08 | VEERESHA G | Ceramic Reinforcement Particle Size Impact on the Mechanical Behavior and Fractography of Al2618-B4C Aerospace Metal Composites | IvaCCT21-ABS021 |
| FTS4-09 | Madhuchhanda Sarkar | Improved indentation hardness of geopolymers by partial replacement of metakaolin with terracotta waste | IvaCCT21-ABS022 |
| FTS4-10 | Abhishek Kumar Singh | Fabrication and Characterisation of Fe-Cr Metal Matrix Composites Reinforced with $ZrO_2$ | IvaCCT21-ABS037 |

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|---|---|---|---|
| FTS4-11 | C V Raja Reddy | An Abstract of Machinability Studies Of Aluminium And Its Alloys | IvaCCT21-ABS048 |
| FTS4-12 | Dr. Anil Kumar | Durability properties study by using central composite design of blended geopolymer | IvaCCT21-ABS052 |
| FTS4-13 | BYRA REDDY | Influence of hot rolling on wear behaviour of Al6063- nanoB4C composites fabricated by ultrasonic assisted stir casting process | IvaCCT21-ABS062 |
| FTS4-14 | Swetha B M | Synthesis, characterization, and catalytic properties of different concentration of cobalt substituted mesoporous aluminophosphate (CoAPO) molecular sieves | IvaCCT21-ABS064 |
| FTS4-15 | Dr. Ananad Kabadagi | Electro-Oxidation of Ethanol Using Mo(VI) Adsorbed Organo-Modified Fe-Montmorillonite | IvaCCT21-ABS083 |
| FTS4-16 | Santosh Chikkamath | Diffusion behavior of Ba(II) on Fe-Montmorillonite Relevant to Geological Waste Disposal | IvaCCT21-ABS084 |
| FTS4-17 | Ashutosh Gupta | A comparative study on physio-mechanical properties of silica compacts fabricated using rice husk ash derived amorphous and crystalline silica | IvaCCT21-ABS089 |
| FTS4-18 | Vaibhav Pandey | Fabrication and characterization of porous $SiO_2$ composite for high temperature engineering applications using low-cost materials | IvaCCT21-ABS090 |

Flash Talk FTS1-01

# Investigation on Diffuse Phase Transition through Raman and Dielectric Properties of $Pb(Fe_{0.5}Nb_{0.5})O_3 – Pb(Co_{0.33}Nb_{0.67})O_3$ Solid Solutions

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We report a series of Pb based multiferroic solid solutions (1-x) Pb(Fe0.5Nb0.5)O3 – (x) Pb(Co0.33Nb0.67)O3 ($0.1 \leq x \leq 0.5$) (shortened as PFCN), synthesized using a single-step solid-state reaction method. The structural, microstructural, Raman, and temperature (301 – 481 K) dependent dielectric (102 – 106 Hz) were thoroughly investigated. The room temperature X-ray diffraction data reveals the monoclinic phase with the Cm space group for all the solid solutions. The atomic-level structural parameters were obtained for all the solid solutions from the Rietveld refinement technique, and it was observed that an increase in the unit cell volume with an increase of PCN content in PFN. The field emission scanning electron microscope images confirm the densely packed, uniform coarse arrangement in all the samples. Energy-dispersive X-ray spectroscopy reveals the existence of Pb, Fe, Co, Nb, and O elements according to stoichiometry. The temperature-dependent Raman spectra of all the solid solutions show a decrease in the intensity and changes in the spectral line shape of B-localized F1u (~250 cm-1) and BO6 octahedral rotation F1g (~260 cm-1) modes around the characteristic temperature, maybe a structural transformation from monoclinic to cubic above Tm. The frequency-dependent ε′ and tanδ reveal the presence of Maxwell-Wagner polarization in the lower frequency. The temperature-dependent ε′ shows the ferroelectric relaxor type diffused phase transition Tm (TC) around ~360 K, ~340 K, ~330 K & ~320 K for x = 0.1, 0.2, 0.3 & 0.4, respectively. The reported Tm (TC) systematically decreases with increasing x due to the lower Tm (TC) of PCN compared to PFN. These results were consistent with the anomalies observed at the vicinity of Tm in the Raman spectra.

**Keywords:** *Relaxor ferroelectrics; Raman spectroscopy; Diffuse phase transition; Dielectric constant.*

Flash Talk FTS1-02

# Numerical Modeling and Drying Analysis of Kaolin in Deep Bed Dryer.

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After shaping the water must be removed so that the shape becomes sufficiently rigid to withstand handling and setting in the kiln. Drying is a critical stage in ceramic manufacturing. The drying process sometimes places more stress. If a clay piece is not completely dry before the first firing, it will crack, warp or even explode.

An analytical study of deep bed drying process considering cross flow where material enters from the one side of the chamber and hot air is directed from the bottom through a plenum chamber. The assumptions include uniform material temperature, any losses from the bed to surrounding. Diffusion in material has been considered, a Specified size of material and drying equation has been used for predicting variation of moisture content within material. The modeling of heat and mass transfer between air and material in moving bed dryers is based on the application of enthalpy balance, mass balance, heat transfer rate, mass transfer rate and diffusion equation for a Specified size material. These equations obtained are highly implicit in nature and need to be solved simultaneously. Equations for mass balance of moisture between material and air, enthalpy balance, heat transfer rate and mass transfer rate at the outer surface of the material and diffusion of moisture inside a considered size of material, have been solved simultaneously through an implicit scheme using TDMA. A mathematical model and a simulation program in C++ have been developed for steady state cross flow deep bed drying process of spherical particles The input parameters include the temperature, moisture content, mass flow rate of material at one side of dryer and the temperature, humidity and mass flow rate of air at bottom of the dryer. The output parameters are moisture content and temperature of the material at the bottom of the dryer along with the temperature and humidity of air at the top of dryer. The results have been generated for drying of kaolin considering multi element.

Flash Talk FTS1-03

# Comparative Wear Study of Pressure Slip Cast Sintered Alumina Solid Bodies

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Alumina ($Al_2O_3$) with its superior mechanical and tribological properties in combination with chemical inertness is a preferred material for the wear resistant applications such as grinding media, especially in harsh environments. Unlike conventional slip casting (CSC), Pressure Slip Casting (PSC) offers very high homogeneity, high production rate and minimum rejections due to the forming under pressure in the colloidal medium. Though the slip is flowable under pressure, a high degree of packing and inter-locking of particles is present, which in turn hold the structure intact during and after the removal of water. PSC samples exhibit close packed microstructure which lead to high green and sintered density in comparison to CSC samples. Although the PSC samples show occasional porosity, which is corroborated by the density values, good mechanical properties like the hardness, flexural strength and fracture toughness are observed. This enhancement in the above-mentioned mechanical properties together with high temperature sustaining capability intrinsically leads to good suitability for the wear properties. Sliding wear test was carried out for both PSC and CSC processed and sintered Alumina bodies. Wear rates of PSC samples were in the range of (2.35-3.11) × $10^{-18}$ $m^3$/Nm in comparison to CSC samples exhibiting (5.97-7.88) × $10^{-18}$ $m^3$/Nm as a function of normal load applied while maintaining a sliding velocity of 0.5m/s. Lower wear rate of 56% observed in the case of PSC samples in comparison with the CSC samples can be attributed to the microstructure, superior density and enhanced mechanical properties. Application of pressure on the slip during casting has significant influence on the continuous thickness built up of layer by layer with enhanced density and hardness of the final product resulting in superior mechanical and wear properties as well.

***Keywords:*** *Pressure slip casting (PSC), Microstructure, Wear rate, $Al_2O_3$.*

## Flash Talk FTS1-04

# Synthesis, Structural and Raman investigations of $PbNi_{1/3}Nb_{2/3}O_3$ Ceramics

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The Pb ($Ni_{1/3}Nb_{2/3}$) $O_3$ (PNN) ceramics were synthesized by two different methods, namely (i) single step and (ii) double step method. For one step method, the initial reactants (PbO (99.9%. Alfa Aessar), NiO (99.998%. Alfa Aessar), $Nb_2O_5$ (99.9985%. Alfa Aessar)) were weighed in appropriate proportions mixed and powders were heat treated at 900°C and sintered at 1200°C.For two step method, Nickel Niobate (NN) was prepared via standard solid state reaction method and thereafter mixed with PbO powder. The phase formation of powders prepared by both the methods at various temperature and lead excess were analyzed by X-ray diffraction and Raman scattering experiments. The studies revealed that for single step reaction method the unreacted phases diminished with increase of firing temperature and only impure nickel niobate phase remains at 1200°C. Addition of 4wt% excess lead reduces the impure nickel niobate phase concentration from 8.9 % to 4.2% for single step method. Excess of 2wt% PbO was found sufficient to remove pyrochlore nickel niobate phase for double step method. The temperature dependent XRD shows the pure phase throughout the temperature range 35 to 350K indicating the stability of phase formed. The Raman studies also confirms the formation of pure perovskite phase.

**Keywords:** *lead, PNN, Lead nickel niobate*

## Flash Talk FTS1-05

# Innovative Approach in Enhancing the Campaign Life of Blast Furnace Refractory & Hot Repair in Hot Blast Main

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In general blast furnace has a campaign life of 10-15 Years, when lined with carbon Refractory. Hearth refractory lining wear is the main determining factor for the end of the blast furnace campaign. Over recent years, owing to the need to increase productivity, it has been necessary among other things to increase the hot metal temperature. As a result, refractory lining wear becomes more intense, for two reasons:

liquid flowrate in the hearth rises substantially because of increased production; therefore, the wear process known as 'elephant's foot' in the tap hole area is accelerated

the high rate of pulverized coal injection (120– 200 kg/Ton of hot metal) reduces dead man permeability while increasing its size. As a result, hot metal flow becomes more turbulent, thereby accelerating even further the lining wear while leading to 'brittle zones', which start inside the carbon refractory walls.

For Hearth relining it takes minimum 12 -18 months in arranging the carbon Refractory. In this paper we will showcase the extension of hearth life by monolithic repair solution which will support in continuing blast furnace operation until we are ready with all resources available for campaign repair.

Hot blast from stoves is conveyed through refractory lined Hot Blast Main where the temperatures will be >1200 C. Generally, most of the refractory failure happens in T Junction of Hot Blast Main. Regular procedure to repair the failure area is blowing down of Blast furnace, forced cooling of Hot Blast Main & carryout cold repairs which takes more than 7-8 days. In this paper we will see the hot repair carried out in Hot Blast Main T junction without much loss in production.

**Key Words:** *Hot Blast Main, Blast Furnace Hearth.*

## Flash Talk FTS1-06

# Reaction sequence of the system Al-O-Si-N-C

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SiAlON ceramics find their applications in various engineering fields due to their unique properties. One of the common routes of synthesizing SiAlON is carbothermal reduction and nitridation(CRN) of alumino silicate which has been a topic of interest of the researchers for many years. In the present study an attempt has been made to understand the different reactions involved in the process of SiAlON synthesis from kaolinite. Starting raw materials were china clay, quartz, Al metal powder. Graphite powder was used as reducing agent as well as an intermediate reactant. Carbothermal reduction and nitridation process were carried out for different batches and the corresponding reactions were studied using TG-DTA, XRD analysis. The reaction sequence of SiAlON formation was proposed in this paper.

**Keywords:** *SiAlON, Carbothermal reduction and nitridation, Reaction sequence*

## Flash Talk FTS1-07

# Steelmaking Slag as Secondary Raw Material Source in a Castable for Low Temperature Applications

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The National Steel Policy of India (2017) envisages a 300 MTPA production capacity by 2030-31. Steelmaking plants being the largest user of refractories, the demand for refractories is going to be equally high. With faster depletion of natural resources in a cutthroat competition scenario to optimize conversion cost, industries have been exploring plausible alternatives in waste management. This has compelled the steel industry to focus its efforts on recycling its by-product, thereby improving the environmental sustainability of steel production as well as usage of natural resources. In the present study, different steelmaking slags such as primary steelmaking slag, steel ladle slags, etc have been used as the aggregate raw material to prepare a conventional castable with calcium aluminate cement as the binder. The developed castables were assessed w.r.t. their physical properties, strength at different temperatures and linear expansion behavior. The material was used in the heat shield of RH degasser, which took 77 heats with a potential to take more heats.

## Flash Talk FTS1-08

# Surface Engineering of Multi-Walled Carbon Nanotubes (MWCNTs) with Ceramic Oxide Coating

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Multi-walled carbon nanotubes (MWCNTs) due to possessing a unique combination of thermal, mechanical as well as electrical properties have been recognized as a potential candidate in multifarious advanced engineering fields. However, on a keynote the successive exploitation of the beneficial aspect of MWCNTs in a particular application field can only be accomplished while comprehending to carefully identify and accordingly amend the basic associated pitfalls of the selected carbonaceous structures. Importantly, for MWCNTs the entire research challenges have been concentrated on the strategic reduction of the agglomeration tendency, enhancement of the thermal oxidative damage tolerance ability and appropriate amendment of the interfacial bond formation characteristics of the MWCNTs network at the concerned engineering field. Surface engineering which has recently come up as a useful tactic, demands to explore for a suitable ceramic material upholding with an ability to strategically address the above challenges. Thus, in the present investigation, binary oxide

spinel ceramic has been selected as a coating material in order to validate its significant potentiality in advanced technological fields. The promising influence of the sol-gel derived binary oxide spinel ceramic towards methodically amending the structural and morphological aspect of the thermally activated MWCNTs architecture are systematically evaluated in the present work.

**Key Words:** *MWCNTs, ceramic oxide, sol-gel, surface engineering*

## Flash Talk FTS1-09

# Effect of Slurry erosive parameters on plasma sprayed Coatings on mild steel Substrate

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Abrasive resistances of engineering components encountering the attack of erosive environments during operation can be improved by ceramic coatings on their surfaces with an optimum technique of plasma spraying. In the present research work the mild steel substrate has been coated with Cr2O3 and Cr3C2 using atmospheric spray techniques and coating of thickness 100 and 200micrometers have been developed. The micro hardness as well as the microstructure of the developed coatings was explored to analyze the composite coatings. Slurry erosive experiments have been conducted by varying the conditions of slurry erosive process such as test duration, slurry concentration, slurry speed and size of impinging particles on the erosive test rig. Under all the test conditions studied, Cr2O3 coatings on mild steel exhibited higher resistance to slurry erosive wear when compared with Cr3C2 coated and uncoated mildsteel,The outcome has shown that with an increase in slurry concentration slurry speed and impinging particle size, the slurry erosive wear loss increases the wear mechanism of uncoated and coated samples have been examined.

**Keywords:** *Atmospheric Plasma spray (APS), Mild steel substrate, Cr2O3, Cr3C2. Slurry Erosive wear*

## Flash Talk FTS1-10

# Sliding wear behavior of plasma sprayed coatings on mild steel

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Wear is one of the most common problems encountered in many industrial applications such as shaft sleeve failure, piston rod failure in reciprocating pump etc. Thermal sprayed ceramic coatings have been widely employed to offer alternative for modifying the

component surface properties in a broad range of industrial applications, primarily for wear resistance and corrosive environment.In the present research work the mild steel substrate has been coated with Cr2O3 and Cr3C2 using atmospheric spray techniques and coating of thickness 100 and 200micrometers have been developed. and the hardness as well as microstructure of the coatings were explored to analyse the developed coatings, sliding wear experiments have been conducted to study the wear behaviour of chromium based composite coating along with the uncoated specimen with respect to various load, sliding speed and sliding distance The wear samples are characterized by SEM. The sliding wear tests revealed that the wear rate was significantly reduced in Cr2O3 coated samples followed by Cr3C2 coated samples as compared to mild steel metal (substrate). In comparison, chromium Oxide and chromium carbide coatings, Chromium Oxide coating has comparably good effect.

**Key words:** *Chromium Oxide/Carbide, Sliding wear, atmospheric Plasma spray, Coatings, Mild steel*

## Flash Talk FTS1-11

# Development of Space-Environment worthy Protective Oxide Thin Films on Germanium Sun-Shield for Spacecraft Application

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In communication satellite, reflector antenna is most necessary part in seamless communication. Reflector is generally exposed to harsh environment of space. To protect the reflector against thermal degradation and physical damage, a protective sunshield on the reflector is required. However, usual technology available as germanium over the Kapton as sunshield is proven to degrade in ground environmental exposure resulting in alteration of its functional properties. Here we describe mitigation of the degradation of coating on sunshield with the help of additional protective layer coating on germanium. The thin film based coatings such as $Al_2O_3$ and $SiO_2$ acts as protective layer for germanium sunshield. The current studies focused on the retention of properties of protective layer after space environmental tests. Hence, the samples were characterized with the help of X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX) techniques to investigate microstructural characteristics. Thermo-optical properties such as infrared emittance and solar absorptance, electrical property i.e. sheet resistance of the deposited oxide films were measured. RF losses such as insertion loss and return loss were measured in both Ku band (11–15GHz) and X band (7–9 GHz). The space worthiness of the developed oxide coated layer on Germanium Black Polyimide (GBP) was examined by simulated environments, such as relative humidity (RH), thermal-shock cycling (TC) and thermo-vacuum (TVAC) tests. There was no noticeable degradation on microstructural and thermo-optical properties. This study indicates the oxide coatings of $Al_2O_3$ and $SiO_2$ can be used for protective layers for germanium based black Kapton without varying the RF transparency and values of thermo-optical properties which are functional requirements for the sun-shield thermal element of communication antenna in satellites.

## Flash Talk FTS1-12

# Silica based mesoporous antireflective (AR) cum hydrophobic coatings on solar cover glass for domestic and agricultural applications

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Generation of solar power as renewable energy source has many applications. Apart from producing power for offices and households, solar energy is an alternative renewable energy that is increasing usage for the agricultural purposes, which consumes considerable amount of power in India. Solar farming uses power generated from solar energy to operate agricultural or farming tools. It is simple, cost effective, reliable and long lasting. Most common agricultural tools such as tractors, watering systems, rotator, roller, planter, sprayers, etc. are worked on battery power and fuel oils. In solar farming, the battery power is replaced with solar power, so that the usage of the electricity from grid-power sources can be reduced substantially. In solar module, solar cover glass is used to protect solar cells. The solar cover glass is always exposed to the weather. Naturally sand, ash, dust/dirt, bird droppings or the like, particularly in Indian conditions can adhere thereon resulting the conversion efficiency of the solar cell module gradually decreasing since the transparency of the cover glass is being reduced. In order to suppress the reduction of the efficiency caused by light reflection or insufficient transparency, CGCRI has developed nanostructured mesoporous silica based hard and antireflective (AR) coating with hydrophobic (self-cleaning) surfaces on solar cover glasses to obtain better light conversion efficiency by both dip- and spray coating techniques. CGCRI has also been working on sol-gel technology for last few decades and has used this to develop various devices including AR cum self-cleaning glasses for solar panels which are being continually monitored for their real-life performance for last 2.5 years.

Some salient technical features coated SCG and its usefulness to fabricate solar panels are given: Coatings refractive index: 1.25– 1.36; coating thickness: 300-500 nm); It passes all ASTM tests; Output photo-power increased to ~5-7% (under ambient solar light); Reflection decreases >3% (average) in the wavelength range, 380 to 2000 nm; Static water contact angle: 127±3°.

## Flash Talk FTS1-13

# Novel ceramic nanocarrier for biomedical applications

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Design of suitable carrier for varieties of nanocargo has become the central theme of drug delivery research. In the present work, mesoporous silica nanoparticles (MSNPs) and

chitosan (CS) coated MSNPs were synthesized to explore the delivery of ova albumin. Prepared nanoparticles have been characterized for their structural, morphological studies and cell metabolic activity by using XRD, FTIR, FESEM, UV-Vis spectroscopy, BET techniques and MTT assay. Particle sizes estimated from DLS and FESEM of MSNPs, ova loaded MSNPs and CS-coated ova loaded MSNPs were found to be 495 nm, 486 nm and 686 nm respectively. FTIR confirmed the loading of ova and CS coating on MSNPs. The synthesized nanocargo vehicles (drug loaded nanoparticles) have successfully been tested in vitro for their cell viability. These novel nanocarriers may find potential applications in drug delivery as cheaper alternative and due to their excellent biocompatibility.

**Key Words:** *Mesoporous silica nanoparticles, Chitosan coated mesoporous silica nanoparticles, Ova albumin and drug delivery.*

**Flash Talk FTS1-14**

## Facile Synthesis And Microwave Absorption Performance Of Paraffin Wax/BCZT/Activated Carbon-Based Composite Within Ku Band

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Microwave absorbing materials have a significant role in electronics, communication, and modern warfare. The BCZT powder was synthesized using a solid-state route. Afterward, the physical blending route was employed to prepare paraffin wax/BCZT/activated carbon composite, having better microwave absorption performance within the Ku (12.4 – 18 GHz ) band of the frequency range. The structural and frequency-dependent microwave absorbing properties of the as-prepared composite were investigated using X-ray diffraction (XRD), Fourier transform infrared (FTIR), and vector network analyzer (VNA). The results showed that the addition of BCZT powder and activated carbon to the paraffin wax enhanced the microwave absorbing capability of the paraffin wax. Initially, it provided an RL value of -9.89 dB at 15 GHz for the pristine paraffin wax sample. Later, it was improved and found to be -17.14 dB at 14.89 GHz and -18.81dB at 14.87 GHz with BCZT and BCZT + activated carbon, respectively. The upgraded microwave absorption performance might be due to the interfacial polarization and impedance matching. This composite material achieved a bandwidth of 0.5 GHz at a thickness of 5 mm from 14.59 GHz to 15.09 GHz with 90% absorbance (-10 dB) of incident microwaves. It proves the possibility of using these materials in stealth technology and constructing futuristic radar-absorbing (RAMs) materials.

**Keywords:** *Microwave absorbing properties, Interfacial polarization, Impedance, Bandwidth, Stealth technology*

## Flash Talk FTS1-15

# Effect of Synthesizing Parameters towards the Evolution of Sol-Gel Derived Mesoporous γ-Alumina

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Mesoporous γ-alumina has received enormous technological importance in multifarious advanced engineering fields such as adsorbent, catalyst support system and membrane technology, etc. However, the unique combination of such excellent properties which make it versatile to become acceptable in the specific application field can only be attained while selecting a promising synthesizing strategy. The soft chemistry based sol-gel route has already been established as a suitable synthesizing technique that can provide good control over the final properties especially via enabling promising attainment of the desired structural parameters as well as the anticipated potential integrity of the end product. Herein, the current investigation deals with the meticulous alteration of the synthesizing parameters such as peptizing acid type and its associative solvent in the specially designed sol-gel based processing system which promotes dominating influence towards changing the atomic scale and surface structural integrity of the synthesized nanostructured gamma-alumina particles. Furthermore, in the present study, the first influential changes at the atomic scale structure which have been noted at the initial stage of the processing maintain its integrity even at the intermediate and final stage of processing and thereby collectively highlighted its authenticity towards attaining the future applicative potentiality with an in-detail scientific understanding.

**Key Words:** *Sol-Gel, mesoporous, nanostructure, γ-alumina.*

## Flash Talk FTS1-16

# Experimental / Practical Method of Finding Hoop Compressive Strength of Ceramic Cylinder

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In this paper a simple experimental method of finding the hoop compressive strength of plain ceramic cylinders is discussed. To find the hoop compressive strength practically,

two half sleeves are used around the ceramic cylinder and they are bolted together using a torque wrench. In the torque wrench predetermined torque on the bolt can be set and set torque is increased in small steps until the cylinder fails and the bolt loads are estimated by using the charts provided in existing literature. Then, by taking the total bolt load acting on the cylinder and by using the thin cylinder concept the hoop compressive strength is determined. The practical method finding this way is selected, because in the actual design of ceramic engine, an arrangement very similar to the testing method, is used to pre-compress the ceramic cylinder.

**Keywords:** *Ceramic engine, IC engine, Diesel engine, Pre-compression, Pre-stressing.*

## Flash Talk FTS1-17

# Relaxation mechanisms in Cerium Oxide doped Polyvinyl Alcohol nanocomposite films by using Impedance Spectroscopy

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The study of dielectric relaxation mechanisms of PVA-CeO2 nanocomposite films in the frequency range 50Hz to 35MHz and temperature range 300K-425K are reported as a function of composition. The Maxwell-Wagner-Sillars model is used to understand the variation of the dielectric constant with frequency. The dielectric loss exhibits a peak corresponding to the plateau region of ε'. Tan δ exhibits two peaks one at high frequency and the other at a low frequency that can be attributed to α and β relaxations respectively. Fitting the dielectric parameters to the modified Cole-Cole equation indicates a non-Debye type of relaxation. The activation energy for the relaxation is different above and below Tg indicating two different mechanisms there. Complex Impedance Spectroscopy indicates that the PVA-2.5wt% CeO2 has the least impedance amongst all the films. The Cole-Cole plot can be modeled by a capacitative element in parallel with a series combination of R and Q. The electric modulus M' and M'' have a plateau region in M' and a peak in M'' in the corresponding region. The curve fitting of the M'' variation to the Kohlrausch-Williams-Watts equation indicates that relaxation is non-Debye in nature both below and above Tg in the composites.

**Key Words:** *(Nanocomposite films, Dielectric, Relaxation mechanisms, Impedance analysis).*

## Flash Talk FTS1-18

# Studies on the Synthesis and Properties of Plasma Sprayed Yttrium Aluminum Garnet ($Y_3Al_5O_{12}$) Coating

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Yttrium aluminum garnet (YAG) is a well-known high temperature ceramic material that is used in solid-state laser materials, cathode-ray tube, field emission displays, scintillation, phosphors and electro-luminescent applications. In recent years, plasma-sprayed yttrium aluminum garnet (YAG) has been explored as an alternative ceramic topcoat for thermal barrier coatings (TBCs) as it is known to prevent the oxidation of the bond coat and also it possesses high resistance to calcium magnesium aluminosilicate (CMAS) attack. In the current investigation, an attempt has been made to fabricate plasma sprayed YAG coating. The flowable powders required for plasma spraying were synthesized by the versatile solution combustion process. The powders possessed blocky angular-shaped particles and possessed very good flowability. The influence of three different plasma spray powers on the crystallinity of the YAG coatings has been studied. The X-ray diffractometry data has been substantiated with the Raman spectroscopy data. The influence of plasma power on the microhardness and in turn on the wear resistance of the coatings has been explored.

## Flash Talk FTS1-19

# Effect of Alumina Nanoparticles on the Mechanical properties of Clay Brick

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Nanomaterials are materials that are gaining importance in construction field due to their unique properties that depends on size. Recently several nanomaterials have been employed in the construction industry as composites in brick, cements and so on. The alumina has been used in concrete bricks for better improvements of mechanical properties of materials. In this study we investigate the influence of the nanomaterials like $Al_2O_3$ and graphite, on the mechanical properties such as compressive strength, density, and water

absorption of the clay bricks. The clay soil is taken from chikkaballapur. The increase in the compressive strength and, higher density, lower water absorption depends on the percentage of $Al_2O_3$ nanomaterials to weight of clay taken such as (0.1%, 0.3%, 0.6%, 0.9%). XRD, SEM, FTIR, analysis is used to confirm the nanomaterials, the compression strength of specimens are obtained from direct compression test in UTM machine, In this study we obtained higher compression strength, higher density, lower water absorption, after addition of 0.6% α-$Al_2O_3$ and 0.6% Graphite nanomaterials to clay mix of bricks.

## Flash Talk FTS1-20

# Use of $SiO_2$ as Si-Source for Direct Single-Step Solution Combustion Synthesis of $CaMgSi_2O_6$ Ceramic Powder and Study of Their Compaction Behavior

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The unavailability of Si-nitrate makes the *solution combustion synthesis* of diopside ($CaMgSi_2O_6$) ceramic powder almost impossible. In this work, we demonstrate a method to synthesize this very useful ceramic in a 'single-step' and by the direct use of earth-abundant '$SiO_2$ ceramics' as the Si-source. This was achieved by the solution combustion of an additional amount of ammonium nitrate (oxidizer) and Oxalyldihydrazide (ODH) fuel in the presence of $SiO_2$, along with available oxidizers (Ca-nitrate and Mg-nitrate) and the corresponding amount of ODH, in the solution. This process is simple, saves time and energy. Furthermore, the powders synthesized by this method facilitate better mechanical compaction behavior and lowers the temperature required for crystallization, demonstrating their attractiveness for potential applications.

**Keywords:** *Diopside; Ceramics; Nanocrystalline materials; Solution Combustion; Silica-as Si-source.*

## Flash Talk FTS2-01

# In situ Radiopaque Bioactive Glass –A Novel Composition For The Treatment Of Osteoporotic Vertebral Compression Fracture

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Osteoporotic vertebral compression fractures (OVCFs) constitute an important public health concern, significantly in elderly patients. In India, the affected population is around 50 million presently with ever increasing numbers. During the last decade percutaneous vertebroplasty (PV) treatment method for OVCFs have gained considerable credibility that the technique involves injection of acrylic cement under fluoroscopic control in the fractured vertebra using a percutaneous approach but acrylic cements doesn't have any inherent radiopacity moreover it is bioinert in nature that does not bond with the adjacent damaged bone. Usually heavy metal salts like barium sulphate, iodinated salts are added with bone cement as radio pacifier which imparts necessary contrast needed during surgery but using these salts have several adverse effects. It has been reported that these heavy metal salts decreases mechanical strength of the resulting implant, shows cell cytotoxicity, also affects injectibility during the injection of the bone cement, can't form homogeneous mixture that can lead phase separation during injection of bone cement .The present work focuses on a *insitu* radiopaque bioactive glass composition that address the above problems which is synthesized by low temperature sol-gel process and then the glass is characterized by X-ray diffraction technique, *in vitro* cell cytotoxicity assay, radiological and mechanical property assessment etc.

**Key Words:** *Radiopacity; Bioactive glass; Vertebroplasty ; bioactivity, compressive strength*

## Flash Talk FTS2-02

# Synthesis and Characterization of Bismuth Borate-Barium titanate glasses

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Ferroelectric glass ceramics exhibit unusual ferroelectric properties owing to the fact of its ceramic-glassy nature. The most promising energy-storage applications of these compounds are due to the synergetic effect of both ferroelectric and glassy nature. Several dielectric ceramic-glass filters have prepared to fabricate capacitors; however, further studies are needed to improve pore-free microstructure of glass-ceramics.

In the present investigation, novel ferroic-glass ceramics were prepared by glass-ceramic route (melt-quenching) and the composition is: (1-x)[0.55Bi2O3-0.30 B2O3-0.15TiO2] +xBaTiO3 (with x=0.1, 0.2, 0.3, 0.4, 0.5 wt %). Appropriate amounts of Bi2O3, B2O3, TiO2 and BaTiO3 are well mixed in agate mortar and melted in a porcelain crucible for half-an-hour at 1100-1200oC, depending on the BaTiO3 concentration and then quickly quenched by pouring onto pre-heated stainless steel plate and pressed with another plate(both maintained at 1000C). XRD analysis revealed the crystalline structure of glass ceramics. Differential Thermal Analysis was also made on the said above glass samples. Based on this data, all glass-ceramics were annealed at 4000C for 12 hours. Detailed optical absorption, impedance, dielectric and ferroelectric measurements were made on the BaTiO3-glass ceramics.

**Key Words:** *Ferroelectric Glass-ceramics, optical absorption, impedance, dielectric*

## Flash Talk FTS2-03

# Experimental Studies on Electro Chemical Discharge Machining Parameters for Silica Glass

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Electrochemical discharge machining (ECDM) process is an advanced non-conventional machining method used for machining non-conductive materials like glass and ceramic substrates. In this work, the experimental investigation of ECDM process parameters, such as voltage, electrolyte concentration, stand-off-distance, pulse frequency, pulse-on-time and their influences on micromachining responses such as material removal rate (MRR) and surface roughness, overcut and during micro-channel generation was examined on silica glass. Taguchi's L27 orthogonal arrays experimental design was used to plan and conduct the experiments, the Scanning electron microscope was used for characterising machined zone. Experimental results showed that voltage, electrolyte concentration and pulse on time have direct influence on responses. This article also showed the SEM analysis of micro-channel.

**Keyword:** *ECDM, Micro-Channel, Silica Glass, SEM.*

## Flash Talk FTS2-04

# Influence of Electric Poling on Pb0.9Bi0.1Fe0.55Nb0.45O3 Multiferroic

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This paper analyses the impact of electric poling on structure, magnetism and ferroelectricity by temperature dependent Raman scattering (180 K - 500 K), magnetic susceptibility and ferroelectric measurements on $0.9PbFe_{0.5}Nb_{0.5}O_3$ - $0.1BiFeO_3$ (PBFNO) multiferroic. XRD has confirmed the *monoclinic* structure for PBFNO sample before and after poling. Unpoled PBFNO exhibit broad and overlapping 10 active modes at room temperature (100 to 1300 $cm^{-1}$) at 147, 212, 255, 431, 479, 561, 700, 795,835 and 1112 $cm^{-1}$. These peaks demonstrate considerable changes in Raman scattering intensity and spectrum structure around $T_C$, indicating a structural change around $T_C$. The octahedral stretching vibration modes reveals a remarkable frequency shift below the Neel temperature $T_N$ and the anomalies are owing to the coupling interaction between the spin-phonons. Changes in Raman modes and magnetization data validate the concept of converse magnetoelectric coupling in PBFNO. By poling the improvement in ferroelectric domain ordering occurs and it is confirmed by P-E loops. The consequences of numerous investigations on electric poling of PBFNO will provide the foundation for future device development and design.

**Key Words:** *X-Ray Diffraction, Raman spectroscopy, Antiferromagnetic, ME coupling.*

## Flash Talk FTS2-05

# Synthesis, Characterization, Mechanical and Machinability Behavior of Mg-PSZ Based 13-93 Bioactive Glass Composite

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The objective of the present study is to evaluate the effect of 13-93 bioglass(BG) addition (varying between 0 to 25 wt %) on the In-vitro bioactivity, mechanical, and machinability behavior of the Mg-PSZ matrix material. All the Mg-PSZ/13-93 BG composite samples were cold uniaxial pressed at 110 MPa and sintered at 1150°C or 1250°C for 4 hrs. The evaluation of microstructure was done by X-ray diffractometer, scanning electron microscopy, and relative density measurement was conducted by the Archimedes principle. Mechanical characterization was performed on a universal testing machine, and a machining

experiment was executed on an abrasive air-jet machine (AAJM). Machinability of all samples was calculated by the weight loss method in the form of material removal rate (MRR) at room temperature. Hardness of composite material was measured by Vicker micro hardness tester. Bioactivity test was performed in simulated body fluid (SBF) solution. The results indicated that the increase of 13-93 BG concentration decreases the grain size of the composite, increases porosity and caused a significant decrease in relative density and flexural strength. On increasing the BG concentration, the value of hardness was increased and machinability decreased of all the samples. It was concluded that the addition of 13-93 BG reduced the sintering temperature and hence reduction in the processing cost, as well as increase in the bioactivity of all the sintered samples with little expense of mechanical properties. So, Mg-PSZ/13-93BG composite material can be used as a potential material for the dental implants.

**Key Words:***13-93 BG; Material Removal Rate; Simulated Body Fluid; PSZ*

## Flash Talk FTS2-06

# Effect of Sintering Temperature in Improving Hard Magnetism of $SrFe_8Al_4O_{19}$ for Permanent Magnet Applications

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Strontium hexaferrite ($SrFe_{12}O_{19}$) is a prevalent ceramic magnet famous for its cost-effectiveness, hard magnetic characteristics, and well-established processing method. It covers numerous application areas of hard magnets. Strontium hexaferrite offers remarkable tunability in its magnetism with the controlling processing parameters and effective substitutions of different elements at either Fe or Sr lattice sites. Many researchers are thoroughly exploring substitutional effectiveness to broaden the application area of the strontium hexaferrite magnets. In this regard, the substitution of four Al ions at the Fe lattice site is found highly effective in increasing the coercivity value of the material. These magnets have high Curie temperature, excellent inertness, and decent magnetization. Further improvement in coercivity and saturation magnetization would make it a cost-effective non-rare-earth magnet for advanced permanent magnet applications.

Substitution of Al ion in strontium hexaferrite ($SrFe_8Al_4O_{19}$) is synthesized via solid-state route assisted with high energy ball-milling process. A pure hexagonal phase ($P6_3/mmc$) of $SrFe_8Al_4O_{19}$ is obtained after calcination at 1150°C/2h with the lattice parameters of $a/b$=5.83 & $c$=22.82 in X-ray diffraction (XRD) pattern. Pellets are sintered at four different temperatures 850°C, 950°C, 1050°C, and 1150°C. For the electromagnetic studies, a vibrating sample magnetometer (VSM) is used for magnetic analysis under 70 kOe applied field at room temperature. The coercivity ($H_c$) is observed in the range of 9.49-12.42 kOe, and saturation magnetization ($M_s$) is found in the range of 10.69-13.82 emu/g. An impedance analyzer is used for dielectric analysis in the 20 Hz-20 MHz frequency range at room temperature. Low dielectric constant ($\varepsilon$) in the range 27-30 are achieved at 1 MHz frequency. Also, a very high electrical resistivity ($\rho$) ranging 344-719 kΩ-cm ensures negligible eddy current losses during applications. These characteristic properties suggest an application of

economic and high-performing Al substituted strontium hexaferrite magnets in different permanent magnet applications.

**Keywords:** *Strontium hexaferrite, Al substitution, Coercivity, Saturation magnetization.*

## Flash Talk FTS2-07

# Pressure-less Sintering of Fluorapatite – ZnO Nanocomposite: Mechanical and Biocompatibility Study

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In the present investigation, fluorapatite (FAp) and nano zinc oxide (ZnO) powder have been successfully synthesized by hydrothermal method. The synthesized fluorapatite powder with different degree of fluorine (F) substitution, (P/F molar ratio=6 and 9, FAp6 and FAp9) were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), ion chromatography (IC) for F content and high resolution transmission microscopy (HRTEM). In this study, FAp nano composites were prepared with ZnO varying from 5, 10 and 15 wt.%. The composites were then sintered at 1200 °C for 2 hrs. XRD of the sintered samples confirmed the absence of any other reactive phases formed during sintering. Relatively, higher density was achieved in FA9 based composites than to its FA6 counterpart. Micro-hardness and fracture toughness of the composites increased and free surface energy decreased with the increasing concentration of ZnO in the composite. In vitro cytotoxicity studies performed using mouse osteoblast cell line (MC3T3-E1) demonstrated that the FAp composites are non-toxic in nature.

**Key Words:** *Nano composite, fluorapatite, in vitro, antibacterial property*

## Flash Talk FTS2-08

# Trace level formalin gas sensing by copper ferrite inverse spinel

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Formalin adulteration in fish and meat products can cause detrimental health hazards, such as, nausea, vomiting blood, diarrhoea, breathlessness, vertigo, damage in upper

digestive system, and even death. Detection of formalin in fish and other food staff is possible using spectrophotometry, chromatography, fluorescence, colorimetry, electrochemical method, formaldehyde specific chemical reagents and reactions etc. Although, such non-destructive techniques are in place, by far no non-contact method has been developed. Metal oxide-based gas sensors are sensitive, selective, rugged, cost-effective, and are suitable for the non-invasive measurement of formalin adulteration in fish and meat products.

In this work, a Copper ferrite (CuFe2O4) inverse spinel-based chemiresistive gas sensor suitable for the detection of trace formalin in adulterated fish products has been developed. CuFe2O4 nanopowder was synthesized by a facile sol-gel route. Microstructural, compositional, and surface characteristics were studied using X-ray diffraction, X-ray photoelectron spectroscopy, Field emission scanning electron microscopy, Transmission electron microscopy, Energy dispersive X-ray spectroscopy, UV-Vis spectroscopy, Raman spectroscopy, BET surface area analysis, non-contact profilometry, and laser diffraction-based particle size analyzer. The developed Taguchi type thick film sensor exhibited high sensitivity towards trace level (5-30 ppm) formalin gas, significant selectivity to the amines commonly emitted from fish, rapid response (~3s) and recovery (~35s) times, appreciable repeatability (at least 50 cycles), long-term stability (at least 3 months) at moderate operating temperature of 200°C. In view of its excellent performance this sensor should have bright commercial prospect.

**Key Words:** *CuFe2O4; Inverse spinel; Formalin; Gas sensor.*

## Flash Talk FTS2-09

# Microstructure and Mechanical Properties of TiC reinforced Al6063 Composites in Hot Extrusion

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The Many of our modern technologies require materials with unusual combinations of properties that cannot be met by the conventional metal alloys, ceramics, and polymeric materials. This is especially true for materials that are needed for aerospace, underwater, and transportation applications. A composite, in the present context, is a multiphase material that is artificially made, as opposed to one that occurs or forms naturally. In addition, the constituent phases must be chemically dissimilar and separated by a distinct interface. Metal matrix composites (MMCs) usually consist of a low-density metal, such as aluminum or magnesium, reinforced with particulate or fibers of a ceramic material, such as silicon carbide or graphite. Compared with unreinforced metals, MMCs offer higher specific strength and stiffness, higher operating temperature, and greater wear resistance, as well as the opportunity to tailor these properties for some particular applications. Among all available aluminum alloys 6000 series alloys are popular owing to their excellent casting properties with medium strength. Al6063 is widely used for automotive, aerospace and marine applications due to its higher specific strength and light weight are also desirable in many other engineering applications. On the other hand, if we look into the limitations of this alloy, it has relatively

poor properties like low micro-hardness, and wear resistance at aggressive environment compared to other materials. Oaks, particles or fibers are some of the examples of reinforcing materials and Aluminum, Nickel, Copper are the examples of matrix materials. In light of above in current investigation Al6063-TiC composites is hot extruded at 550°C. It was subjected to the study of optical and SEM characteristics. Further, the Casted and Casted + extruded composites were subjected to evaluate and compare the hardness, tensile strength, ductility.

**Key Words:** *Aluminium, Titanium Carbide (TiC), Casting and Extrusion.*

## Flash Talk FTS2-10

# Protein Encapsulated Sugar glass nanoparticles loaded nanofibrous patch for Tissue Engineering Applications

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Sustained release of biological cues like Proteins/Growth Factors on the site of action utilizing tissue engineering techniques was one of the primary areas of research in the biomedical industry. Over the decade emulsion-based techniques were occupying the field though it has some hindrances like burst release, losing bioactivity of small molecules during the process, inadequate loading efficiency. Stabilizing proteins using sugars and encapsulating inside the nanocarrier was the ideal role of Sugar Glass Nanoparticles (SGnPs) which could overcome the difficulties of emulsion-based nanocarriers. Though it has unique property in storing biomolecules, crucial properties like size, encapsulating efficiency, stability of storing molecule was directly related to ratio of precursors (Aqueous phase, Organic phase, Protein, Sugar). To test this hypothesis, we have synthesized different grades of SGnPs by varying organic and Aqueous solvents from that size, shape and uniformity of SGnP have been studied by microstructural analysis. Further, using optimal SGnP (Size ≈ 760 nm), we have successfully encapsulated Bovine Serum Albumin (Size ≈ 261 nm), Growth and Differentiation Factor-5 (size ≈ 85 nm), and Rhodamine-B (Fluorescent dye). Different physio-chemical characterizations confirmed the successful formulation of SGnP and SGnP with BSA/GF. Encapsulating efficiency of BSA and GDF-5 loaded SGnPs were around 90% and prolonged release behavior of SGnP (SGnP-BSA ≈ 25% of protein release in 30 days) were elucidating the reliable loading capability, burst-free release. Further, the Uniform distribution of Rhodamine B encapsulated SGnP loaded nanofiber mat was determined by FESEM and Confocal Microscopy. Significantly, increased in-vitro cell proliferation of human adipose derived mesenchymal stem cells (hAMSCs) by SGnP-BSA turned out to be the efficient outcome of the system from cytotoxicity studies. These findings were proposing the nanocarrier could be a sustained-release depot for therapeutic molecules and potential carrier in tissue engineering applications.

***Key Words:*** *Sugar Glass Nanoparticles, Protein, Tissue engineering, Human Adipose-Derived Mesenchymal Stem Cells.*

## Flash Talk FTS2-11

# Dielectric and Ferroelectric properties of CT and ST added NBT based composites

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0.80NBT+0.20ST and 0.80NBT+0.20CT composites are prepared by solid state reaction method where individual powders are prepared with sol gel chemical route. XRD and SEM confirm the formation of composites. High temperature sintering leads to dense microstructure of the samples. Dielectric and PE loops are studied as a function of temperature. The relative density, grain size, and ST concentration influenced the polarization properties of the specimens. The phase transition in NBT is associated with changes in alignment of dipoles into micropolar regions. For NBCT composite, the ferroelectric and polarization properties are degenerated. Activation energy of the composites was calculated using dielectric parameters.

**Key words:** *NBT, ST, CT, dielectric and PE loops*

## Flash Talk FTS2-12

# Zinc Chromite Ceramic Spinel Nanoparticle Based Trace Acetone Sensor

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Ceramics based chemiresistive gas sensors have gained increasing interest for their ability to detect various gases of low concentration. Acetone is one of the most prominent breath biomarkers for diabetes [1-2]. Concentration of acetone in exhaled breath of healthy person is below 1ppm, which increases up to 10ppm in case of diabetic patient.Therefore, selective detection of acetone in exhaledhuman breath is effective for health monitoring. In present work, excellent acetone sensing property with high selectivity has been observed in spinel ceramic zinc chromite nanoparticles based sensor. The characterization of the phase pure $ZnCr_2O_4$ were conducted using sophisticated instruments viz. X-ray diffractometer, Field Emission Scanning Electron Microscopy,Furier-transform-infrared spectroscopy, Brunauer–emmett–teller surface area analysis. The $ZnCr_2O_4$ based sensor showed remarkable response (S=1.95) towards 1ppm acetone at operating temperature 200°C with quick response and recovery times of 1.25s and 27s, respectively. The prepared sensor is highly selective towards acetone among different interfering gases and also irresponsive towards moisture. The sensor exhibits high stability 6months with negligible deviation. Therefore, ceramic spinel $ZnCr_2O_4$

sensor could be a potential candidate for non-invasive monitoring of diabetes by analyzingbreath.

**Key Words:** *Zinc-chromite, Nanoparticle, Acetone sensor, Diabetes monitoring.*

## Flash Talk FTS2-13

# Electrical and Magnetic Studies on Promising Aurivillius Intergrowth Compound

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Aurivillius multi-ferroic phases are well-established layered-perovskite compounds and inspiring to many researchers owing to the fact of scientific and magnetoelectric applications. The present layered-compounds are generally formulated as $(Bi_2O_2)^{2+}$ $(A_{n-1}B_n-O_{3n+1})^{2-}$. Here, n- represents number of perovskite ($A_{n-1}B_nO_{3n+1}$) blocks, interleaved between Bismuth oxide $(Bi_2O_2)^{2+}$ layers.

Recently, it has been reported that the intergrowth route is an effcive preparative method in order to enlarge the ferroic properties. In this process, one-half of unit cell having n- layer structure combines with another (n+1) layer structure compound along c-axis. In the present study, promissing ferroelectric compound namely $Bi_{3.25}La_{0.75}Ti_3O_{12}$ (BLT) and $Bi_4NdTi_3Fe_{0.7}Co_{0.3}O_{15}$ (BNTF) were synthesised by conventional solid state reaction method. The intergrowth of BLT-BNTF XRD-data was compared with standard eight – layered compound ($SrBi_8Ti_7O_{27}$). From The SEM pictures, non-uniform disk-like grains were observed. A detailed dielectric, magnetic and ME measurements were made on the said above intergrowth ceramic. In order to extract more information about relaxation species, Nyquist plots (Cole-Cole plots) were drawn at different temperatures. According to the Arrhenius law: $\sigma = \sigma_0 e^{-E_a/KT}$, the ac activation energies were measured at 10kHz, 50kHz and 100kHz from $\sigma_{ac}$ vs 1000/T curves. Activation energies were found to be 0.79eV, 0.68eV and 0.60eV at 10kHz, 50kHz and 100kHz respectively. Based on the impedance studies it is concluded that hopping mechanism prefers through the doubly ionized oxygen atom vacancies in the prepared compound. This phenomenon explains the ionic role in the relaxation mechanism. Magnetic and Magnetoelectric measurements were also made on the title compound.

**Key Words:** *Aurivillius phases, Multiferroic, Magnetoelectric, Dielectric*

## Flash Talk FTS2-14

# Thermal Calculations for Ceramic Engines - Prototype - 1

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To increase the poor 30-35% efficiency of the conventional diesel engines used in the lorries, buses, and heavy vehicles running on roads now, it was proposed to use ceramic cylinders and cut of the liquid lubricant and hence the radiator. The thermal calculations corresponding to the converted engine - prototype - 1, wherein, it was proposed to use SS304 grade stainless steel for the attachments and tie-bolts. The material temperature is expected to be around 600$^{o}$ - 650$^{o}$C. On achieving success in prototype - 1, it is planned to replace stainless steel with Inconel, and in that case, the material temperature will be around 800$^{o}$ - 850$^{o}$C with almost 60 - 65% efficiency. In prototype - 3, it is planned to replace the Inconel cylinder with a ceramic cylinder as it may prove economic during large-scale manufacturing. The thermal calculations, based on the diesel cycle are dealt with in this paper for prototype - 1.

**Keywords:** *IC engine, Diesel engine, Efficiency, Ceramic Engine*

## Flash Talk FTS2-15

# Evolution of Ceramic Engines

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The diesel engines used in heavy trucks, lorries & buses in India, are working at a poor efficiency of 30 - 35%. This is because the radiator that is used to cool the engine, dissipates 30 - 40% of the total heat input into the atmosphere. The engine material temperature requires to be kept below 100$^{o}$C, because of two reasons, viz.,

1) The liquid lubricant gets charred and sticky at 140$^{o}$C and hence the piston and cylinder will seize.

2) Radiator water boils out at 100$^{o}$C.

Owing to the above two reasons, it is required to cool the engine, wasting up to 40% of total heat input. To solve this problem, it was first thought of to eliminate, liquid lubricant and use graphite liner inside the cylinder, so that it serves as a solid lubricant. Then, owing to the reason that, graphite cannot withstand the shock loads created by the piston slapping on both sides, alternatives were through off. A final configuration was arrived at, for converting the existing conventional diesel engine and this paper presents the various alternatives proposed, their merits and demerits, and the final evolution of the present idea.

**Key Words:** *IC engine, Diesel engine, ceramic engine, High-efficiency engine.*

## Flash Talk FTS2-16

# $Fe_3O_4$ Nanoparticles Supported $MoS_2$ Nanoflowers ($MoS_2$-$Fe_3O_4$) as Magnetically Recoverable and Reusable Heterogeneous Catalyst For Reduction Of Organic Dyes

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As per the global concern, there is a need to develop catalysts with good catalytic activity, operational simplicity, eco-friendliness, recoverability, and cost-effectiveness. These heterogeneous catalysts are well employed in eliminating organic and inorganic effluents present in wastewater. In the present study, $Fe_3O_4$ nanoparticles supported $MoS_2$ nanoflowers ($MoS_2$-$Fe_3O_4$) are prepared by simple and environmentally friendly hydrothermal method and well-characterized for their structure, morphology, size, phase composition, and magnetic property using XRD, FT-IR, SEM, EDX, HR-TEM, and VSM techniques. As prepared $MoS_2$-$Fe_3O_4$ catalyst in the presence of $NaBH_4$ was achieved a remarkable reaction rate constant of 0.152 $min^{-1}$, 0.882 $min^{-1}$ and 0.534 $min^{-1}$ in 10 min, 2 min, and 2 min for p-Nitrophenol, Methylene blue, and Methyl orange dyes, respectively. Results suggest that the synthesized $Fe_3O_4$-$MoS_2$ is highly effective in the reduction of organic dyes. The catalyst particles were recovered after the reaction using an external magnet without any loss of the catalyst and the recovered catalyst shows similar catalytic efficiency even after several cycles.

**Keywords:** *Heterogeneous magnetic catalyst, reduction of p-Nitrophenol, Methylene blue, and Methyl orange dyes.*

## Flash Talk FTS2-17

# Synthesis of Organic-Inorganic Porous Framework Using Locally Available Fullers Earth

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Bentonite also popularly known as fullers earth which has a large specific surface area & high cation exchange capacity is a powerful powder in recovering waste oil. In this

work, different types of nano-organo bentonite were prepared using locally available fullers earth. The Fullers earth obtained from Kalaburgi district, Karanataka was characterized by WD-XRF to know its chemical composition and was purified to remove impurities using a conventional method like treatment with HCl and washing with distilled water. The purified fullers earth was modified using different types of organo-modifiers viz. octadecyl amine (ODA), dodecyl amine (DDA). The modified bentonite was characterized by FTIR, XRD, and BET surface area analyzer.

The intercalation of the ODA and DDA into the fullers earth structure was confirmed by the peaks obtained by FTIR analysis at 2917cm$^{-1}$ &2928cm$^{-1}$. It was observed in XRD analysis that the d-spacing of fullers earth modified with ODA and DDA was increased which was established by the shifting of peaks at lower 2Θ angles. The BET surface area of the untreated fullers earth was 22.596 m$^2$/g whereas the fullers earth modified with DDA and ODA had a surface area of 54.596 m$^2$/g and 55.495 m$^2$/g.

**Key Words:** *Fullers earth, Octadecylamine, Dodecylamine*

**Flash Talk FTS2-18**

## UV light Assisted De-colorization of Dyes and Sensing of Arsenic and Lead by using 2-Dimensional CuO–ZnO Hybrid Nanocomposite

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The CuO-ZnO 2-Dimentional nano-composites were effectively prepared by an ultrasound-assisted probe sonication route, with the structure, electronic and photocatalytic properties analyzed by means of experimental and theoretical methods. The X-ray diffraction patterns revealed that a CuO/ZnO heterostructure was formed, while FE-SEM analysis indicates the role of different morphologies for CuO, ZnO and CuO/ZnO heterostructures. The solar-driven photocatalytic measurements combined with DFT calculations indicate that CuO, as a p-type and narrow band-gap sensitizer, can make the n-type ZnO respond to visible light and promote the separation of photogenerated charge carriers by building a p-n heterogeneous structure. As a result, the CuO/ZnO heterostructure shows good promise for solar driven photodegradation. Also, cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) techniques were employed to analyze the electrochemical

properties of prepared samples by using modified carbon paste electrodes for the determination of Arsenic and Lead.

**Keywords:** *CuO-ZnO nanocomposite; Photocatalytic; Cyclic Voltammetry; Electrochemical sensor.*

**Flash Talk FTS2-19**

## CZTS Crystal growth by the slow vapor diffusion process

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Copper zinc tin sulfide (CZTS) is a quaternary semiconductor material having a high absorption coefficient of 104 $Cm^{-1}$, direct bandgap material and it is compatible with the solar spectrum. CZTS material is more attractive worldwide in recent years due to its wide range of applications viz. photovoltaic, thermoelectric and photocatalytic, etc. CZTS thin films were deposited by vacuum and non-vacuum-based methods. The majorly used non-vacuum methods are chemical bath deposition (CBD), spray pyrolysis deposition (SPD), electrochemical deposition and spin coating methods. Other non-vacuum techniques for crystal growth include slow evaporation, slow cooling, slow heating, vapor diffusion, and liquid-liquid diffusion. These are less popular due to the longer time required for crystal growth (a few days to several weeks) and need more attention to choose well-suitable solvents. Here, we performed the CZTS crystallization growth on conductive electrode substrate by a slow vapor diffusion process. The crystals were grown within two weeks of time. The CZTS crystal formation was characterized by X-ray diffraction (XRD), scanning electron microscope (SEM), X-ray fluorescence spectrometer (XRF) and Raman spectroscopy. XRD results are in good agreement with standard JCPDS 26–0575 and confirmed kesterite CZTS structure with having main diffraction peaks are at (112), (220) and (312). Further, CZTS material E transverse optical (E(TO)) vibrational mode peaks at 342 cm-1 was confirmed by Raman spectroscopy. The advantages of the slow vapor diffusion process include a low cost, non-vacuum method, and the ability to obtain high-quality crystals.

**Key words:** *CZTS, thin-film, non-vacuum method, and slow vapor diffusion.*

Flash Talk FTS2-20

# Synthesis of novel heterostructured Fe-doped Cu2O/CuO/Cu nanocomposite: Characterization, enhanced Sunlight driven photocatalytic activity, efficient antibacterial agent and supercapacitor properties

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Bacterial and organic pollutants pose persistent challenges with inherent harmful effects on human wellbeing and the ecosystem. A plausible strategy to combat these problems is through scheming newer photo catalysts with a broad range of applications. A novel, reusable, highly efficient heterostructured CuO/$Cu_2O$/Cu and 5 mol % Fe doped CuO/$Cu_2O$/Cu nanocomposites with photocatalytic and antibacterial property were prepared successfully by combustion method. Prepared nanocmposites were investigated for crystallinity, optical nature, structure and morphology. The proximity of Fe directly affects the crystallinity and observable voids and pores in the morphology of CuO/$Cu_2O$/Cu. Diffraction peaks related to CuO, $Cu_2O$, metallic Cu were observed in the XRD pattern of nanocomposite. Also, XPS evidenced the substitution of $Fe^{3+}$ and $Fe^{2+}$ states into the CuO/$Cu_2O$/Cu lattice. A decrease in the band gap energy from 1.9 to 1.7 eV of the material hinders the recombination of $e^-$–$h^+$ pairs by trapping electrons and holes, causing enhanced degradation. Methylene Blue (MB) and Rhodamine B (RhB) dyes degraded upto 93 % and 81 %, respectively within 60 min under sunlight for 5 mol % Fe doped CuO/$Cu_2O$/Cu. Whereas, for CuO/$Cu_2O$/Cu, the obtained result was 65 % (MB) and 60% (RhB) under same conditions. This renders Fe-doped CuO/$Cu_2O$/Cu to be a better photocatalyst than CuO/$Cu_2O$/Cu. Moreover, the Fe doped nanocomposite has closely resembling photocatalytic effect and does not show any kind of photo-corrosion despite completing 5$^{th}$ cycle. Presence of Fe-dopant resulted in an effective bactericidal performance against *E. coli* and *S. Aureus* up to a concentration of 100 µg/mL. The substantiating results could be observed among the crystallinity, energy gap, photocatalytic and antibacterial activity of prepared nanocomposites. Fe-doped CuO/$Cu_2O$/Cu hetrostructured nanocomposite showed a prominent multifunctionality in suppressing organic pollutants and bacteria in the environment.

Flash Talk FTS2-21

# Study of Green route Synthesis for Nano $MgFe_2O_4$ and its application as photocatalyst

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Spinel $MgFe_2O_4$ nanoparticles (NPs) were prepared by low temperature combustion method via green route. Green route combustion method was followed by using curry leaf extract. X-ray diffraction (XRD), Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FT-IR), UV visible Spectroscopy were used to study the effect of synthesis methodology on the behavior of synthesized NPs. Differences in crystallinity, particle size, photocatalytic and electrochemical activity of the $MgFe_2O_4$ NPs prepared by sol-gel method were observed. PXRD pattern of nanoferrite obtained by green method confirmed spinel phase structure of the prepared NPs with average size ranging from 20-35nm. The flake like morphology was seen for the prepared nanoferrite. FTIR confirms the absorption value of tetrahedral and octahedral sites. The $MgFe_2O_4$ nanoferrite synthesized by green route combustion method revealed exceptional electrochemical property with less charge transfer resistance. The correlation for EIS data with the photocatalytic mechanism is observed.

**Keywords:** *Green combustion synthesis; photocatalytic activity, EIS.*

## Flash Talk FTS3-01

# "Paper Separator" with Improved Porosity, Thermal Stability and Electrochemical Performance for Application in Lithium-Ion Batteries

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In coming years, lithium-ion battery (LIB) will be the most demanding power system for its application in solar energy storage as well as powering devices for Electric Vehicles (EVs). This technology forecast has triggered multi-fold research activities globally to develop LIB components (anode, cathode, separator and electrolyte) from low cost, easily available and sustainable sources. In this context, CSIR-CGCRI is also engaged in developing a low cost cellulose-ceramic composite separator for its application in metal-ion batteries (Li/Na based LIBs, SIBs) and Supercapacitors.

Paper has become a material of choice due to its flexibility, cost-effectiveness and natural abundance. Cellulose based paper offers plenty of room to functionalize paper matrix with integration of application specific engineered nanomaterials or other ceramic/polymeric composite. An effort has been made for the first time to develop paper based separator for LIBs by engineering the paper matrix with suitable polymer and nanostructured ceramic materials.

In the present research work, a paper separator has been fabricated by dip-coating method using a blend of ceramic powder (<100 nm) and polymer. The as-fabricated separator was then oven-dried, calendared and demoisturized to use in 2032 coin cells. The fabricated paper separator showed excellent air permeability (15-25 Gurley Seconds), porosity (>40 %), quicker electrolyte soaking ability, improved thermal stability up to 200oC with no observable shrinkage and good electrochemical charge-discharge performance and reversibility when tested against standard cathode, anode and electrolyte.

**Key Words:** *Separator, Cellulose, Electrochemical performance, Lithium-ion Batteries*

## Flash Talk FTS3-02

# Insights into the Redox Activity of La/Ba-Sr-Co-Fe-O-based Perovskite Oxides for Electrochemical Reactions in Solid Oxide Cells (SOC)

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As a consequence of massive climate change and increasing population, the global energy crunch has driven the researchers to explore the field of Solid Oxide Cells (SOC), an

emmerging energy conversion technology having the potential to equilibrate the chain of renewables supply and demand with reduced green gas emission. Surface oxygen exchange kinetic, one of the prime driving force which governs the electrochemical reactions at SOCs is comprised of the oxygen reduction (ORR) and oxygen evolution (OER) reaction. In this context, perovoskite based air electrodes play a vital role in the oxygen redox mechanism with high oxygen vacancy concentration and oxygen vacancy mobilization. In an attempt to recognize the governing steps involve in the surface exchange kinetics, La/Ba-Sr-Co-Fe-O (LSCF/BSCF) based perovskite materials have been studied. While comparatively higher DC electrical conductivity of 826 $S.cm^{-1}$ is obtained for La-Sr-Co-Fe-O system, the individual oxidation states of B-site cations calculated from the Co 2p, Fe 2p and O 1s survey spectrum as received from X-ray photoelectron spectroscopy (XPS) depth profile analyses confirm the superior surface adsorption ability of Ba-Sr-Co-Fe-O compared to that of the La based system. The time dependent potentiostatic measurements (200h) reveal a current degradation of ~3.9% (0.02 $mA.h^{-1}$) and ~15% (0.06 $mA.h^{-1}$) under constant anodic potential @+0.8V (OER) and cathodic potential @-0.8V (ORR) respectively for BSCF system at an operational temperature of 800°C. The lower rate of degration of BSCF proves better electrokinetic phenomena in the context of OER with a maximum current density of 1.37$A.cm^{-2}$ which may be scaled upto ~900 $Nl.h^{-1}.kW^{-1}$ with CGCRI's cell foot print area 80$cm^2$ .

**Key Words:** *Solid Oxide Cell (SOC), Perovskite Oxide, Oxygen Reduction Reaction (ORR), Oxygen Evolution Reaction (OER).*

## Flash Talk FTS3-03

### Structural and electrical characterizations of a novel lead-free ferroelectric bulk ceramics (1-*x*)$BiFeO_3$ –*x*$CaTiO_3$ for energy storage application

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Even though promising results have already been obtained in lead titanate-based dielectrics, lead-free alternatives are strongly desirable due to the environmental concerns. Development of advanced dielectrics with high power density and large energy storage has seen a surge in research interest recently because of their capacitive energy storage potential in modern electronic devices. A novel lead-free ferroelectric bulk ceramic (1-*x*)$BiFeO_3$ - *x*$CaTiO_3$ (*x* = 0.6, 0.7, and 0.8) (BFO-CTO) composites were prepared by direct mixing of BFO and CTO powders in stoichiometric amount. Structural, morphological and electrical properties were explored. Rietveld analysis of the powder XRD data indicated single-phase perovskite structures for *x* = 0.6, 0.7, 0.8, and 1 with Pbnm space group symmetry. Grain size distribution revealed an increase in average grain size from ~0.9 μm for x = 0.6 to ~1.5 μm for x = 0.8 of (1-*x*)$BiFeO_3$ - *x*$CaTiO_3$ sintered ceramics. A significant four orders of magnitude decrease in the leakage current density J from $1.9 \times 10^{-1}$ A $cm^{-2}$ for x = 0 to $7.4 \times 10^{-5}$ A $cm^{-2}$ for x = 0.8 was observed with a corresponding decrease in the electrical conductivity from $1.04 \times 10^{-5}$ S $cm^{-1}$ to $4.9 \times 10^{-8}$ S $cm^{-1}$. In the present paper enhanced electrical properties with significant decrease in the leakage current, improved structural stability, electrical insulation

and electrical breakdown strength will be explained in terms of suppressed Fe ions valence fluctuation, formation of oxygen vacancies, reduced impurity phases and porosity content in the CTO incorporated BFO matrix.

**Key Words:** *BFO-BiFeO3, CTO-CaTiO3, energy storage*

## Flash Talk FTS3-04

# Effect of Co-Doping in $CeO_2$ Based LT-SOFC Electrolyte on Structural and Electrical Properties

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Recent development in hydrogen ecosystem has necessitated the development of power generators like fuel cells which use not only hydrogen as fuel but also few other combustible gases. Solid Oxide Fuel Cells (SOFCs) is considered for its very high energy generation efficiency involving the electrical power and total CHP. Although high temperature SOFC technology is commercially established, challenge lies with high operating temperature (~1000$^o$C) for choice of materials, their degradation issues, use of costly ferritic steel interconnects etc. Considerable research efforts are in force for the development of low temperature SOFC (LT-SOFC) operating at around 500$^o$-600$^o$C. For LT-SOFC electrolyte application, doped $CeO_2$ oxide nano and submicron grains are good candidate material as they exhibit significant oxygen ion vacancy conductivity around that temperature regime. Keeping this in mind, gadolinium doped ceria (GDC) electrolyte co-doped with varied mole fraction of neodymium (Nd) has been synthesized using combustion technique. Because of the exothermicity of the reaction, phase purity has been achieved after calcination of the synthesized powder only at 700$^0$C. While, the measured crystalline size was found to be in range of 22-26 nm for the calcined powders, sintered microstructures reveal grain size of 0.5-0.6 µm. DC electrical conductivities for such tailored submicron grain co-doped CeO2 are evaluated through two probe electrochemical impedance spectroscopic (EIS) measurements where the conductivities are found to remain in the range $10^{-3}$-$10^{-4}$ S.cm$^{-1}$. The clinical correlations are being established for the grain sizes to the electrical conductivities of the Nd and Gd co-doped $CeO_2$ and will be presented with other detailed investigations for the synthesized powders and bulk materials.

**Keywords:** *LT-SOFC, electrolyte, co-doped CeO2, nanocrystalline, grain and grain-boundary conductivity*

Flash Talk FTS3-05

# Engineered microstructure of $Li_7La_3Zr_2O_{12}$ Garnet Electrolyte derived from Water Hyacinth for All Ceramic Monolithic Lithium Batteries

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All Solid-State Lithium Batteries (ASSLBs) with "Monolithic" and "zero gap" configuration has tremendous potential to act as safe and powerful energy source for electric vehicles (EVs)[1]. Such monolithic configuration particularly requires a solid electrolyte with high lithium ion conductivity in the order of $10^{-3}$-$10^{-4}$ S/cm at RT. Among several other electrolytes, LLZO ($Li_7La_3Zr_2O_{12}$) garnet has shown real promise in terms of conductivity as well as wide electrochemical window and exceptional compatibility with lithium metal (theoretical specific capacity 3860 mAh $g^{-1}$). However during cycling of battery dendritic growth of lithium metal remains as a challenge which needs to be solved by engineering of grain boundaries, microstructure and tuning other physical properties.

Bio-templating is a synthesis methodology which can produce materials with unique and engineered microstructure. A template is basically a textured architect that provides a path/scaffold for synthesis and when the template is removed, a control morphology of desired component is achieved. Depending upon the choice of template, materials are produced either in nano or in micro domain.

In our previous study we successfully synthesized $BaBi_{0.02}Co_{0.35}Fe_{0.45}O_{3-\delta}$ (BBCF) perovskite type MIEC membrane using water hyacinth, an aquatic weed and bio-waste as sacrificial template and achieved improved physico-chemical properties.

In the present research, we have first time attempted to synthesize LLZO garnet using water hyacinth petioles as sacrificial template. The primary results revealed the formation of desired LLZO cubic phase along with several oxide impurities at 900°C in air atmosphere. A multifaceted spectacular rod like morphology was observed in FESEM micrographs. Thermal analysis by using TGA/DTA confirmed that even after heat treatment at 900°C, a residual mass (~20%) remained for the template which might be the reason for appearance of impurity phases in LLZO powder. The initial results thus obtained are encouraging and the details will be presented in the conference.

**Key Words:** *Water Hyacinth, Bio Templating, Solid State Electrolyte, Engineered Microstructure.*

Flash Talk FTS3-06

# Structural and Electrical Characterizations of $Nd^{3+}$ doped Bismuth Ferrite

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With ever-increasing demand in the data storage and microelectromechanical applications, multiferroics with superior ferroelectric and piezoelectric responses are of great interest. Although lead-based $Pb(Zr,Tr)O_3$ group of materials has served as the mainstay for these applications, toxicity in these lead-based materials has always been the major concern. Lead-free bismuth ferrite, a well-known multiferroic material, has been extensively studied due to its superior properties such as high Curie temperature (~1,100K), high Neel temperature (~650K) and giant spontaneous polarization. However, its relatively high leakage current due to bismuth volatility has poised as a major challenge for practical applications. In this work, lead-free $Nd^{3+}$ doped bismuth ferrite ($BiFeO_3$) ($Bi_{1-x}Nd_xFeO_3$, $x$ = 0.1, 0.15, 0.20) was prepared by conventional mixed oxide solid state synthesis route using $Bi_2O_3$, $Fe_2O_3$ and $Nd_2O_3$ as the raw materials and sintered at $900^0$C, as estimated by the thermogravimetric analysis (TGA) of the calcined powders. The primary objective of this work was to study the influence of $Nd^{3+}$ doping on the structural, microstructural and electrical properties of bismuth ferrite (BFO) and hence the resulting change in leakage current density. X-ray diffraction pattern revealed a structural transition from *R3c* to *Pnma* phase of the $Nd^{3+}$ doped BFO samples with reduction in the impurity phases. FESEM micrographs showed a decrease in grain size with increasing dopant concentration. Marginal increase in leakage current density with increasing electric field up to ~2 KV/cm has been observed for all the samples indicating insulating nature of the samples. An order of magnitude increase in resistivity has been observed with increasing doping concentration. The details of the experimental results and analysis will be presented in this paper.

Flash Talk FTS3-06

# Thermal Fundamentals of Ceramic Engine

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This paper analyses the combustion fundamentals like determining air required for combustion from the elements present in diesel based on their atomic weights and the proportion of oxygen in atmospheric air. Also, the calculations to find out the temperature attained by the gases released during combustion is discussed. It is also shown by calculation, that, what can be the maximum temperature of the gases that can be attained, which is possible

by using stoichiometric air for combustion and the same is called as adiabatic temperature, by assuming the specific heat of the gas. Also the temperature attained by the gas, for different excess air levels have been determined.

**Key Words:** *IC engines, diesel engines, combustion, adiabatic temperature*

## Flash Talk FTS3-08

# Concept of Using Ceramic Cylinders in IC Engines for Improving Efficiency

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In view of almost doubling the brake thermal efficiency of heavy trucks, buses and Lorries, a novel idea was thought of, to add two attachments over the conventional engine. It is planned to use ceramic cylinder and an Inconel piston in the top attachment and the combustion of the fuel is shifted to this top attachment from the conventional engine cylinder. It is evident that, ceramic material selected for the cylinder is highly brittle and as such when it is used in IC engine, it will break in to pieces. In order to avoid the brittle failure of the ceramic cylinder, it is enveloped by two mild steel half sleeves and bolted together to pre-compress the ceramic cylinder and develop hoop compressive stresses. During explosion of diesel, inside the engine in power stoke, heavy hoop tensile stresses are produced and part of it is offset by the previously produced hoop compressive stresses and hence design thickness requirement for the ceramic cylinder will be drastically reduced and the cost of production of the ceramic cylinder will be economic. This technology is known pre-compressing and it was first followed for casting pre-compressed concrete beams to carry more load.

**Key words:** *IC engine, diesel engine, pre-compressing, pre-stressing, ceramic cylinder.*

## Flash Talk FTS3-09

# Futuristic Problems and Solutions.

**Prof. PR Lakshminarayanan[1]**
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Currently, India is importing crude oil for a worth of Rs. 5 Lakh crores, out of which Rs. 4 Lakh crores worth of diesel is consumed by heavy trucks, Lorries, and Buses. These heavy vehicles are currently working at a very low efficiency of 30% -35%. A novel idea was thought of, that, by adding two attachments, the efficiency can almost be doubled, thereby saving about half of diesel consumption. That is, if all the heavy vehicles are converted by

adding the attachments as mentioned before, about 1.5 to 2 Lakh crores of rupees could be saved on diesel consumption every year. More to this, there are so many other issues that need to be tackled for a smoother life in the upcoming future are dealt with in this paper.

**Keywords:** *Diesel engine, IC engine, Energy, Future*

## Flash Talk FTS3-10

# Effect of 20 mol % Doping of Gd on Ionic conductivity of Ceria Electrolyte for Intermediate Temperature Solid Oxide Fuel Cells

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The doped ceria shows ionic conductivity one order higher than yttria-stabilized zirconia (YSZ) system at the much lower operating temperature [1]. The high conductivity in doped ceria oxides is attributed to a large ionic radius of $Ce^{4+}$ (0.87 Å) compared to $Zr^{4+}$ (0.72 Å), creating a more open structure to ease the conduction for oxide ions. The common dopants used for the ceria are $Gd^{3+}$, $Sm^{3+,}$ and $y^{3+}$. The $Gd^{3+}$ is the most common since the $Gd^{3+}$ and $Ce^{4+}$ ions have the lowest ionic radius mismatch. Doping of $Gd^{3+}$ to $Ce^{4+}$ lattice can present the smallest stress and yield high ionic conductivity at lower activation energy for the $O_2^-$ conduction. The composition having 10 mol % Gd doped- Ceria ($Ce_{0.9}Gd_{0.1}O_{1.95}$) was found to be most promising for IT-SOFC application because of its high ionic conductivity at 773 K [1]. However, it is found that with an increase in the dopant content up to its solubility limits the ionic conductivity increases, after which it will suffers because of the blocking effect from the un-dissolved dopant impurities at the grain boundaries. In the present study the 20 mol % Gd doped- Ceria (GDC20) have been synthesized by sol-gel assisted citrate-complexation method [2]. The prepared GDC20 sample is characterized by XRD, Raman, FTIR, FESEM-EDX and electrochemical impedance spectroscopy. The high oxide ion conductivity of $6.79 \times 10^{-3}$ at 973 K and $1.11 \times 10^{-2}$ S $cm^{-1}$ at 1023 K have been observed with lower activation energy of 0.88 eV. The obtained ionic conductivity value in the present study at 973 K for GDC20 are lower than one order compared to reported for GDC10 at 973 K ($5.4 \times 10^{-2}$ S $cm^{-1}$) [3]. Thus, present work tends to focus on the concentration of the dopant required to obtain the optimum ionic conductivity for GDC.

**Keywords:** *Electrolyte • Ce0.8Gd0.2O2–δ • a.c. impedance • Ionic conductivity*

## Flash Talk FTS3-11

# $MnFe_2O_4$ Synthesis and Characterization for Mg-Ion Battery Application

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Magnesium metal complex oxides are potential electrode materials for magnesium ion batteries with high specific capacities. However, the strong electrostatic interaction between Mg2+ and the host lattice due to its di-valency induces slow intercalation kinetics of Mg ions within the crystal lattices. Thus, nanocrystalline particles with shortened Mg ion diffusion distance enable the insertion/extraction of Mg ions and improve the specific capacities of the batteries. Herein, we report the solvothermal synthesis of crystalline $MnFe_2O_4$ nanocrystals. The material was characterized with XRD, SEM, TEM and Electrochemical studies. The Crystalline $MnFe_2O_4$ were controllably synthesized for the first time, which are active materials for magnesium-ion batteries showing a specific capacity of 139.70mAhg$^{-1}$ at a discharge rate of about 0.05C, 139.70mAhg$^{-1}$ at a discharge rate of about 0.1C, 279.34 mAhg$^{-1}$ at a rate of about 0.2C 195.82mAhg$^{-1}$ at a rate of about 0.5C, 25.04 mAhg$^{-1}$ at a rate of about 1C & 14.16mAhg$^{-1}$ at a rate of about 2C.

## Flash Talk FTS3-12

# Synthesis and Supercapacitive Study of CNT-Black $TiO_2$

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We present the fabrication of Carbon Nanotube (CNT) growth on the surface of Black TiO2. Firstly, Black-TiO2 was synthesized using wet chemical method and using wet chemical method and then CNT was grown using chemical vapour deposition method. The structural analysis was performed by X-ray diffraction (XRD) pattern, and scanning electron microscopy (SEM). The SEM images show the very well defined grains of Black-$TiO_2$ and tube like structures in the image shows the presence of CNT in the nanocomposite. The CNT Grown Black-TiO2 has gone through cyclic volumetry, and Galvanostatic charge-discharge measurements for the supercapacitive performance study.

**Key Words:** *Black TiO2, Carbon Nanotube, Supercapacitor, Photocatalysis.*

Flash Talk FTS3-13

# A Novel Aloe Vera mediated Solution Combustion Synthesis and Photoluminescence properties of ZrTiO4 nanorods

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In the present communication, for the first time, $ZrTiO_4$ (ZTO) ceramic material is synthesized by using economical and low cost solution combustion method using Aloe Vera gel as a reducing agent and calcined at 700°C. The synthesized samples were characterized with powder X-ray diffraction (PXRD), scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Photon Spectroscopy (XPS), Fourier transform infrared spectroscopy and UV-visible spectroscopy. The Bragg's reflection of PXRD pattern clearly confirms the formation of orthorhombic structure. The SEM image and TEM image clearly confirms the formation of nanorods. The energy bandgap was estimated by using the Wood and Tauc's relation and was found to be 2.7 eV. The Photoluminescence spectra shows the emission peaks at 360, 405, 433, 460, 484, 527 and 540 nm which confirms that the present nanophosphor might find applications in display technology. The studied Photoluminescence properties might be useful in the display applications and radiation shielding applications.

Flash Talk FTS3-14

# Study of Charge Generation and Effect of the DC Supply on the Growth of Carbon Nanotubes and Their Electrochemical Properties

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Preparation of chirality-defined few-walled CNT (FWCNT)is the peak challenge in the carbon nanotube (CNT) fields. In the last 20 decades, significant progress has been made in preparing chirality-controlled synthesis (CCS) few-walled CNT (FWCNT) through both a controlled direct synthesis approach and a post-synthesis separation approach For few-walled CNT (FWCNT)due to insignificant changes in the tube diameter and twist angle when using certain connectivity indices (n, m), their electrical conductivity is converted from one property of the metallic state to one property of the semiconductor and will be they also change the band gap. However, this structure-function relationship is fully utilized only when using pure SWNT structures. Also, we discuss some examples that demonstrate that individual SWCNTs have clear advantages for wide-ranging CNTs and wide distribution of dominance. Hopefully, this review can encourage further research on the preparation of few-walled CNT (FWCNT) and also utilize key research and practical applications of few-walled CNT (FWCNT). In these grown nanotubes the SEM images of as-grown nanotubes show that applying electric field during the growth process affects the growth of the nanotubes and nanotubes can be achieved by changing the voltage by DC supply alone. Raman spectroscopy has been used to analyze the structure of the samples. A Raman analysis from all obtained carbon materials shows the presence of two peaks, corresponding to the 1350 cm-1 and 1570 cm-1 bands attributed to few-walled CNT.

**Keywords:** *CNTs; Chemical Vapor Deposition (CVD); DC power; Specific capacitance: Few-wall carbon nanotubes (FWCNT).*

Flash Talk FTS3-15

# Facile green synthesis of Molybdenum Oxide Nanoparticles using *Centella Asiatica* plant extract: Its photocatalytic and electrochemical Sensor applications

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The molybdenum oxide nanoparticles ($MoO_3$ NPs) have been successfully synthesized via green combustion method using *Centella asiatica* plant extract have been investigated. PXRD, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and diffuse reflectance spectroscopy (DRS) were used to characterize the $MoO_3$ nanoparticles that were produced. The PXRD patterns of the sample revealed pure hexagonal phase. The Scherrer's method was employed to find the crystal size of the synthesized material and it was noted that the obtained results were also confirmed by the TEM analysis. The optical energy band gaps (Eg) of the samples were calculated using the Tauc relation, and it was found to be around 3.41 eV. The photocatalytic degradation of $MoO_3$ NPs on Direct Green (DG) and Navy Blue (NB) dye was evaluated under UV light irradiation. The electrochemical study of prepared electrode with graphite powder in 0.1 M KOH electrolyte solution displayed superior redox potential output as intended by cyclic voltametric and amperometric studies, where the material was employed for its sensing abilities such as a highly toxic metal like lead.

**Keywords:** *$MoO_3$ NPs; green combustion; Photocatalytic; Cyclic voltammetry; Amperometry; Lead Sensor.*

Flash Talk FTS3-16

# 2D Heterostructures based on Sulfur Nanosheets and reduced Graphene oxide for Li-S batteries

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Sulfur and other two-dimensional carbon materials (2DMs) have attracted intensive interest for energy storage and conversion systems because of their unique structure and remarkable properties. Although significant progress has been made in this field, certain intrinsic limitations obstruct the achievement of desired properties. In the present study, reduced graphene oxide (RGO) sheets stacked on Sulfur nanosheets (SNS-RGO) were synthesized by heat treatment method and confirmed the stacking of RGO sheets on Sulfur nanosheets by various analytical techniques. The synthesized SNS-RGO nanocomposite demonstrated improved interaction of sulfur nanosheets with RGO, confirmed through XPS analysis. The synthesized SNS-RGO significantly improved reversible specific capacity and higher rate capability (1016 mAh/g at 0.1C, 467 mAh/g at 1C) with a 77% sulfur loading amount on the cathode of the Li-S battery. Therefore, the present study opens up new insights into sustainable development in Li-S battery energy storage applications.

**Keywords:** *Nanosheets; sulfur nanosheets-RGO; heat treatment; Li−S battery*

Flash Talk FTS3-17

# CZTS-rods/MXene Binary Heterostructure for the Application of Enhanced Photo-responsive Activities

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Since last two decades, much attention has been devoted to the photo-responsive materials to meet the greener solution of global energy crisis in a sustainable way. Herein, a novel reflux method has been approached first time, for the designing of CZTS-rods/MXene binary composite in which CZTS rods are optimized and MXene-layers are prepared separately. 3D-CZTS rods are hierarchically arranged on the external surface of 2D-MXene layers which not only enhances the conductivity, but also effectively helps to alter the band gap energy of the material. The physical and photophysical properties of the heterostructure are analysed by X-ray diffraction, scanning electron microscope, and UV-VIS DRS (diffuse reflectance spectroscopy). The photocatalytic study of the heterostructure has been carried out using methylene blue solution as a model, resulting into an excellent and stable photodegradation activity under visible light irradiation. Subsequently, the photoelectrochemical measurements have been conducted under several on-off cycles under visible range irradiation in solar simulator which indicates the charge-carrier efficiency of the binary heterostructure. The possible mechanism of the photodegradation process has been proposed for this novel binary heterostructure. Thus, this work illuminates light on the designing of CZTS-rods/MXene binary heterostructure as an efficient photo-responsive material which can open a new way of developing advanced MXene-based materials for the generation of green energy in future.

## Flash Talk FTS4-01

# Study on Partial Replacement of E-plastic Waste as Coarse-Aggregate

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The Electronics sector has experienced fast expansion, owing to constant technological advancements and the introduction of new technologies to the market. As a result, E- Plastic waste has become one of the world's fastest growing solid wastes. India is the world's third-largest producer of E-plastic garbage. The tremendous expansion of construction activity in India has resulted in a huge demand for aggregates for concrete. This has resulted in the depletion of natural resources and detrimental environmental effects. Natural sand is in short supply due to the rapid development of the infrastructure industry.

This paper outlines the experimental work carried for the partial replacement of E-plastic as coarse aggregates. On hardened concrete, strength tests were performed. The results reveal that using E-Plastic waste as coarse aggregates results in concrete that is substantially more workable and less dense. This research presents a cost-effective, environmentally acceptable, and efficient disposal solution for E-Plastic waste, which can be used as a partial replacement for coarse aggregates in concrete. Researchers have recently begun to examine an alternate source of aggregate in concrete by employing E-Plastic waste as a building material, which increases the water retention characteristic of new mortar while lowering the bulk density of hardened mortar.

**Keywords:** *Solid waste, Workable concrete, Less dense concrete, Efficient disposal.*

## Flash Talk FTS4-02

# Effect of Ceramic $Al_2O_3$ Reinforcement on Microstructure Evolution, Tensile Failure, Fracture and Fatigue Behavior of Aluminum Metal Composites: T-6 Condition

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In the present work Al2014-15 wt. % $Al_2O_{3p}$ composite is synthesized with an average particle size of 20 μm using a novel two-stage stir casting method. To improve the dispersion

of the reinforcing particles and wettability the preheated (250°C) alumina particles are incorporated in two-stages into vortex of the Al2014 molten alloy instead of adding all of them at a time. The central portions of the casted specimens of Al2014 and Al2014-15 wt. % $Al_2O_{3p}$ composites are selected for microstructure studies using electron microscope/energy dispersive spectroscope (EDX) and X-ray diffraction (XRD). The synthesized composites are investigated for hardness, Ultimate tensile strength, yield strength, percentage elongation, fracture, and wear characteristics. Further the produced composites are subjected to heat treatment (T-6) to know the further enhancement in mechanical and wear properties later it is followed by fracture and fatigue studies. The uniform dissemination of ceramic $Al_2O_{3p}$ in Al2014 matrix is more after heat treatment. The existence of alumina particulates are confirmed by XRD analysis carried out on the synthesized composite both at room and heat treated condition. Wear behavior of Al2014 matrix alloy and synthesized composites are studied at both room and T-6 conditions. Dry sliding wear tests were performed utilizing a pin on disk machine with a load range of 9.81 N-49.05 N and sliding speed of 100–600 RPM. At room temperature, the wear rate of Al2014 matrix alloy and synthesized composite increases with the increasing sliding speed and load, but decreases when heat treated.

**Key words:** *Al2O3; Tensile failure; Fatigue; Wear*

**Flash Talk FTS4-03**

## Microstructural Evolution in Ceramic $Si_3N_4$ Reinforced Al6082 Composites Subjected to SPD- ECAP Process

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Equal Channel Angular Pressing is one of the methods of severe plastic deformation to produce ultra fine grain (UFG) structures. In this ECAP process higher rate of plastic strains are imposed on the specimen without altering the geometry of the specimen. Die channel angle, outer curvature angle, number of passes and different passing routes plays an important role in reducing the grain size of the material leads to improve in the grain structure. Primarily, Composite specimens are prepared by stir casting process using aluminium 6082 matrix and Ceramic Si3N4 which has high strength and toughness. Die design is one of the vital factors in to produce UFG since it needs higher compressive forces as the channel angle decreases. In this research ECAP Die is designed for a Die channel angle (Ø) 90° and outer curvature angle (Ψ) 20° which extremely imposed severe plastic deformation in the specimen. A specially designed heating coil elements and antifriction materials were used in ECAP process for smooth pass of the specimen. Microstructure evaluations and hardness tests were conducted on the casting specimens with and without ECAP process using grain size analyzer microscope. This research shows that ultra fine grain structures are produced by severe reduction in the grain size.

**Key words:** *SPD, ECAP, UFG, Si3N4 Ceramic*

## Flash Talk FTS4-04

# Fatigue Behavior of Ceramic $Si_3N_4$ Reinforced Al6082 Composites

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Ceramic $Si_3N_4$ reinforced Al6082 composites were produced using stir casting process for different weight percentages of reinforcement. $Si_3N_4$ is varied in steps of 3 from 6 wt% to 12wt%. Microstructural studies and fatigue strength tests were conducted on both as cast and produced composites. Homogeneous distribution of $Si_3N_4$ particles and excellent bond between the reinforcement and matrix were observed in Microstructural studies. Comparative analysis has been conducted for different weight percentages of reinforcement to evaluate the Microstructural and fatigue properties. This research reveals that there is a significant increase in the fatigue strength of the composites as the weight percentage of reinforcement increases. An additional care was taken during machining process of the specimen to reduce the surface irregularities by maintaining the surface roughness of 1µ on the gauge length of the specimen. However, compared to as cast alloy $Si_3N_4$ reinforced composites shows higher fatigue strength under identical testing conditions. Possible fracture mechanisms were identified by subjecting the fractured surfaces of the composites in Scanning Electron microscopy (SEM).

**Key words:** *Fatigue, Si3N4, Al6082,Composites*

## Flash Talk FTS4-05

# Metallurgical and Mechanical characterization of Al7075-WC-Co composite manufactured by combined ball milling and stir casting

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Aluminium matrix composites (AMCs) are candidate materials for aerospace and automotive industry owing to their improved strength, thermal stability, and wear resistance qualities, AMCs with multiple reinforcements have gained popularity as a replacement for single-reinforced AMCs. The impact of varying ball milled WC-Co particles on the microstructure of as cast Al7075 and the mechanical properties of Al7075-WC-Co composites made with a combination of ball milling and stir casting has been studied. The combined reinforcement of WC-Co particles was varied in a step of 3 from 0 to 9 Wt.%. Ball milling

the tungsten carbide and cobalt powder enhanced the wettability of WC-Co into the aluminium melt, ensuring that the combined reinforcement of WC-Co does not float or sink in the melt. The inclusion of mixed WC-Co reinforcement increased hardness and ultimate tensile strength with reduction in percentage elongation.

**Key Words:** *Aluminium Matrix Composites (AMCs), Metal Matrix Composites (MMCs), Microstructure, Hardness, Mechanical Properties.*

## Flash Talk FTS4-06

# "Studies on Removal of neutral red dye from it's aqueous solution using water insoluble β-cyclodextrin polymers"

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The increasing world-wide pollution of natural waters by dyes has highlighted the need for versatile and effective removal approaches. In this study,water insoluble **β**-cyclodextrin polymers were synthesized and characterized by FT-IR and scanning electron microscopic analyses. The synthesized adsorbents were used to remove neutral red dye from aqueous solutions through adsorbtion, for which the best adsorption was achieved at pH values higher than 4.0. The correlation coefficients obtained using the Langmuir and Friendlich isotherms enabled elucidation of adsorbtion mechanism. Citric acid showed the highest absorption at 10mg compared to malic and tartaric acid. Thermodynamic tests performed at 30°, 40° and 50°C showed that the adsorbtion was spontaneous and temperature-dependent, with adsorbtion following the psuedo second order model and being the fastest at the early stages, with equilibrium achieved for around 4h. The results showed that the polymers based on β-cyclodextrin could be used for the removal of dyes from aqueous media and could serve as alternatives for expensive adsorbents. Additionally, the adsorbents can be easily prepared, are of relatively low cost besides exhibiting good adsorbtion properties. They can also be easily regenerated too.

## Flash Talk FTS4-07

# Impact of Test Temperature on Wear Properties of 6061Al Reinforced with Ceramic $B_4C$ Micro-Composites Processed through Rheo Metallurgy

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The present examination involves evaluation of wear rate of Al6061 reinforced with 9wt. % $B_4C$ particulate composites of room temperature and elevated temperature (150°C). Al6061/$B_4C_p$ composites are prepared by rheo/compo casting technique, particulate size of 8

microns are used as reinforcements 9wt.% ceramic $B_4C_p$ mixed with $K_2TiF_6$ flux (0.10 ratios) is added to molten Al at 575°C followed by vigorous stirring in order to improve wettability. SEM photographs proved uniform distribution and proffer mixing of micro sized $B_4C$ particulates in Al matrix. Hardness and density of composites were found to be increased and decreased respectively, as compared to Al6061 alloy.

Pin-on-disc wear testing machine was used to investigate wear behavior of unreinforced Al6061 alloy as well as Al6061-$B_4C_p$ composites at both room and 150°C test temperatures under atmospheric humidity conditions. Wear tests were carried out by varying sliding distance and test temperature; applied load being constant. Wear rate of Al6061-ceramic $B_4C_p$ at all distance was found to be minimum at both room and elevated temperatures compared to rest of the cases. Worn surface was studied using SEM/EDS to identify the wear mechanisms and to understand the surface morphology.

**Key words:** *Rheo casting, elevated temperature, Pin-On-Disc, SEM.*

**Flash Talk FTS4-08**

## Ceramic Reinforcement Particle Size Impact on the Mechanical Behavior and Fractography of Al2618-$B_4C$ Aerospace Metal Composites

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The size of the reinforcement particles plays an important role in determining the mechanical behavior of metal composites. Hence, in the current studies an investigations were made to know the impact of 20 micron and 44 micron sized $B_4C$ particles addition on the mechanical behavior of aerospace alloy Al2618 metal composites. Al2618 alloy with 2, 4 and 6 weight percentages of 20 and 44 micron sized $B_4C$ particles reinforced composites were produced by stir cast process. These synthesized composites were tested for various mechanical properties like hardness, compression strength and tensile behavior along with density measurements. Further, microstructural characterization was carried by SEM/EDS and XRD analysis to know the varying sized particles distribution and phases. Both 20 and 44 micron sized particles distributed uniformly in the Al2618 alloy composites. The comparison studies indicated that 20 micron sized boron carbide particles reinforced Al2618 alloy composites were exhibited superior mechanical properties over 44 micron sized particles reinforced composites. Fractography studies demonstrated with the help of SEM micrographs to know the various fracture mechanisms.

**Key words:** *Al2618 Alloy; B4C; Mechanical Behavior; Fractography.*

## Flash Talk FTS4-09

# Improved indentation hardness of geopolymers by partial replacement of metakaolin with terracotta waste

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Metakaolin is an expensive component of a geopolymer cement. It was partially replaced by fired red clay (like bricks, terracotta items) in a geopolymer cement formulation. The geopolymer binders composed of two calcined aluminosilicates [viz. Metakaolin (MK) and terracotta waste (TW) in different ratios], NaOH and sodium silicate. The control composition contained only Metakaolin and the experimental composition contained MK: TW = 1:2 (w/w). This incorporation of TW resulted in change in Si/Al from 3.36 to 5.16 and the Na/Al ratio increased from 0.93 to 1.38. Geopolymerisation in the modified composition was confirmed with XRD and FTIR spectroscopic studies. Unlike metakaolin which completely reacted, TW only partly reacted to form geopolymer phase. After curing the geopolymer without terracotta waste, the Vickers hardness value was 33 HV with standard deviation 9.05. Interestingly, the incorporation of TW in geopolymer binder led to a very significant increase in indentation hardness to 62.2 HV. The inherent hardness of TW particles is high due to prior sintering. Incorporation of it in partly reacted form in the composite structure led to enhancement of hardness. Also, an enhanced particle packing was achieved due to combination of different sized particles of MK and TW in the geopolymer cement. Combination of above factors resulted in higher hardness. But the spread (standard deviation 18.34) of the indentation values for TW -containing cement is considerable. This can be attributed to introduction of heterogeneity in the geopolymeric paste by incorporation of partly reacting TW particles. SEM studies clearly show that incorporation of TW in the cement changed the texture of geopolymer. Presence of un-reacted particles and lesser amorphous matrix was evident in terracotta waste -containing the geopolymer.
**Key Words:** *Geopolymer, Metakaolin, Terracotta waste, Hardness*

## Flash Talk FTS4-10

# Fabrication and Characterization of Fe-Cr Metal Matrix Composites Reinforced with $ZrO_2$

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Zirconia-based ceramics with higher toughness seem to be the candidate materials for tribological applications. The microstructure and the wear behavior of iron and chromium alloys have been studied using several alloy compositions, several sintering temperature and

different substrates. It has been demonstrated that the sliding wear resistance of alloy can be further improved by zirconia additions. The composition of $ZrO_2$ varies by 5%, 10% and 15% in Fe80-Cr20 alloy. Introduction The microstructure and the wear behavior of iron and chromium alloys have been studied using several alloy compositions, several sintering temperature and different substrates. It has been demonstrated that the sliding wear resistance of alloy can be further improved by zirconia additions. The composition of $ZrO_2$ varies by 5%, 10% and 15% in Fe80Cr20 alloy. Metal matrix composites are generally fabricated by two different routes, either by casting process or by powder metallurgy. The casting processes offer several advantages like ease of fabrication of complex shapes in a cost-effective way and being most suited for mass production of components. However, the casting route suffers from excessive reinforcement/matrix interface reaction and poor wettability of the ceramic reinforcing phase in the metal matrix. These demerits of casting route can be overcome by powder metallurgy route

**Key Words:** *(Powder Metallurgy, ZrO2, Fe-Cr Alloy).*

## Flash Talk FTS4-11

### An Abstract of Machinability Studies of Aluminium And Its Alloys

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Aluminium alloys, especially Al-Si alloys are being used extensively in recent times in, automobile and aerospace applications, primarily because of their combined ability of strength and light weight, and also heat resistance. In this context machinability characteristics are studied exhaustively to provide information to industry and researchers, to make decisions when they come across with machining of these alloys. This abstract compiles the developments in machinablity studies of aluminium alloys briefly, and Al-Si alloys in particular.

**Keywords:** *Aluminium alloys; Cutting forces; cutting tools materials; surface integrity*

## Flash Talk FTS4-12

### Durability Properties Study by Using Central Composite Design of Blended Geopolymer

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Disposal of fly ash (FA), bottom ash (BA) and granulated blast furnace slag (GBFS) which are by-products of power plants, steel production units is a challenging environment

problem and eco-friendly disposal adds significantly to the cost of production. The aim of the paper is to generate solution to the above problem by developing eco-friendly geopolymer products and study their durability in adverse conditions. Central composite design, a statistical technique is used to study the effect of variables such as FA content, BA content and molarity of activator solution and exposure time in various atmospheres (such as air, 1% and 3% of $H_2SO_4$, $CH_3COOH$, $Na_2SO_4$, $MgSO_4$, NaCl) on the compressive strength of geopolymer samples. Sixteen second order mathematical models have been developed to predict the compressive strength of the samples over the experimental domain. In all the experimental conditions except three (2% acetic acid, 3% $MgSO_4$ and 2% $Na_2SO_4$), the maximum compressive strength is predicted for 43% FA blended geoplymer.

**Key words:** *Fly Ash, Bottom Ash, Geopolymer, Compressive strength, Central composite design*

**Flash Talk FTS4-13**

## Influence of hot rolling on wear behavior of Al6063- nano$B_4C$ composites fabricated by ultrasonic assisted stir casting process

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The present work aims to investigate the influence of hot rolling on wear behaviour of boron carbide nanoparticulates reinforced Al 6063 alloy composites. The Al-$B_4C$ composites were prepared using ultrasonic assisted casting technique followed by hot rolling process at a temperature of $400^0$C. The weight fractions of reinforcement used were 2, 4 and 6wt% of cast composites were hot rolled for reduction ratios of 20%, 40%, 60% and 80%. Both as cast and hot rolled composites were studied for microstructure and wear properties, the effect of hot rolling on wear behavior of composites were evaluated, it was found that the wear rate of the rolled composites was lower when compared to the unrolled composites. With Increasing the weight percentage of $B_4C$ particles in the matrix was found to enhance the wear resistance of the composite samples. It was also observed that the wear rate increased with increasing load and the sliding velocity.

**Keywords:** *Ultrasonic cavitation Assisted Stir Casting, Al6063, Hot rolling and wear*

Flash Talk FTS4-14

# Synthesis, characterization, and catalytic properties of different concentration of cobalt substituted mesoporous aluminophosphate (CoAPO) molecular sieves

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Environmental issues arising from the industrial waste have been the major challenge for scientists to resolve and restore it. In this regard, newer materials have been synthesized to address these issues. Zeolites are reported to be very fascinating among such materials. These zeolites are mesoporous molecules which belong to the family of crystalline materials. In this class, metal substituted aluminophosphate gained high importance due to their promising applications in industrial processes such as adsorption, separation, ion exchangers and also, newer applications in the field of magnetism, chemical sensors, electronics and medical fields. Cobalt is one of the important transition metal, Co substituted aluminophosphate are very good heterogeneous catalysts for the oxidation of cycloalkanes. Cobalt ion exchanged molecular sieves are showing very high activity in the selective catalytic reduction of NOx by methane and ethane in the presence of $O_2$. CoAPO are pervasively studied due to the possibility of redox reaction and potential use in solid-acid catalysis, CoAPO molecular sieves catalyse the auto oxidation of cyclohexane in the liquid phase.

In this paper we are presenting cobalt aluminophosphate molecular sieves synthesis, characterization, and its application in nitrophenol reduction. The different concentrations of divalent cobalt-incorporated into mesoporous aluminophosphate molecular sieves by the combination of hydrothermal and pyrolysis method. X-ray diffraction studies show the presence of alumina phosphate structure with or without the presence of secondary phases. The absence of secondary phase peaks in diffraction peaks corroborates to the successful doping of the Co into aluminophosphate structure. And the Samples calcinated at 1000°C showing high crystallinity compared to as prepared and pyrolyzed samples. TGA analysis shows more weight loss for as-prepared samples and less weight loss for calcinated samples. This weight loss measurements indicates that as prepared samples having higher carbon content. TEM micrographs of calcined samples show the core zeolite particles are needle shaped and are connected with each other by the graphitic carbon. UV-DRS spectra show that, high absorption for the pyrolyzed samples due to the presence of more carbonaceous content whereas it is lower for the calcined samples. From this data we can see the difference in percentage reflectance and absorption properties must be associated with the carbon present in each sample. The samples were also subjected to the BET analysis to find out the pore diameter and surface area. The analysis showed that the pore diameter for all the samples were above 2 nm. The results clearly indicate the presence of mesoporosity of the materials and then the samples substituted with different molar concentration of Co. Among all the samples1.5 mmol Co incorporated and calcinated at 1000° C shown higher surface area. The highly porous and active surface resulted in improved catalytic activity in the nitrophenol reduction process. The improvement seems to be more reactive compared to that of alumina phosphates. The Characteristic activities of cobalt aluminophosphate is controlled by varying

the concentration of cobalt insertion into the framework. The Co incorporated 1.5 mmol calcinated sample shows good catalytic activity than other Co substituted with different molar concentration of Co molecular sieves. The CoAPO-1.5 mmol sample exposes more surface area for nitrophenol reduction reaction due to this it act as a good catalyst in all these prepared samples.

**Flash Talk FTS4-15**

## Electro-Oxidation of Ethanol Using Mo(VI) Adsorbed Organo-Modified Fe-Montmorillonite

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A green and cost-effective methodology for the removal of molybdate ions from the aqueous and acidic solutions using organo-modified Fe-montmorillonite (Fe-Mt) as an adsorbent were demonstrated here. The adsorption of Mo(VI) was recorded using UV-Visible spectrophotometer in the pH range of 1–10 and ~ 90% Mo(VI) was adsorbed on Fe-MMT surface within 4 h and maximum adsorption capacity of Fe-Mt is found to be 720 mg/g at pH 4. After completion of adsorption process, the properties of the obtained samples were characterized by X-ray diffraction (XRD), field emission scanning electron microscopy (FE-SEM), energy dispersive X-ray (EDX) analysis, thermogravimetry (TG)/ differential thermal (DT) analysis and fourier transform infrared (FT–IR) spectroscopy. The XRD pattern of oragno modified Fe-MMT revels that Mo(VI) adsorbed as hexagonal molybdenum oxide (*h*-$MoO_3$) phase and transformed to orthorhombic molybdenum oxide ($\alpha$–$MoO_3$) upon heating to 500 ˚C, which was confirmed by TG-DT analysis.

The $MoO_3$ adsorbed Fe-Mt was coated on glassy carbon electrode (GCE) to study electrooxidation of ethanol using cyclic voltammetry (CV) in alkaline medium (0.5 M NaOH). The modified electrode significantly enhanced the catalytic efficiency for EOR compared to a bare glassy carbon (GC) electrode. Viability parameters, ethanol concentrations, scan rate and upper potential limits were examined and analyzed. This study suggests that the *h*–$MoO_3$–OMC catalyst has potential application for direct EOR in fuel cells.

## Flash Talk FTS4-16

# Diffusion behavior of Ba(II) on Fe-Montmorillonite Relevant to Geological Waste Disposal

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The bentonite clay mineral is proposed as backfill or buffer materials in the engineered barrier system for high-level nuclear waste (HLW) disposal in deep geological repository (DGR). The major clay mineral of bentonite, montmorillonite (Mt), is expected to undergo alteration owing to its interaction with corrosion products from overpack/ canister over a long time period [1-3]. As a typical and simple altered clay mineral, we used Fe(II)–, & Fe(III)-Mt for preliminary investigation on the diffusion behavior of $^{133}$Ba relevant to HLW. Ba(II) is one of the high-yield fission products of uranium- and plutonium-based nuclear fuels and it has $t_{1/2}$ = 10.51 y ($^{133}$Ba) [4]. Instantaneous planar source method was used to determine the apparent diffusion coefficient ($D_a$) using compacted ($\rho_d$ = 1.6 g/cm$^{-3}$) and water saturated Fe–Mt. In Fe(II)–Mt, the $D_a$ values (in m$^2$/s) for $Ba^{2+}$ ($1.4 \pm 0.4\times10^{-11}$) and in Fe(III)-Mt ($1.09 \pm 0.6 \times 10^{-12}$) shown in figure below. In general, the $D_a$ value is higher for Fe(II)–Mt compared to that in Fe(III)–Mt, which is in conformity with the sorption data and these are first report on Fe–Mt ($Fe^{2+}$ or $Fe^{3+}$ as exchangeable interlayer cations).

**Key words**: *Bentonite, Fe-montmorillonite, Apparent diffusion coefficient (Da, m2/s).*

## Flash Talk FTS4-17

# A comparative study on physio-mechanical properties of silica compacts fabricated using rice husk ash derived amorphous and crystalline silica

**Ashutosh Gupta, Vaibhav Pandey, Mayank Kumar Yadav, Kalyani Mohanta, Manas Ranjan Manjhi**
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Rice husk an agricultural waste, is widely used as cheap source of silica to fabricate silica-based composites. Though a lot of research work have been reported related to utilization of RHA as silica source, no concrete information is available on the behaviour of rice husk ash (RHA) obtained at different temperatures. We herein report a systematic study on the physical and mechanical behavior of silica compacts prepared using amorphous and

crystalline silica obtained from rice husk ash. Phase analysis of RHA treated at various temperatures is carried out using XRD. Amorphous silica is obtained above 400°C and below 800°C. A phase transformation takes place in the temperature range of 880°C-900°C, after which RHA converts to crystalline phase. Crystalline silica consists of mostly cristobalite and tridymite phases. Conversion of tridymite to cristobalite occurs at temperature above 1200°C. Physical and mechanical properties of silica compacts fabricated using RHA treated at different temperatures has been studied. Green density of silica compacts prepared using crystalline silica is low compared to amorphous silica attributing to haphazard nature of amorphous silica. In contrast to green density, sintered silica compacts prepared using amorphous silica shows better strength and more relative density compared to crystalline silica. Obtained results were correlated with SEM micrograph.

**Keywords:** *Rice husk ash; Amorphous; Crystalline; Mechanical properties.*

## Flash Talk FTS4-18

# Fabrication and characterization of porous $SiO_2$ composite for high temperature engineering applications using low-cost materials

**Vaibhav Pandey, Ashutosh Gupta, Mayank Kumar Yadav, Kalyani Mohanta, Manas Ranjan Manjhi**

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The present work is focused on the effective and potential utilization of white silica sand (WSS) for the development and characterization of porous silica compacts through a low-cost method. WSS is used as the source of silica. Sucrose along with distilled water is used as low-cost organic binders. Green compacts of different composition of WSS, sucrose powder and distilled water is fabricated with 5 to 15 % binders using dry pressing process followed by sintering in the range of 1200°C to 1500°C. Compaction load, heating schedule and binder amount has been optimized. Effect of particle size of WSS, binder amount and sintering temperature on the porosity, thermal and mechanical properties of porous silica compacts has been studied. Results revealed that porous silica composite can be possible with good mechanical properties. Porous silica having apparent porosity in the range 5- 30 % and compressive strength up to 50 MPa is successfully obtained. Increase in particle size irrespective of increasing porosity increases the strength of porous silica. Increasing sintering temperature will increases strength up to an optimum temperature after which it starts decreasing due to the formation of glassy phase. WSS above 250 micron and 95 % wt. at 1300°C sintering temperature give optimum result. The fabricated composites are suitable for wide range of applications like thermal insulation, gas separators, refractories etc.

**Keywords:** *White sand; Silica; Porous; Compressive strength.*

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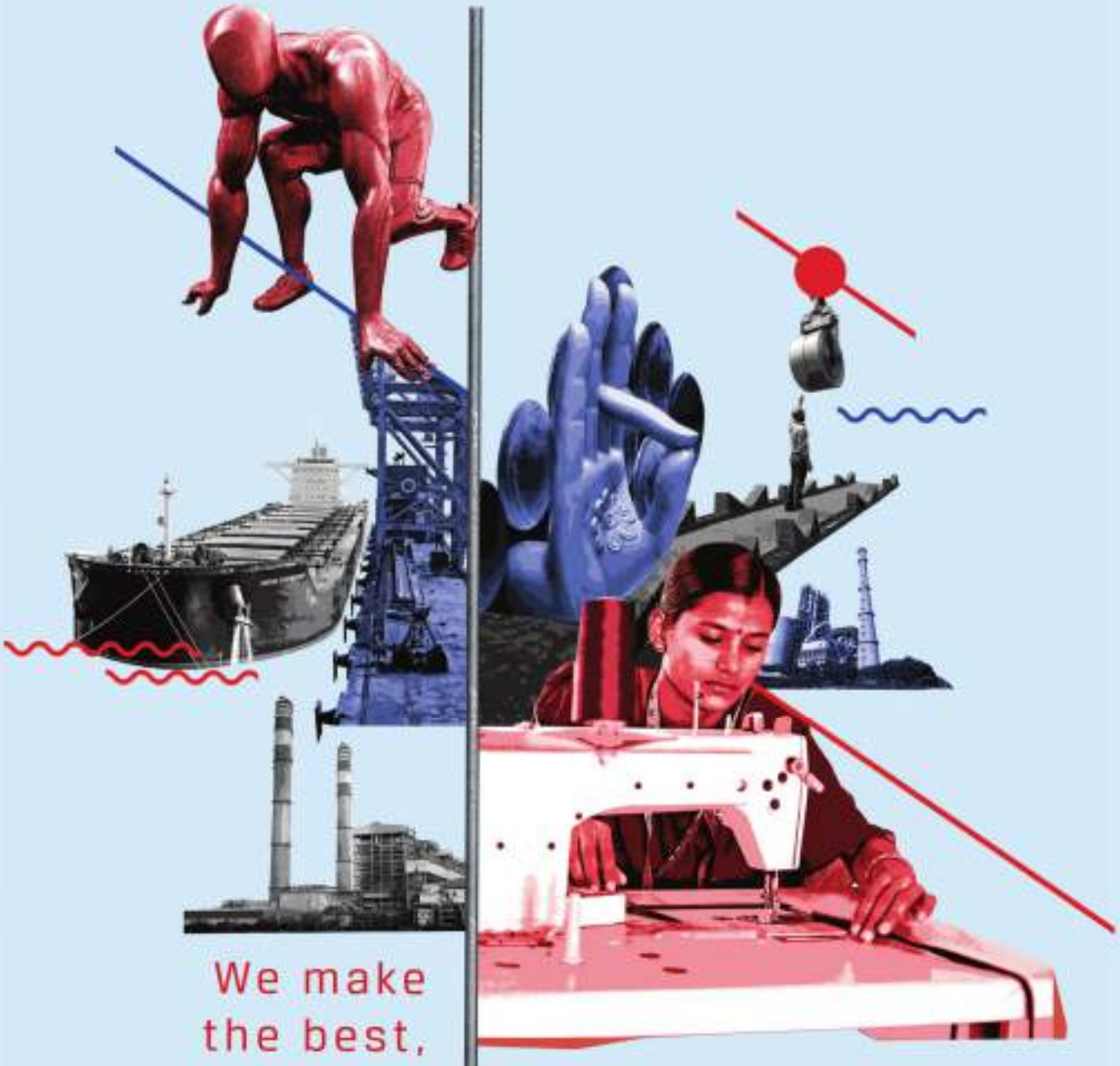

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It takes a strong will to be ranked among India's top business houses. But it was stronger dreams and, ambition that made us venture into the core sectors of Steel, Energy, Cement and Infrastructure. Our strength, state-of-the art technology and excellence in execution have helped them grow and that has helped India grow multi-fold. By harbouring dreams of transformation, focusing on sustainability and a philosophy; to give back to the country, the JSW Group is making a better world every day.

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JSW
Better Everyday

COMMITED TO EXCELLENCE IN CEMENT REFRACTORIES

Marvels Refractory Company is located in Anshan, Liaoning, China. MRL has state of the art, automated, production and R&D facility with production capacity of 110,000 MT. Marvels operates, three ultra- high temperature (1850 °C) tunnel kiln production lines. MRL has enjoyed long standing technical collaboration with leading global refractory producers

CMS Spinel brick has good resistance to thermal shock, thermal load, chemical corrosion, heat damage, oxidation reduction, high temperature mechanical flexibility and abrasion.

CFS brick is a hybrid brick made primarily of magnesia grain, hercynite and spinel grain. CFS bricks exhibit properties of good clinker coating, sound thermal shock resistance, good heat load fatigue resistance, excellent high temperature mechanical flexibility and good wear resistance.

CNS brick is a hybrid brick that consist primarily of magnesia, MA spinel and manganese compound. CNS brick exhibits better resistance to thermal shock, abrasion and high temperature mechanical flexibility and kiln coating property. CNS bricks can be used in burning and transition zone.


| Specific Recommendation | | | |
|---|---|---|---|
| CONDITIONS | LTZ | BZ | UTZ |
| Normal condition | CMS-10AS | CFS-15AS | CMS-10AS |
| Medium Mechanical Stress | CMS-15AS | CFS-15AS | CMS-15AS |
| Severe Mechanical Stress | CMS-15AT | CFS-15AT | CMS-15AT |
| High Thermo Chemical stress(AF) | CNS-15AS | CNS-15AS | CNS-15AS |
| Severe Chemical stress (AF) | CNS-15AT | CNS-15AT | CNS-15AT |
| Stable Coating condition in BZ | | CFS-15AS | |
| Unstable coating condition in BZ | | CNS-15AS | |
| Very thin coating / No coating in BZ | | CNS-15AT | |
| High Thermal load | CNS-15AS | CNS-15AS | CNS-15AS |

| Physical and chemical properties | | | | | | |
|---|---|---|---|---|---|---|
| Item | | | CNS-15AS | CFS-15AS | CMS-15AS | CMS-10AS |
| MgO | | wt% | 84.5 | 87.9 | 83.6 | 86.8 |
| $Al_2O_3$+MnO/$Fe_2O_3$ | | wt% | 13.5 | 10.2 | 14.5 | 11.1 |
| Apparent porosity | | % | 15.8 | 15.5 | 15.5 | 15.8 |
| Bulk density | | g/cm³ | 2.96 | 2.99 | 2.96 | 2.95 |
| Cold crushing strength | | MPa | 70 | 70 | 70 | 70 |
| HMOR | 1400℃ | MPa | 2 | 1.6 | 1.5 | 1.5 |
| RUL | 0.2MPa $T_{0.6}$ | ℃ | >1700 | >1700 | >1700 | >1700 |
| TSR | 1100℃- water | times | 9 | 9 | 15 | 16 |
| | 950℃- air | | >100 | >100 | >100 | >100 |
| TC | 1000℃ | w/(m-k) | 2.7 | 2.7 | 2.95 | 3.00 |
| TE | 1000℃ | % | 1.19 | 1.17 | 1.21 | 1.21 |
| Wear loss (Abrasion) | | cm³ | 6.63 | 10.44 | 12.08 | 12.15 |
| Permeability | | nPm | 3.2 | 2.8 | 3.4 | 3.5 |

| Physical and chemical properties | | | | | |
|---|---|---|---|---|---|
| Item | | | CNS-15AT | CFS-15AT | CMS-15AT |
| MgO | | wt% | 84.7 | 88.4 | 83.9 |
| $Al_2O_3$+MnO/$Fe_2O_3$ | | wt% | 13.7 | 9.9 | 14.5 |
| Apparent porosity | | % | 15.0 | 15.0 | 15.0 |
| Bulk density | | g/cm³ | 2.98 | 3.01 | 2.98 |
| Cold crushing strength | | MPa | 70 | 70 | 70 |
| HMOR | 1400℃ | MPa | 2.1 | 1.7 | 1.6 |
| RUL | 0.2MPa $T_{0.6}$ | ℃ | >1700 | >1700 | >1700 |
| TSR | 1100℃- water | times | 9 | 9 | 15 |
| | 950℃- air | | >100 | >100 | >100 |
| TC | 1000℃ | w/(m-k) | 2.7 | 2.7 | 2.95 |
| TE | 1000℃ | % | 1.19 | 1.17 | 1.21 |
| Wear loss (Abrasion) | | cm³ | 6.54 | 10.01 | 11.88 |
| Permeability | | nPm | 3.1 | 2.7 | 3.3 |

Address : Chaitanya, Plot No. 5, Sector 106, Gautam Budh Nagar, NOIDA, UP: 201 301
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Tel : +91 99990 63790
Web : http://www.mrlrefractories.com
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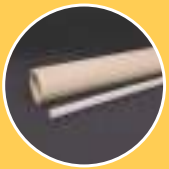
Mortar & Pestle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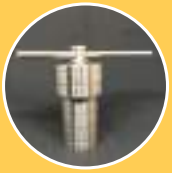
& Labwares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- Magnesite upto 95%
- Chrome
- Andalusite / Mullite / Sillimanite
- Magchrome
- Magnesia Carbon / Al. Magnesia Carbon / Al. Silicon Carbide Carbon / Magnesia Spinel Carbon

**► CASTABLES**
- Conventional upto 97% Alumina
- Low Cement upto 95% Alumina
- Alkali resistant LC
- Silicon Carbide based
- Insulation

- High Al. Ramming / Gunning Mass
- Basic Ramming / Gunning Mass
- Neutral Ramming Mass

**► MORTARS**
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- Basic
- Insulation

**► SPECIAL**
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- Rotary Kiln for manufacture of High Alumina **CEMENT BINDERS, SYNTHETIC RAW MATERIALS BAUXITE & CLAY CALCINATION**
- Strong Experienced Team for TECHICAL **SUPPORT**
- Total Refractory Management Solutions

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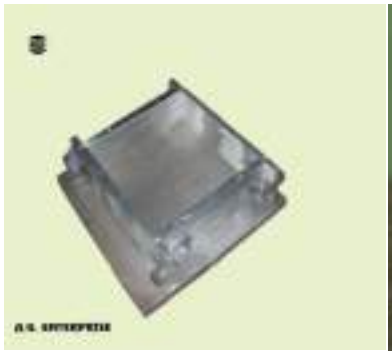



We have given above some of our manufacturing items.

Thanking you,
With best regards.
**For A. G. Enterprise**

**A.K.Sahoo (M 9830057016)**
Proprietor.

## About us

**Dhavaa Technical Ceramics & Consultancy** is a start-up, initiated by IITian and is located in Coimbatore, the southern part of India. It offers wide ranges of services to the advanced materials manufacturing and research organisation.

### Materials supply

supply bill of materials used for advanced materials manufacturing.

### Technical consultancy

expertise in various ceramic manufacturing methods that to offer re-engineering of your existing process/product to enhance the performance.

### Research & development

collaborate with national, international research organisations and ceramic industries and to contribute new functional materials development and performance enhancement.

### Contract Manufacturing

Facilitate the manufacturing of ceramics components with high precision as local and international client's requirement.

## Our Business Associates

| Company | Country | Product | Application |
|---|---|---|---|
| **KCM Corporation** | Japan | Zirconia powder | Structural, Dental, SOFC and Oxygen sensors |
| **YJC Co Ltd** | South Korea | Kiln furniture Refractories | LIB, MIM, CIM and Industrial ceramics |
| **GTop Technology** | Taiwan | AlN powder | Semiconductor |

## Few of our clients:

## Contact us for further enquires:


| | |
|---|---|
| Dr. Dhavanesan Ramachandran M.Tech, PhD.<br>**Business Head** | Dhavaa Technical Ceramics & Consultancy<br>11B-A Marutham Nagar, Vadavalli,<br>Coimbatore- 641 041, India<br>Contact No: +91 975975 2244<br>Email : info@dhavaa.com |

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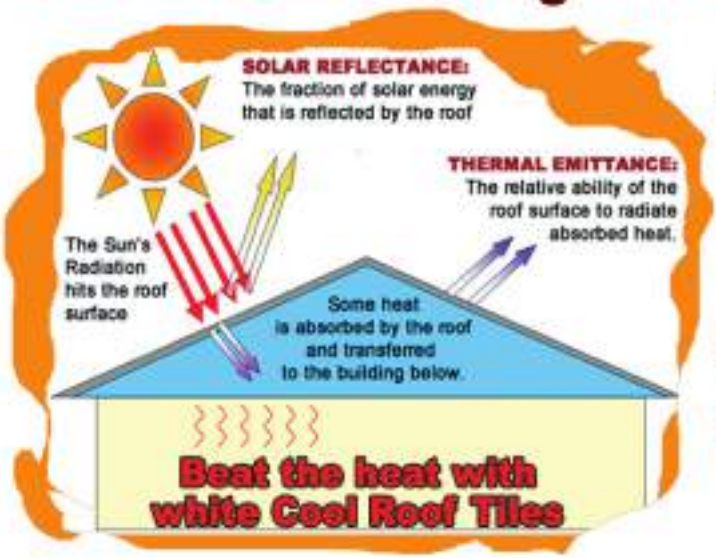


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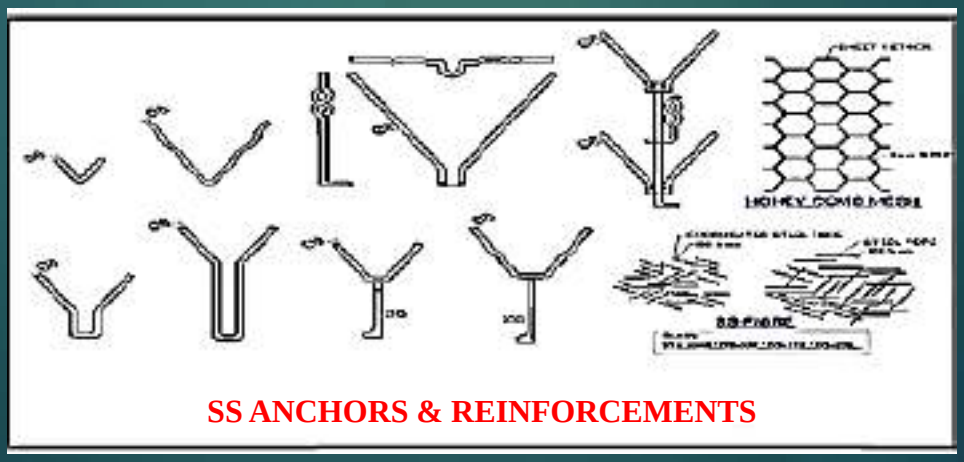

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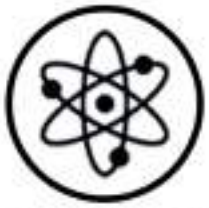

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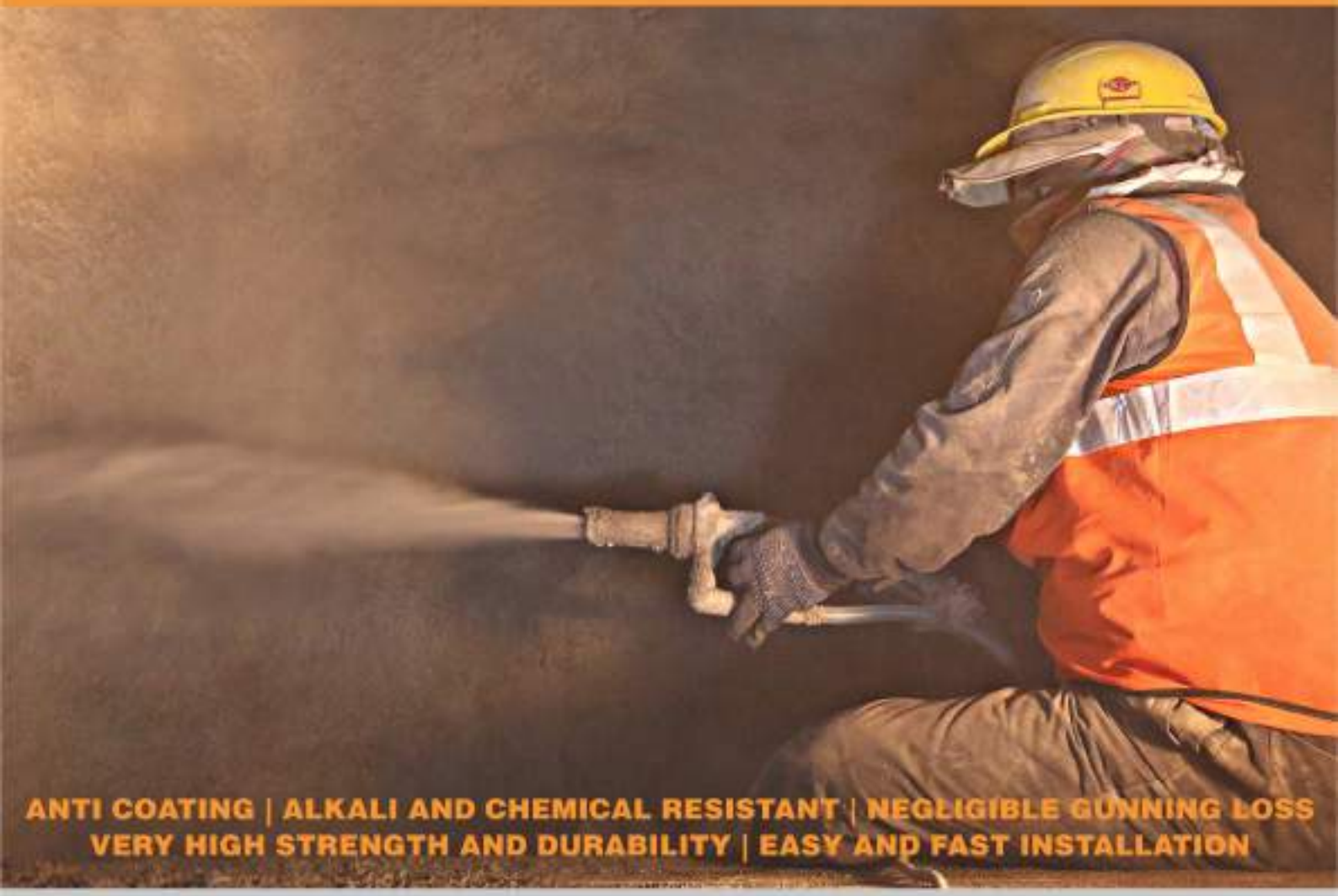


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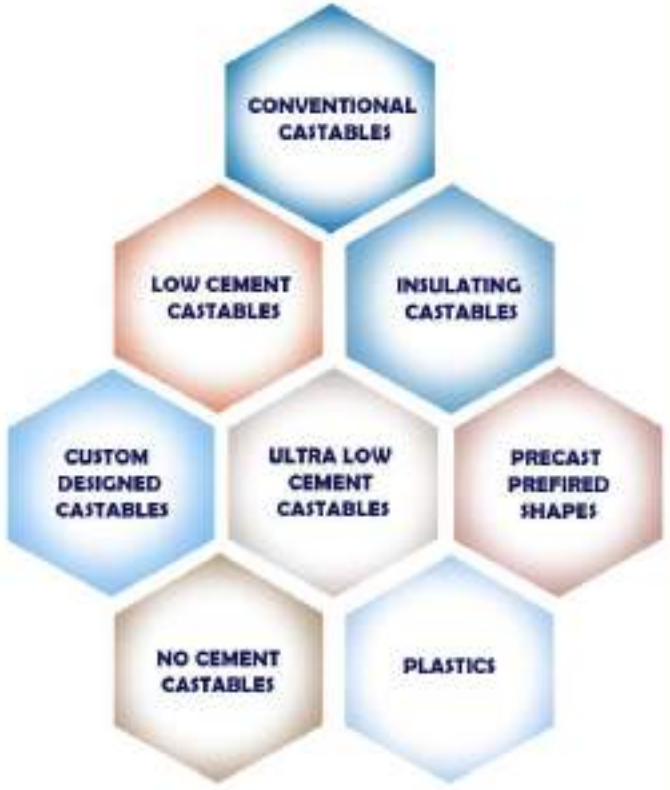


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# CSIR - Central Glass & Ceramic Research Institute

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Email: director@cgcri.res.in

## Major Research & Development Activities

- Fibre Optics & Photonics
- Specialty Glasses
- Sensor & Actuator
- Sol-gel processing
- Whiteware & Rural Pottery
- Engineering Ceramics
- Bioceramics & Coating
- Solid Oxide Fuel Cell & Li-ion Battery
- Ceramic Membrane Filters
- Refractory & Tiles from Industrial Waste
- Nano-structured Coatings
- Nano-structured Materials

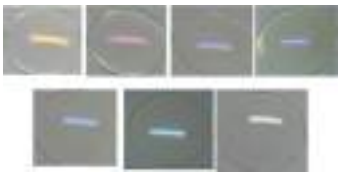
## Recently Transferred Technologies

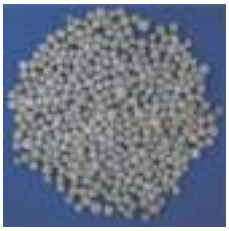
- Ceramic membrane based water purification systems
- Glass nodules for nuclear waste immobilization
- Coated medical implants
- Bioceramics hip & orbital implants
- Optical amplifier for cable TV network
- Glass lining material for reactor

## PRODUCTS DEVELOPED BY CSIR-CGCRI


Refractory Products


Orbital Implant


Wavelength Selective AR Coating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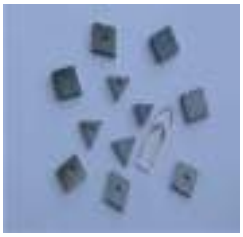
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CSIR-CGCRI is devoted to achieve excellence and providing leadership in the niche areas of specialty glass, optical fibres, advanced ceramics and nano-structured materials covering frontier science, viable technology and societal empowerment.

## Outreach Centres

### Naroda Centre

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Tel.: 079 2282 3345, Fax: 079 2282 2052
Email: siccgcrinc@cgcri.res.in

### Khurja Centre

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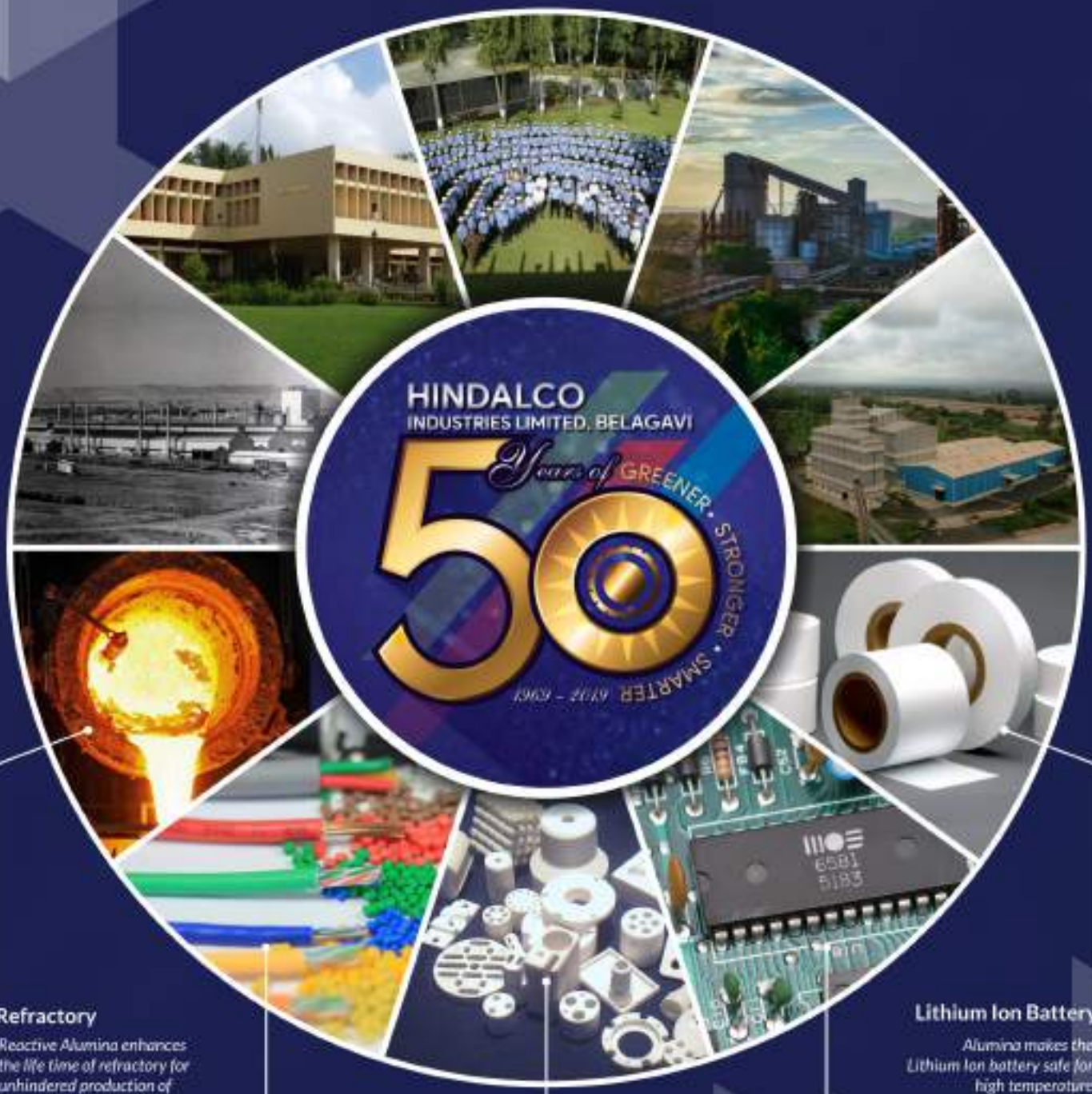


**Refractory**

*Reactive Alumina enhances the life time of refractory for unhindered production of metal/glass.*

**Cable Compounds**

*Fine Alumina hydrate is the life saving fire retardant filler*

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*Alumina is a versatile raw material for high purity and strong ceramic components.*

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FAUCETS

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Photos of IVaCCT-2021 Inauguration Function

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Introduction to MAX and MAB Phases
Synthesis of Ternary Ceramics ($Cr_2AlC$) by Using Biochars
Synthesis of Nanolayered Ternary Borides Powders (MAB Phases) by Sustainable Molten Salt Infiltration and Encapsulation Method
Design of Green Foams and Bioplastics for Multifunctional Applications
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POOJYA DODDAPPA APPA COLLEGE OF ENGINEERIN
Kalaburagi Karnataka
Department of Ceramic and Cement Technology
in Association with
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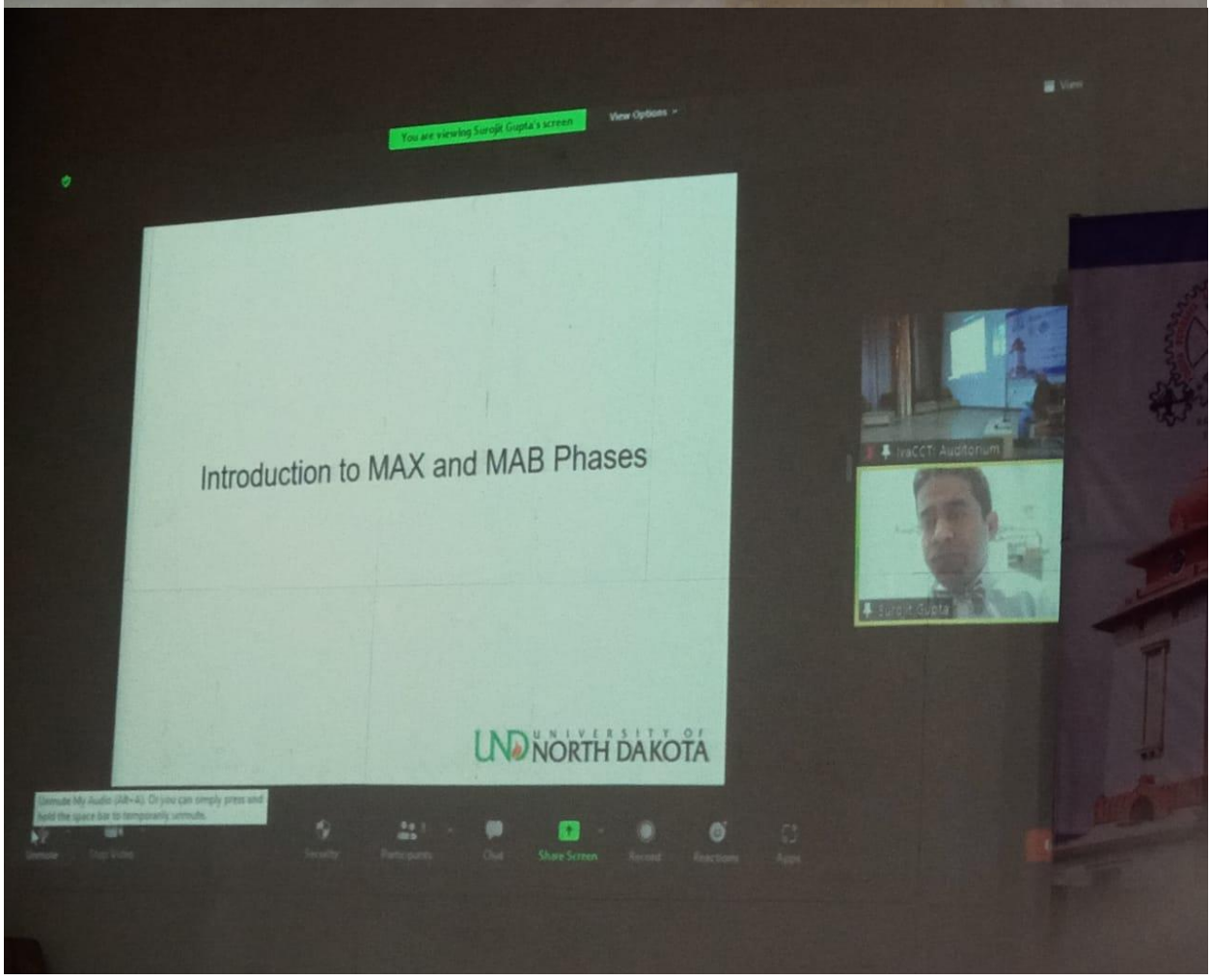
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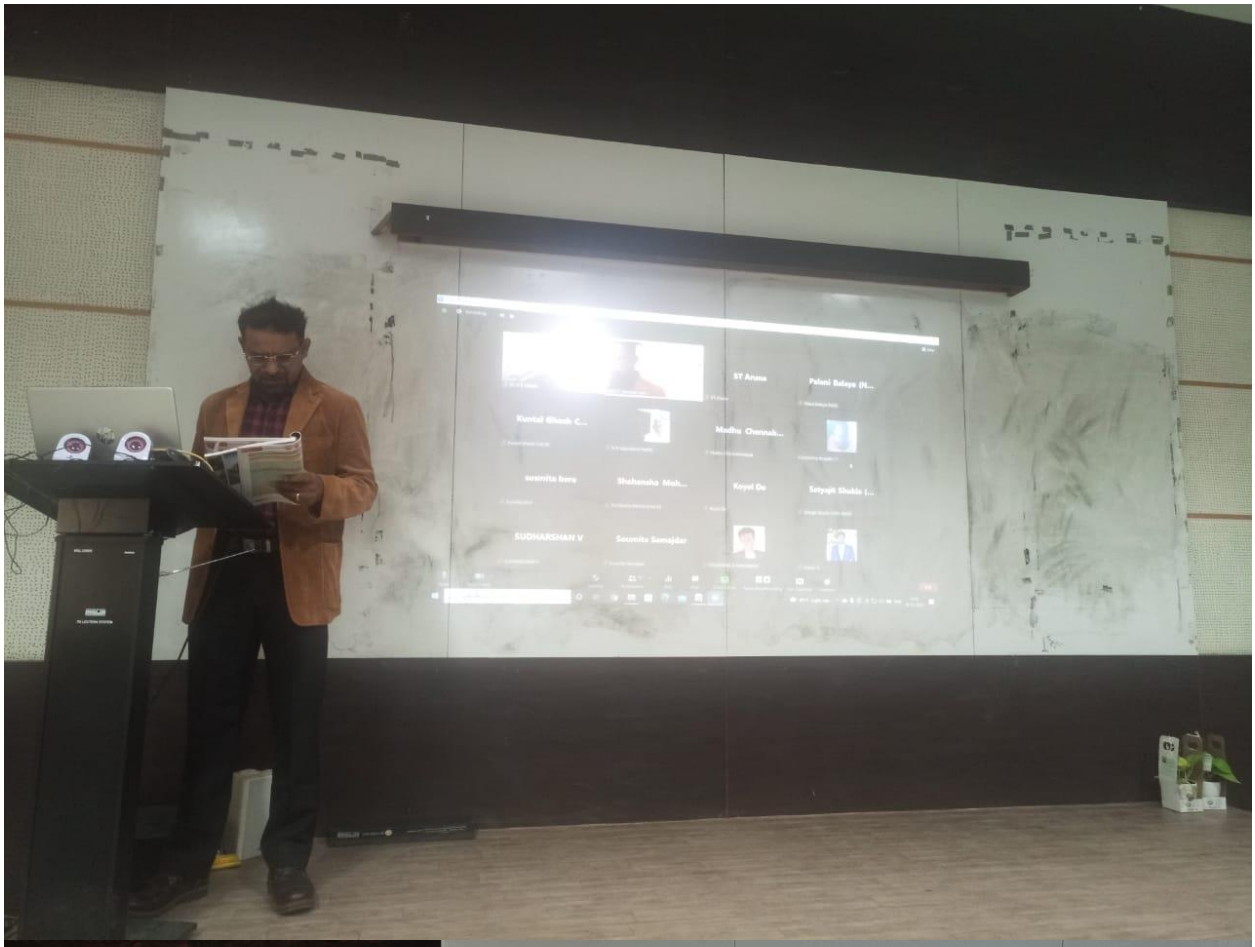

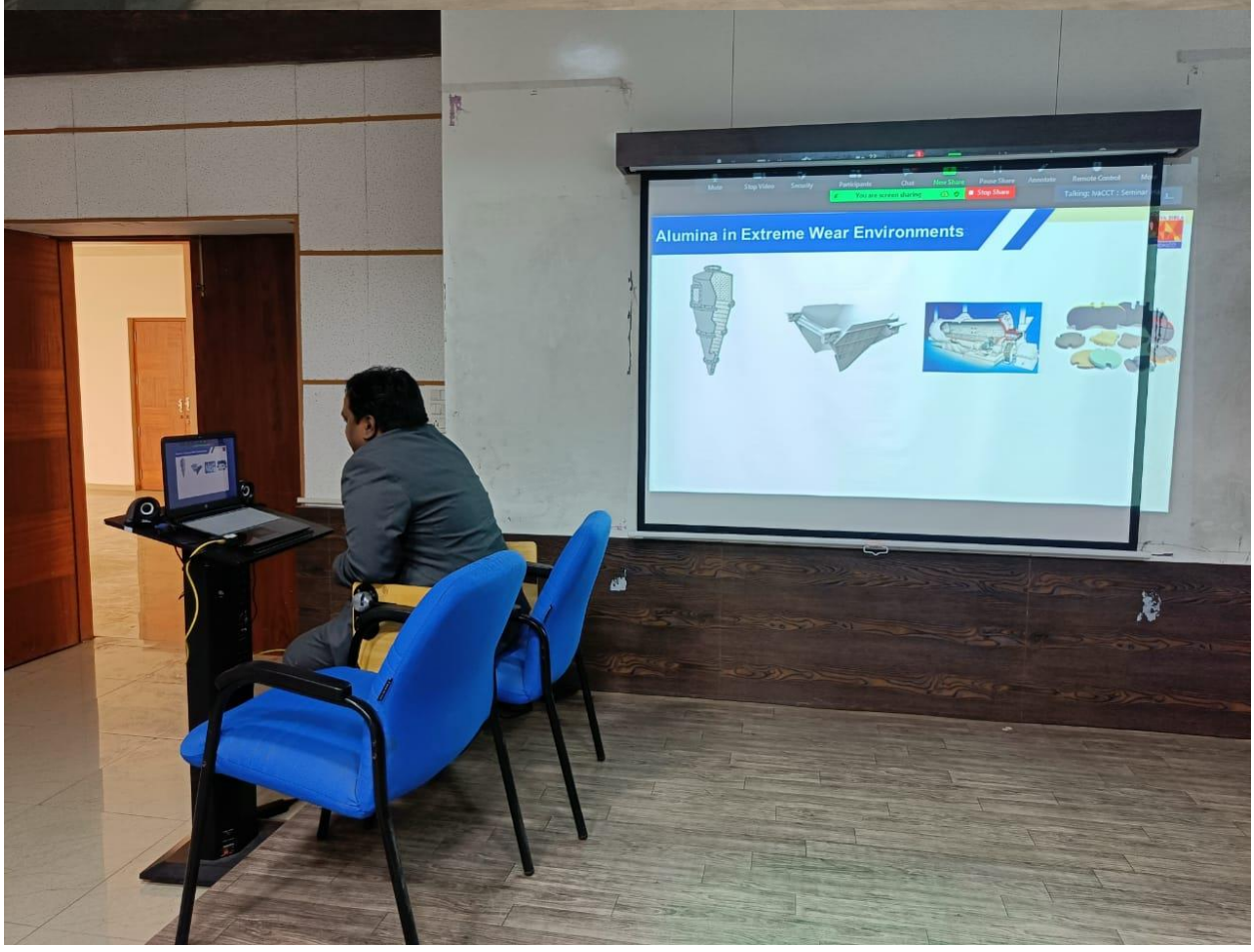
Alumina in Extreme Wear Environments


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