

National Seminar on Ceramic and Glass Technology For a Sustainable Future: Challenges, Opportunities, and Innovation (CGTSF-2026)

7-8 AUGUST, 2026

VENUE: CSIR-CGCRI, KOLKATA

Organized by



Indian Institute of Ceramics
Kolkata

Jointly With



CSIR-Central Glass & Ceramic
Research Institute,
Kolkata

CGCRI

In Association with



All India Pottery
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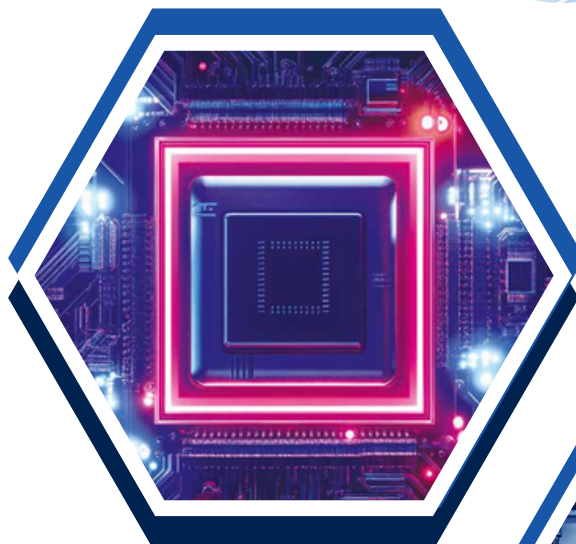


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National Seminar on Ceramic and Glass Technology for a Sustainable Future: Challenges, Opportunities, and Innovations (CGTSF- 2026)

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National Seminar on Ceramic and Glass Technology for a Sustainable Future: Challenges, Opportunities, and Innovations (CGTSF-2026)

PROGRAMME SCHEDULE

Day 1: 7th August, 2026

Time	Venue: Meghnad Saha Auditorium, CSIR-CGCRI, Kolkata
09:00 to 10:00 hrs	Registration
10:00 to 11:00 hrs	Inauguration Programme
10:00 to 10:05 hrs	Lighting of the ceremonial lamp with Invocation
10:05 to 10:10 hrs	Presentation of flower bouquets to the dignitaries on the dais
10:10 to 10:15 hrs	Welcome Address by Dr H S Tripathi Former Scientist G & Co-Chairman, CGTSF-2026
10:15 to 10:20 hrs	Address by Prof Bikramjit Basu, Director, CSIR-CGCRI & Patron, CGTSF-2026
10:20 to 10:25 hrs	Address by Dr. Debashish Bhattacharjee, Member, Technology Development Board, GOI & Chief Guest
10:25 to 10:30 hrs	Address by Dr G Ramaguru, Director, DIACoE, IIT Hyderabad & Guest of Honour
10:30 to 10:35 hrs	Address by Shri Sabyasachi Roy, President, AIPMA
10:35 to 10:45 hrs	IIC and AIPMA award distribution
10:45 to 10:50 hrs	Release of Abstract Book by the dignitaries on the dais
10:50 to 10:55 hrs	Felicitations of the dignitaries on the dais
10:55 to 11:00 hrs	Vote of Thanks by Dr Shirshendu Chakraborty, Scientist F, CSIR-CGCRI and Organizing Secretary, CGTSF-2026
11:00 to 11:30 hrs	High Tea: Venue- K. D. Sharma Multipurpose Hall, CSIR-CGCRI
11:30 to 13:00 hrs	Technical Session-I Chair: Dr BD Mukherjee
11:00 to 11:30 hrs	Keynote Lecture "Ceramic Materials" by Debashish Bhattacharjee, Member, Technology Development Board, GOI
11:30 to 12:00 hrs	Keynote Lecture "Ceramic Tiles & Composites for Aerospace Applications" Dr G Ramaguru, DIACoE, IIT Hyderabad
12:00- 12:30 hrs	Keynote Lecture by Prof Bikramjit Basu, Director, CSIR-CGCRI
12:30 to 13:00 hrs	Plenary Lecture "Firing the Future: Cross-Pollinating Missile Technology Ceramics for Sustainable Traditional Ceramic Manufacturing" Dr Anil Kumar, ASL-DRDO
13:00 to 14:00 hrs	LUNCH: Venue: K. D. Sharma Multipurpose Hall, CSIR-CGCRI



14:15 to 16:30 hrs	Technical Session-II	
	TS:II(A): Venue: Meghnad Saha Auditorium Chair: Dr A Ghosh	TS:II(B): Venue: APC Roy Seminar Hall Chair: Dr S Ghatak
14:15 to 14:45 hrs	Novel Diborides for Ultra-High Temperature Applications Prof. Peter Tatarko, SAS, Bratislava(Online)	Prediction of Flow-Accelerated Refractory Corrosion Regions in Electric Glass Furnaces Using CFD Modelling Dr. Jitendra Sehgal, Borosil
14:45 to 15:15hrs	CUMI Advance Ceramics: From Material Innovation to Engineered Solutions Dr Santanu Mandal, CUMI	Strategic Material Capabilities at Industrial Scale are is key for Atmanirbhar Bharat Mr. Niraj Bhukhanwala, Bhukhanwala
15:15 to 15:35hrs	Energy Efficient Ceramic Tile Bodies Using Calcined Colemanite Dr. Parvesh Agrawal, CGCRI Naroda	Mr. Kushal Agarwal, Sarvesh Refractory
15:35 to 15:55hrs	Ceramics in automobiles : Emerging opportunities for Advanced Alumina Materials in Conventional and Electric Mobility Dr. Shekhar Nath, Hindalco	Development of Hydroxyapatite Coated With Silk Reinforced Polycaprolactone Bio-Composites for Bone Applications Prof. S. Manisha Vidyavathy, Anna Univ
15:55 to 16:15hrs	Development of Glass Foam Bricks from Waste Glass: Various stages of TRL Dr Ashish Mondal, CSIR-CGCRI	Advanced Calcium Phosphate Bioceramics: Fundamental Material Design, Synthesis, Processing, and Additive Manufacturing of Hydroxyapatite, β-TCP, and Bioactive Glass Mr. Sabyasachi Roy, Ceramat
16:15 to 16:30hrs	Atomic Pair Distribution Function (APDF): Screening tool to have the insight into the local structure of complex perovskites Dr J Ghosh, CSIR-CGCRI	Rational Construction of Direct Z-Scheme $\text{Zn}_{0.5}\text{Cd}_{0.5}\text{S}/\text{SrTiO}_3$ Heterojunction for Superior Charge Separation and Hydrogen Evolution Dr Srabanti Ghosh, CSIR-CGCRI
16:30 to 17:00hrs	TEA BREAK	
17:00 to 18:30hrs	Technical Session-III	
	TS:III(A): Venue: Meghnad Saha Auditorium Chair: Dr S Mandal	TS:III(B): Venue: APC Roy Seminar Hall Chair: Dr R C Das
17:00-17:25hrs	Porous alumina-based membrane development at CSIR-CGCRI Shri. Swachchha Mazumdar, CSIR-CGCRI	Carbon fibre reinforced ceramic matrix composite and advances in ceramic machining Shri S.Gangadharan, CSIR-CGCRI
17:25-17:50hrs	Role of Ceramic Materials and Process Engineering in High Temperature Electrolyser towards Deep Decarbonization Dr Jayanta Mukhopadhyay, CSIR-CGCRI	Mr. Vamshi Kiran, TA Instrument



17:50-18:10hrs	Silicon carbide : Processing, properties, and critical applications Dr Prasenjit Barick, ARCI	Tailoring Multifunctional Nanocomposites for Smart and Sustainable Technology Dr Shrabane Sen, CSIR-CGCRI
BREAK		
18:30 - 19:00 hrs	TEA BREAK	
19:00 - 20:00 hrs	Cultural Programme (Meghnad Saha Auditorium)	
20:00 - 21:30 hrs	DINNER (K. D. Sharma Multipurpose Hall)	

Day 2: 8th August, 2026

Time	Venue: Meghnad Saha Auditorium and APC Roy Seminar Hall	
10:00 to 11:30hrs	Technical Session- IV (Student Technical Presentation; Parallel) Coordinator: Dr S Chakraborty & Dr S Sinhamahapatra	
11:30 to 11:50 hrs	TEA BREAK	
11:50 to 13:30 hrs	Technical Session -V(A) Venue: Meghnad Saha Auditorium Chair: Dr H. S. Tripathi	Technical Session -V(B) Venue: APC Roy Seminar Hall Chair: Dr. Parvesh Agrawal
11:50 to 12:10hrs	High-Resolution Analytical Transmission Electron Microscopy of Advanced Ceramics and Thin Films Dr. Sandip Bysakh, CSIR-CGCRI	Refractory Research at CSIR-CGCRI: A 75-Year Legacy Dr Kausik Dana, CSIR-CGCRI
12:10 to 12:30hrs	Role of Carbide-Induced Solid Solution Strengthening on Mechanical Reliability and Oxidation Resistance of Ultra-High Temperature Ceramics Dr. Pradyut Sengupta, CSIR-IMMT	Materials and Manufacturing Advances in Scaffold for Bone Tissue Engineering Dr Mitun Das, CSIR-CGCRI
12:30 to 12:50hrs	Multifunctional Magnesium Phosphate Bioceramics Prof Mangal Roy, IIT KGP	Solution combustion processed high entropy oxide dielectric ceramics: A solution for optoelectronic applications Dr Saumen Mandal, NIT Suratkal
12:50 to 13:10hrs	From Laboratory to Market: Lessons in Technology Commercialization and Entrepreneurship Smt Reshmi Dharmadhikari Roy, Metwiz	Oxidation behaviour of ZrB₂-SiC-AlN ultra-high temperature ceramics Prof Pratik K. Ray, IIT Ropar
13:10 to 13:30 hrs	Shifting Paradigms in Doped-Zirconia Ceramics: Microstructural Engineering Driven Novel Properties & Perspectives Prof Anirban Choudhary, IIT Patna	High-Purity Aluminas: Enabling Advanced Technologies Through Tailored Properties Sourojit Pal, Almatiss Alumina Pvt Ltd
13:30 to 14:20 hrs	LUNCH (K. D. Sharma Multipurpose Hall)	



14:20 to 15:25 hrs	Technical Session-VI Venue: Meghnad Saha Auditorium Chair: Prof. Rituparna Sen
14:20 to 14:40 hrs	Challenges and Prospects of Granite Waste Utilization in Vitrified Tile Body Batch Composition Dr. Asha Anil, CSIR-CGCRI
14:40 to 14:55hrs	Effect of Nickel Doping on LSM Cathodes for Intermediate-Temperature SOFC Applications Dr Barnasree Chanda, CSIR-CGCRI
14:55 to 15:10hrs	Challenges in the Fabrication of Cordierite-based Ceramic Monolith Catalytic Converters for Flue Gas Treatments Dr Rajan Biswas, CSIR-CGCRI
15:10 to 15:25hrs	Transforming Low-Cost Kaolin into a High-Flux Zeolite Interlayer: A Hierarchical Composite Membrane Strategy for Sustainable Ethanol Dehydration Dr. Somjyoti Basak, CSIR-CGCRI
15:25-16:00 hrs	SessionVII: Valedictory Session : Meghnad Saha Auditorium Concluding session and Presentation of students award



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Message from Patron



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Professor Bikramjit Basu, FNA FNAE FNASc FASc FAMS
DIRECTOR



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CSIR-CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
(Council of Scientific & Industrial Research)
196 Raja S C Mullick Road, Jadavpur, Kolkata 700 032
website : www.cgcri.res.in

16th July, 2026



Message

It gives me great pleasure that the Indian Institute of Ceramics and CSIR-Central Glass and Ceramic Research Institute are jointly organizing a national seminar on "Ceramic and Glass Technology For a Sustainable Future: Challenges, Opportunities, and Innovations (CGTSF-2026)" in association with the All India Pottery Manufacturers' Association (AIPMA) during 7-8 August, 2026 at CSIR-CGCRI, Kolkata.

Ceramics and glass have been integral to the advancement of Indian civilization across several millennia. During the modern era. These technologies have played pivotal roles in diverse sectors such as steel, automobile, civil, defence, space, atomic energy, electronics, cosmetics, and societal. The core expertise of CSIR-CGCRI in these domains have made the institute a preferred destination for various stakeholders interested in cutting edge technological solutions and know-how.

This seminar shall provide an effective platform to leverage on such partnerships, with large number of participants drawn from academia, R&D institutions and industries promises to make the conference truly comprehensive. A phenomenally broad coverage of subjects such as engineering and technical ceramics, refractories, potteries and sanitaryware, glass, bioceramics, energy materials, recycling and waste utilization etc. promises to make the conference truly comprehensive.

I have no doubt that this seminar will be an useful platform for all scientists and technologists in their current and future research program. The deliberation at this conference will lead fruitful collaborating opportunities.

I wish the seminar a grand success.

Prof. Bikramjit Basu
Director, CSIR-Central Glass & Ceramic Research Institute
Patron, CGTSF-2026

Message from President, IIC

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Message from the President

All India Pottery Manufacturers 'Association (AIPMA)

Dear Delegates and Distinguished Guests,



It gives me immense pleasure to welcome you to the National Seminar on “**Ceramic and Glass Technology for a Sustainable Future: Challenges, Opportunities, and Innovations (CGTSF-2026)**”, jointly organised by the **Indian Institute of Ceramics (IIC)** and **CSIR–Central Glass and Ceramic Research Institute (CSIR-CGCRI)** in association with the **All India Pottery Manufacturers 'Association (AIPMA)** on **7–8 August 2026** at **CSIR-CGCRI, Kolkata**.

The ceramic and glass industries play a vital role in advancing sectors such as steel, automotive, construction, healthcare, defence, space, electronics, and energy. As sustainability and advanced materials become increasingly important, our industry has a unique opportunity to drive innovation and contribute to national development.

The theme of this seminar is both timely and significant. It brings together researchers, academicians, students, industry professionals, and policymakers to exchange ideas, discuss emerging technologies, and strengthen collaboration between academia and industry. Such interactions are essential for translating research into practical solutions and fostering sustainable growth.

As AIPMA organization, we strongly believe that innovation, indigenous manufacturing, skill development, and close industry–academia partnerships will shape the future of the ceramic and glass sectors. Together, we can build a globally competitive ecosystem that supports the vision of **Atmanirbhar Bharat** while addressing the evolving needs of society.

I sincerely appreciate the efforts of the organising committee, CSIR-CGCRI, the Indian Institute of Ceramics, our sponsors, speakers, and all contributors who have made this seminar possible. I also extend my best wishes to all the delegates for a productive and enriching conference.

I am confident that **CGTSF-2026** will inspire meaningful discussions, new collaborations, and innovative solutions for a sustainable future.

With warm regards,

Sabyasachi Roy

President

All India Pottery Manufacturers 'Association (AIPMA)



Message from the Chief Guest

Respected Chief Guest, Esteemed Guests of Honour, Distinguished Dignitaries, Keynote Speakers, Invited Speakers, Oral Presenters, and Dear Delegates,

It is with immense pride and great privilege that I welcome you all to the National Seminar on "Ceramic and Glass Technology for a Sustainable Future: Challenges, Opportunities and Innovation" (CGTSF - 2026), being held on 7th and 8th August, 2026, at the CSIR-Central Glass and Ceramic Research Institute (CSIR-CGCRI), Kolkata - 700032.

As the President of the Indian Institute of Ceramics and the Chairman of the Organizing Committee, it is an absolute honor to host this prestigious gathering of brilliant minds, industry leaders, researchers, and academicians.

The theme of this seminar addresses some of the most critical imperatives of our time. The ceramics and glass industries stand at a crucial crossroads where technological advancement must align seamlessly with environmental stewardship and sustainable development. Over the next two days, this platform will witness insightful deliberations on pioneering innovations, emerging challenges, and untapped opportunities that will shape the future trajectory of our sector.

I am confident that the collective expertise, engaging discussions, and collaborative spirit within these halls will yield profound insights and coveted outcomes. May this programme be richly fruitful, fostering new partnerships and paving the way for a greener, more sustainable tomorrow driven by advanced material science.

I wish all our participants an inspiring conference and a wonderful stay in the cultural heart of Kolkata.

Warm regards,

Prof. Dr. Rituparno Sen
President, Indian Institute of Ceramics
Chairman, Organizing Committee, CGTSF - 2026



Message from the Secretary, IIC

Dear Delegates and Guests,

It is with great pleasure and enthusiasm that the Indian Institute of Ceramics and CSIR-Central Glass and Ceramic Research Institute are jointly organizing a national seminar on Ceramic and Glass Technology For a Sustainable Future: Challenges, Opportunities, and Innovations (CGTSF-2026)" in association with the All India Pottery Manufacturers' Association (AIPMA) during 7-8 August, 2026 at CSIR-CGCRI, Kolkata.

The theme of the seminar highlights critical discussion and innovations in almost all industrial ceramic and glass sectors such as steel, automobile, civil, defence, space, atomic energy, electronics, cosmetics, and societal. The seminar will provide an excellent platform for students, research scholars, academicians, and industry experts to engage in meaningful discussions, offering solutions that will shape the future of the ceramic and glass sectors.

We extend heartfelt gratitude to our sponsors, organising committee members, and all those who have worked tirelessly to make this conference a reality. Let us join hands to drive sustainable growth and innovation in the these sectors.

Wishing you an inspiring and productive conference experience!

With regards,

Dr Shirshendu Chakraborty
Organizing Secretary, CGTSF-2026



KN - Ceramic Materials and Human Civilisation: From the First Fire to the Future of Sustainable Technologies

Debashish Bhattacharjee

Managing Director, Martensite Ventures

Former Vice President, Technology, Tata Steel.

debashish@martensiteventures.com

Abstract:

Ceramic materials have accompanied humanity from the dawn of civilisation and continue to shape its future in profound ways. Long before metals, polymers or semiconductors transformed society, ceramics enabled humankind to control fire, store food and water, build permanent settlements, and create art, culture and written history. Pottery, bricks, glass and porcelain became the foundation upon which early civilisations flourished, leaving archaeological records that continue to narrate the story of human progress.

Today, ceramics occupy a position at the very frontier of science and engineering. Modern advanced ceramics possess exceptional combinations of hardness, temperature resistance, corrosion resistance, electrical, magnetic and ionic functionalities, biocompatibility and chemical stability that cannot be achieved by most other classes of materials. They have become indispensable in aerospace, electronics, telecommunications, energy systems, biomedical implants, defence, environmental protection and advanced manufacturing. From semiconductor fabrication and fibre-optic communications to artificial joints, dental restorations, thermal barrier coatings, batteries, fuel cells and catalytic systems, ceramics quietly underpin many of the technologies that define contemporary society.

The next chapter of civilisation is equally dependent on ceramic innovation. As the world confronts the grand challenges of climate change, energy transition, resource scarcity and an ageing population, ceramic materials will play a central role in enabling sustainable solutions. Solid-state batteries, hydrogen production through advanced electrolyzers, carbon capture systems, high-temperature reactors, additive manufacturing of functional components, quantum technologies, biomimetic materials and intelligent multifunctional ceramics represent only a few of the emerging frontiers. Increasingly, ceramics are evolving from passive structural materials into active materials capable of sensing, storing, transporting and converting energy and information.

History of civilisation can be viewed through the evolution of its materials. If stone defined the prehistoric world, bronze and iron shaped empires, and silicon enabled the digital age, advanced ceramics are one of the defining material platforms of the twenty-first century. Understanding and harnessing their extraordinary potential will be critical to building a resilient, sustainable and technologically advanced future.



KN - Ceramic Tiles & Composites for Aerospace Applications

G Ramaguru

Director, DIA-CoE, IITH, OS (Retd.) and former PGD – Agni, ASL

Abstract:

Ceramics Tiles & Ceramic Composites are playing major role in Aerospace applications like Space Systems (Space Shuttle Nose tip & Leading edges) and Hypersonic Missile Systems. These systems undergo very severe Aero dynamic and Thermal loads during operation. Ceramic Tiles are used to safeguard the space system during re-entry due to low thermal conductivity

Developments in Ceramic Composites (Carbon-Carbon and Carbon-Silicon Carbide) are playing major role in Aerospace system due to its low weight, retention of Mechanical properties at elevated temperature, high Thermal conductivity, Low thermal expansion, high specific heat and high specific strength. These Materials are being used in Many applications. The Challenges, Opportunities and innovation required in Ceramic composites and application will be covered in the Key note address.



PL - Prediction of Flow-Accelerated Refractory Corrosion Regions in Electric Glass Furnaces Using CFD Modelling

Shivam Swarnakar¹ and Jeetendra Sehgal^{1*}

¹B.L. Kheruka Research and Development Center, Borosil Renewables Ltd.,
Hinjewadi Phase-1, Pune-411057

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Abstract:

This work discusses the outcomes of Computational Fluid Dynamics (CFD) modelling of electric glass furnaces. In electric furnaces, the positioning of the melting electrodes plays a critical role in determining the molten glass circulation pattern and the overall melting effectiveness of the glass batch. The CFD results indicate that molten glass generally flows towards the electrodes and rises along their surfaces due to the heating effect. Upon reaching the glass melt–batch interface, the flow diverges away from the electrodes and moves both towards the furnace centre and the side walls. Furthermore, the melt streams emerging from adjacent electrodes and travelling towards the side walls merge in the regions between the two adjacent electrodes at the side walls. The flow directed towards the furnace centre is generally benign. However, the merged glass flow from the two adjacent electrodes as it moves towards the side walls and descends along them, generates regions of high-shear stress in the upper half of the side walls. These high-shear regions promote flow-accelerated corrosion of the refractory, resulting in an increased sidewall-wear especially at the regions in the sidewalls corresponding to the centre of the two adjacent electrodes and thereby resulting in a reduction in furnace campaign life. The CFD model also predicts high-shear stress in the throat entry region, and thus identifies locations susceptible to accelerated refractory corrosion. Furthermore, the CFD predictions correlate well with the refractory corrosion patterns observed after the completion of the furnace campaign life, demonstrating good agreement between the predicted high-corrosion regions and the actual refractory wear observed in the furnace.



PL - Firing the Future: Cross-Pollinating Missile Technology Ceramics for Sustainable Traditional Ceramic Manufacturing

Anil Kumar

Advanced System Laboratory, DRDO

**Email: Anilkumar.asl@gov.in*

Abstract:

The traditional ceramics industry—encompassing earthenware, vitrified tiles, sanitary ware, and porcelain—stands at a critical environmental crossroads. It is heavily challenged by high energy consumption during sintering, dependence on primary mineral raw materials, and substantial greenhouse gas emissions. Conversely, the defense and aerospace sectors have driven rapid, high-budget innovations in Advanced Ceramics for Missile Technology. These materials are designed to withstand hypervelocity friction, extreme thermal fluxes, and aggressive oxidation.

This plenary talk explores how the sophisticated material science developed for missile thermal protection systems (TPS) and extreme-environment structures can be cross-pollinated to revolutionize the sustainability of traditional silicate ceramics.

First, some of the missile system ceramics shall be discussed. A few of those technologies that can be adopted for traditional ceramics will be discussed

- » Thermal Barrier Coatings (TBCs):
- » Low-Activation Sintering Mechanisms:
- » Microstructural Toughening & Waste Valorisation:
- » Concepts of Ceramic Matrix Composites:
- » Modern processing technologies
- » Gel casting
- » Additive manufacture
- » Engineered stoness

This session presents a blueprint for a low-carbon, circular ceramic economy. The presentation will demonstrate that some of the defense technologies engineered to breach thermal frontiers hold the exact keys required to safeguard our planet's resource frontiers.



PL - Strategic Material Capabilities at Industrial Scale is key for Atmanirbhar Bharat

Niraj P. Bhukhanwala

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email: niraj@bhukhanwala.in : Skype ID: niraj.bhukhanwala*

Abstract:

As India moves towards developing various capabilities and industries as its push to be Atmanirbhar, it is critical for the country to also develop Industrial Scale manufacturing capabilities for Strategic Materials is a key towards the successful realization of this goal. This talk will focus on High Performance Ceramic materials required for Defence, Nuclear and Aerospace applications. It will talk about the success story of becoming a global leader in Boron Carbide which was successfully transferred from BARC and scaled up. We will also talk about a host of new materials that are being worked on for strategic programs in India.



PL - Novel Diborides for Ultra-High Temperature Applications

Tatarko P.^{1*}, Ünsal H.¹, Hosseini N.¹, Zhukova I.¹, Kovalčíková A.², Matović B.³, Dlouhy

¹*Institute of Inorganic Chemistry, Slovak Academy of Sciences, Bratislava, Slovakia*

²*Institute of Materials Research, Slovak Academy of Sciences, Košice, Slovakia*

³*Vinča Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia*

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Key words: high-entropy ceramics; spark plasma sintering; high temperature applications; mechanical properties; theoretical predictions;

Abstract:

Highly pure high-entropy diboride ceramics (HEBs) were produced by two-step spark plasma sintering, consisting of boro/carbothermal reduction of oxides mixtures at 1800°C and pressure-assisted sintering at 1900°C. The aim of this work was to improve the mechanical properties of (Ti-Zr-Hf-Nb-Ta)₂B₂ diboride system by the addition of different amounts of SiC (5 – 25 vol.%) and formation of new non-equimolar diboride structures in this diboride system.

The addition of SiC significantly improved densification of HEB materials. The room temperature mechanical properties, such as hardness, flexural strength and fracture toughness continuously increased with the increasing amount of SiC up to 20 vol.%. A significant drop in the mechanical properties observed for the composite with 25 vol.% was caused by the significant coarsening of the microstructure. On the other hand, the dynamic oxidation rate of the materials significantly decreased with the addition of SiC up to 25 vol.%. It was concluded that the (Ti_{0.2}Zr_{0.2}Hf_{0.2}Nb_{0.2}Ta_{0.2})B₂ composite sintered with 20 vol.% SiC showed the best combination of room and high temperature mechanical properties.

Based on the (Ti_{0.2}Zr_{0.2}Hf_{0.2}Nb_{0.2}Ta_{0.2})B₂ structure, a group of high-entropy diborides with non-equimolar transition metal ratios were theoretically predicted using Density Function Theory implemented in VASP and experimentally investigated. Three most promising non-equimolar diboride structures were selected, considering the formation energy, cohesive energy and mechanical properties of the structures: (Ta_{0.6}Hf_{0.1}Zr_{0.1}Ti_{0.1}Nb_{0.1})B₂, (Ta_{0.6}Hf_{0.25}Zr_{0.05}Ti_{0.05}Nb_{0.05})B₂, (Ta_{0.6}Hf_{0.2}Zr_{0.1}Ti_{0.05}Nb_{0.05})B₂. All of these non-equimolar structures were successfully synthesized to a single phase and sintered to a relative density higher than 96 %. The nanohardness of the individual grains of non-equimolar structures was significantly higher when compared to the equimolar composition. Similarly, the Young's modulus of non-equimolar compositions was slightly higher than that of equimolar one. It was shown that by optimization of the molar ratio of the individual transition metals, the mechanical properties of HEBs were improved.



PL - Prediction of Flow-Accelerated Refractory Corrosion Regions in Electric Glass Furnaces Using CFD Modelling

Santanu Mandal, Ritendu Ganguly, Jabaseelan P, Suresh Kumar Chatakonda, Prathap Kumar

Carborundum Universal Limited (CUMI), India

Key words: Technical ceramics, oxides, non-oxides, advanced ceramics processing, advanced ceramic applications

Abstract:

Technical ceramics' remarkable mix of mechanical, thermal, electrical, chemical, and tribological qualities for a diverse range of applications has made it essential engineering materials for cutting-edge industrial and advanced applications. Advanced ceramics, such as oxide ceramics, non-oxide ceramics, and ceramic matrix composites, are widely used in components that are resistant to wear and corrosion, thermal management systems, electrical insulation, energy conversion and storage technologies, fluid handling equipment, electronic devices, aerospace and defense systems, and emerging sustainable energy technologies. Their adoption in high-performance engineering applications is still fueled by their exceptional durability, thermal stability, and functional adaptability.

Carborundum Universal Limited (CUMI), a flagship company of the Murugappa Group, has been at the forefront of advanced ceramics manufacturing in India for over six decades. Established in 1954, CUMI has evolved from a pioneer in abrasives and electro-minerals into a globally recognized manufacturer of industrial ceramics, engineered materials, refractories, and advanced ceramic solutions. The Industrial Ceramics Division of Carborundum Universal Limited (CUMI-IC) is a leading Indian manufacturer of advanced ceramic materials and engineered ceramic solutions, supported by a fully integrated "Materials-to-Solutions" capability encompassing powder processing, formulation development, component shaping, sintering, precision machining, metallization, ceramic-to-metal joining, surface engineering, and final assembly. Renowned for its expertise in wear-resistant, engineering, and metallized ceramics, CUMI-IC has established itself as a key supplier of high-reliability ceramic-to-metal sealing solutions for power electronics, vacuum devices, medical equipment, sensors, defence, aerospace, semiconductor manufacturing equipment, and other mission-critical applications. Through strategic technology transfers and collaborative development programmes with national institutions including CSIR-CGCRI, CSIR-NAL, SAC-ISRO, VSSC-ISRO, DRDO laboratories, IIT Madras, IIT – Patna and other research organizations, CUMI-IC has successfully indigenized critical technologies such as tape-cast alumina substrates, thin-film Cr-Cu-Au metallization, advanced ceramic substrates, functional ceramics, strategic defence materials, and electrochemical energy devices. The division manufactures a broad portfolio of oxide and non-oxide ceramics, including high-purity alumina, alumina titanate, zirconia-based ceramics, reaction-bonded silicon carbide, reaction-bonded boron carbide, and metal matrix composites, engineered to withstand extreme wear, corrosion, thermal, electrical, and impact loading environments. Its advanced manufacturing capabilities, including tape casting, sputter metallization, brazing, hermetic packaging, plating technologies, and precision machining, enable the production of high-performance ceramic components for electronic packaging, vacuum interrupters, microwave systems, armour protection, molten metal handling, wear-resistant systems, space hardware, and clean-energy applications. Building on its strengths in advanced ceramics, CUMI Industrial Ceramic (CUMI – IC) is actively contributing to India's strategic sectors through indigenous development of ceramic solutions for defence, aerospace, semiconductors, green hydrogen generation, and next-generation energy systems. The company has also initiated research in advanced non-oxide ceramic technologies, recognizing their strategic importance for defence, aerospace, high-temperature structural applications, and thermal management systems. Through a Joint Development Programme with IIT Madras under the Indo-German Science & Technology Centre (IGSTC) framework, research is progressing on advanced non-oxide ceramic materials and associated processing technologies. Through sustained investments in research and development, innovation-led manufacturing, import substitution initiatives, and strong application engineering capabilities, CUMI-IC continues to transform advanced ceramic materials into high-value engineered solutions that enhance reliability, performance, sustainability, and technological self-reliance across a broad spectrum of industrial and strategic applications.



Our focus is on make-in-India effort for import substitution and addressing the large export market in niche application, process innovation, and qualification to stringent standards enabling reliable indigenous manufacturing for mission-critical applications. Through its philosophy of "Making Material Difference," CUMI-IC delivers innovative ceramic solutions that bridge the gap between advanced materials and industrial performance, enabling reliability, efficiency, sustainability, and technological advancement across a diverse sectors of industries

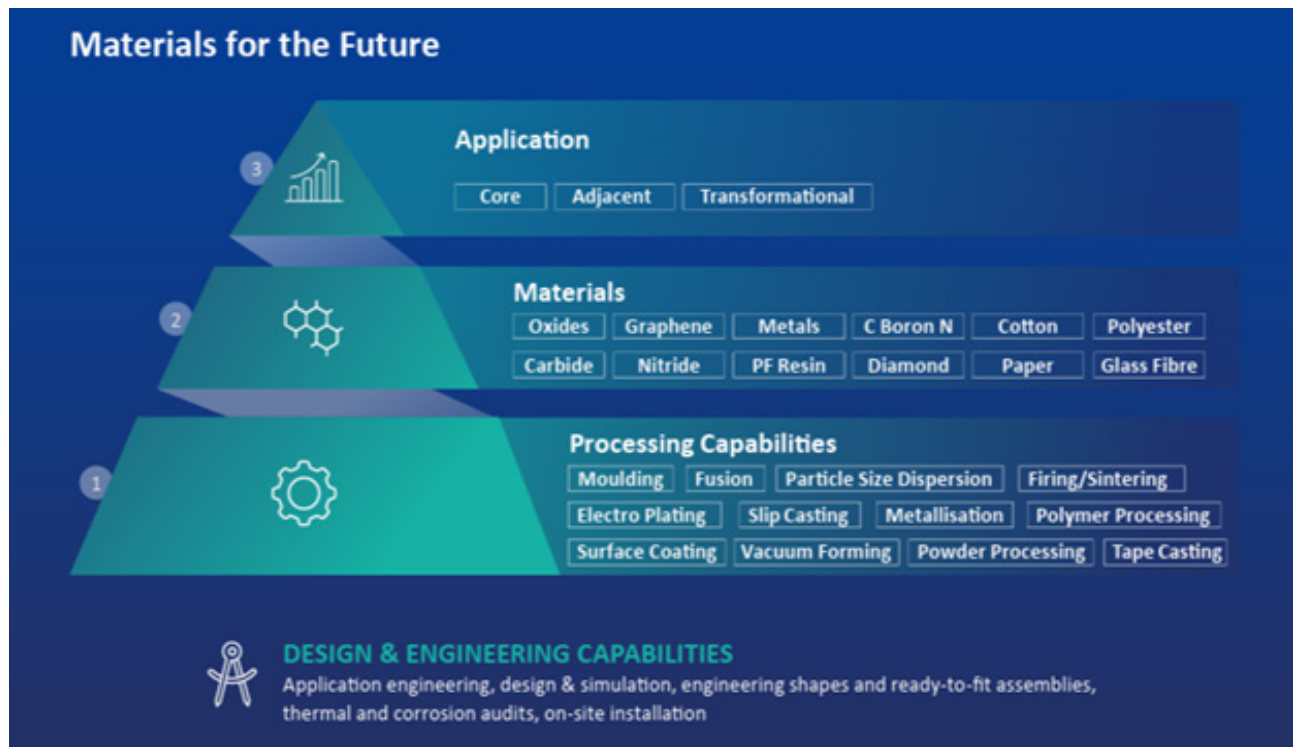


Figure: Materials science platform for diverse industries (Reference: 72nd Annual Report CUMI)



IL - Advance Calcium Phosphate Bioceramics: Fundamental Material Design, Synthesis, Processing, and Additive Manufacturing of Hydroxyapatite, β -TCP, and Bioactive Glass

Sabyasachi Roy

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Abstract:

Calcium phosphate bioceramics, including hydroxyapatite (HA), β -tricalcium phosphate (β -TCP), and bioactive glass, have emerged as key materials for bone regeneration, implant coatings, and tissue engineering due to their excellent biocompatibility and bioactivity. Recent advances in material design, synthesis, processing, and additive manufacturing have enabled the development of high-performance, patient-specific biomaterials for next-generation healthcare applications.

This lecture will present the fundamental aspects of composition development, synthesis routes, particle engineering, and processing techniques that govern the performance of these bioceramics. Emphasis will be placed on scalable manufacturing, quality control, and regulatory considerations essential for biomedical applications. Drawing on Cerammat Private Limited's experience, the talk will highlight the successful translation of laboratory research into commercially viable products, including plasma spray grade hydroxyapatite for implant coating, nano-hydroxyapatite for oral care, β -TCP as bone void fillers, and materials for additive manufacturing. The presentation will also discuss current challenges and future opportunities in indigenous biomaterial development, advanced manufacturing, and industry-academia collaboration for sustainable healthcare solutions.



IL - Challenges and Prospects of Granite Waste Utilization in Vitrified Tile Body Batch Composition

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Abstract:

India is one of the world's largest producer of granite. Granite industry generates approximately 50% waste during mining and ~ 15% and ~5% during cutting and polishing respectively. Granite is rich in feldspathic minerals having fluxing properties, yet potential utilization of mining waste remains underexplored in India for ceramic application. This paper will discuss challenges in using granite waste in vitrified tile bodies, factors determining successful utilization of waste, and effect of progressive incorporation of one type of granite mining waste from Gujarat as a feldspar replacement in vitrified tile body batch composition. Fired properties such as shrinkage, modulus of rupture, breaking strength, water absorption, bulk density, coefficient of thermal expansion, and color coordinates (Lab), and microstructure of granite incorporated tile body samples fast fired in an industrial roller furnace at 1200 ± 5 °C and comparison between obtained properties with requirements for Bla and Blb group classification as per BIS 15622:2017 and ISO 13006:2018 will be discussed. These findings demonstrate that granite mine waste can serve as a sustainable alternative to feldspar in vitrified tile production, enabling resource conservation and waste valorization subjected to judicial utilization.

Key words: Granite Mining waste, Vitrified Tile body.



IL - Shifting Paradigms in Doped-Zirconia Ceramics: Microstructural Engineering Driven Novel Properties & Perspectives

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Abstract:

Zirconia (ZrO_2) is a cornerstone engineering ceramic for applications spanning heat sink substrate, biomedical implants, solid oxide fuel cells, and wear-resistant components, where the stabilization of tetragonal or cubic phases is essential. Conventionally, yttria-stabilized zirconia (YSZ) has dominated industrial usage. However, limitations related to phase stability under extreme environments, fracture behavior, thermal transport, higher cost and scarcity of yttria motivate the search for alternative dopants. We demonstrate the stabilization of phase-pure tetragonal zirconia using ultra-low calcia doping (3–4.5 mol.% CaO) through a patented nanoparticle synthesis route, yielding fine, uniform powders with controlled size distributions[1–3]. The stabilisation of CaO-doped ZrO_2 (CaSZ) ceramic was achieved via “Garvie stabilization protocol” where restricting the grain size within 100 nm was crucial[4]. The CaSZ ceramic portrayed 2–3 times higher thermal conductivity than YSZ for temperatures between 100–1200 °C. It was attributed to reduced phonon scattering arising from the lower atomic mass and larger ionic radius of Ca^{2+} compared to Y_3^{3+} . [5] Mechanical properties of the CaSZ ceramic remain competitive, with hardness comparable to YSZ, enhanced toughness (~150%), and an elastic modulus of ~200–210 GPa [6–8]. The CaSZ ceramics also demonstrated better translucency compared to most of the tetragonal zirconia compositions known till today [9]. It is also shown that cubicity is no longer a prime requirement anymore for obtaining translucency in zirconia bodies.

With an optimized microstructural engineering, we have also stabilised the tetragonal zirconia phase with minimum yttria (Y_2O_3) doping (1.5 mol.%) [10]. Starting with ultrafine (~9 nm), near spherical, phase pure 1.5YSZ nanoparticles, pressureless sintering at 1100 °C (without any binders, additives, sintering aids or slurry-based processing) produced fully tetragonal nanoceramics with >98.5% density and ~50 nm grains. The ceramics showed 46% transmittance at 630 nm, comparable or superior to typical 3 mol% YSZ [11]. The hot corrosion study on 3YSZ nanograined ceramic busted the myth that grain boundaries are ‘usually bad’ for corrosion. Contrary to common belief, fine-grained ceramics showed superior corrosion resistance despite having ~450% more grain boundaries. Our works showcases the importance of a refined microstructure on stabilizing the tetragonal zirconia phase and its subsequent influence on optical, mechanical and corrosion properties.

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IL - Multifunctional Magnesium Phosphate Bioceramics

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Abstract:

Magnesium phosphate (MgP) bioceramics have emerged as promising resorbable alternatives to conventional calcium phosphates for bone repair, offering higher solubility and degradation rates that better match the pace of new bone formation. However, unmodified MgP suffers from overly rapid degradation and limited mechanical integrity, restricting its clinical translation. This work presents a multifunctional design strategy in which selective ionic and biomolecular doping is used to tailor the degradation kinetics, mechanical performance, and biological response of MgP ceramics for site-specific bone regeneration.

Collectively, these results establish MgP as a versatile ceramic platform whose properties can be engineered through targeted ion substitution and biomolecule incorporation to meet the combined mechanical, degradation, and biological demands of load-bearing and infection-prone bone defects — positioning multifunctional MgP bioceramics as a next-generation alternative to calcium phosphate-based bone grafts.

Moreover, Magnesium Phosphate can also be used as bone cement for treating cancellous bone defects, vertebral body fracture, craniomaxillofacial surgery, stabilizing hip implants, ligament anchor, reinforcement of osesynthesis screws and for drug delivery. We will also discuss the use of magnesium phosphate bone cement for fracture fixation device anchoring and its ability to reduce the in vivo corrosion of Mg metal plate and screw.



IL - Selection of Different Fused Magnesite for Magnesia-Carbon Refractories.

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Abstract:

Glass has become an indispensable material in our modern society. A report in Industrial Ecology proposed that in the year 2014, global glass production grew by 150 million tonnes. Therefore, its growing industrial production rate is accompanied by a strong need for recycling.

Among several methodologies of waste glass recycling, glass foam become a unique waste-derived material with multi-field applications. The glass powder in its desired particle size range was directly sintered based on the glass composition and choice of foaming agent to a temperature range of 700-900 °C. The bulk density in the range 0.2-0.5 g.cm⁻³ and porosity within 80-94 % of the material indicates its lightweight nature. Variation of pore size and its uniform distribution was successfully obtained by optimizing process parameters like heat treatment temperature, time, etc. The low thermal conductivity (0.1-0.30 W/m.K) of this material makes it suitable for its application in thermal insulation. The rigid porous network (particularly closed pores) possesses relatively high compressive strength (3-7 MPa) making it suitable material in construction. The glass foam generated from tube light glass; waste sheet glass appears white (Fig. 1) whereas bottle waste glass foam becomes yellow in appearance. Lightweight glass foam bricks prepared utilizing 98-99% waste glasses. These lightweight, porous bricks offer:

- » Thermal insulation for buildings
- » Furnace wall lining
- » Acoustic insulation
- » Cold storage insulation
- » Pipeline insulation

This eco-friendly innovation:

- » Supports circular economy by minimizing waste generation
- » Reduces material requirements and transportation costs due to its lightweight nature
- » Saves energy consumption with low thermal conductivity and comparable compressive strength to conventional bricks
- » Enhances building safety in hilly regions by reducing load and potential damage during disasters

Hence, glass foam bricks contributes to safety, environmental protection, and sustainable waste management. CSIR-CGCRRI has successfully demonstrated the fabrication technology of glass foam at industrial environment and transferred this technology.



Fig. 1 : Glass foam bricks of dimension 235x110x70 (mm) [Inset: Floating Glass foam Bricks]

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IL - Carbon fibre reinforced ceramic matrix composite and advances in ceramic machining

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Abstract:

Carbon fiber-reinforced ceramic matrix composites (C/CMCs) are advanced engineering materials that combine the high strength and low density of carbon fibers with the exceptional thermal stability and oxidation resistance of ceramic matrices. Among these, carbon fiber-reinforced silicon carbide (Cf-SiC) and carbon fiber-reinforced silicon carbide–zirconium diboride (Cf-SiC–ZrB₂) composites have emerged as promising materials for high-temperature structural applications, including aerospace, defense, thermal protection systems, and brake components. The incorporation of a three-dimensional carbon fiber architecture provides near-isotropic mechanical properties while reducing delamination, a common limitation of conventional two-dimensional laminated composites. A thin interphase coating applied to carbon fibers improves fracture toughness by promoting crack deflection and preventing catastrophic brittle failure. Among various manufacturing techniques, liquid silicon infiltration is widely preferred due to its shorter processing time and relatively low fabrication temperature of approximately 1600°C. Recent developments have also led to ultra-high-temperature ceramic matrix composites (UHTCMCs), which combine the superior characteristics of ceramic matrix composites and ultra-high-temperature ceramics for extreme service environments. With increasing technological advancements, the demand for high-performance ceramics capable of operating under severe thermal and mechanical conditions continues to grow. Precision machining of these hard and brittle materials remains a significant challenge. Modern manufacturing techniques, particularly laser-assisted diamond machining, have enabled ductile-mode machining of advanced ceramics such as alumina, improving surface quality, reducing tool wear, and enhancing machining efficiency. In addition, our group is actively working on low-mach and high-mach EM windows for defence and aerospace applications. It discusses the materials, fabrication methods, applications, and precision machining of alumina ceramic, highlighting their importance in the development of future-ready engineering systems.

Keywords: SiC, CMC, UHTC, fibre, EM window

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IL - Solution combustion processed high entropy oxide dielectric ceramics: A solution for optoelectronic applications

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Abstract:

High entropy oxides (HEOs) are single-phase ceramics that consist of a minimum of four different cations or anions, and they are formed in part due to their high configurational entropy. To achieve low-voltage operation in optoelectronic devices, there is an ongoing search for a new, elegant dielectric with high relative permittivity, with HEOs as a potential candidate to fulfil the requirements. In high entropy oxides, phase stabilization is crucial since it directly affects the various characteristics. An extensive study is conducted to evaluate the dielectric constant of a sintered HEO capacitor made of Co, Cu, Mg, Zn, Ni (CoCuMgZnNi)O, Ce, La, Pr, Sm, Y (CeLaPrSmY)O, and Co, Cr, Fe, Mn, Ni (CoCrFeMnNi)O that have been developed using solution combustion synthesis. At 270 °C, the precursors of (CoCuMgZnNi)O were discovered to combust, which further completely stabilized at 1000 °C and exhibits a single-phase (CoCuMgZnNi)O, rocksalt structure with an Fm-3m space group. Dielectric constant (κ) ranged, with magnitudes of about 1.9×10^3 , 4.7×10^1 , and 0.9×10^1 at 100, 1 k, and 100 kHz [1]. Furthermore, a low-temperature (CeLaPrSmY)O synthesis with a single-phase, fluorite structure and an Fm-3m space group was seen at 500 °C which further fully stabilized at 1000 °C. Dielectric constant (κ) ranged from 29 to 5.7 from 100 Hz to 1 MHz at ambient temperature [2]. The precursors of (CoCrFeMnNi)O burn simultaneously at temperatures lower than 250 °C and phase-stabilized into a spinel structure (Fd-3m) only at 500 °C. At 100, 1 k, and 100 kHz, the spinel (CoCrFeMnNi)O showed a high κ , with values of 1.2×10^3 , 7.3×10^2 , and 3.1×10^1 [3]. The optimized processing parameters are then applied to the deposition of a thin film transistor and a (CoCrFeMnNi)O dielectric thin film. At 1 kHz, the spinel (CoCrFeMnNi)O thin film demonstrated a low leakage current density ($\sim 10^{-8}$ A.cm⁻²) and a high κ , with a value of almost 3×10^1 . The thin-film transistors (TFTs) had a field effect mobility of 8.8 cm² V⁻¹ s⁻¹, an on-off ratio of around 10⁵, a threshold voltage of -1.5 V, a subthreshold swing of 0.38 V.dec⁻¹, and low voltage operation (5V) [4]. With its exceptional performance, HEO can find potential applications in optoelectronics such as active and passive matrix displays.

» **Keywords:** High entropy oxide, phase stabilisation, spinel, dielectrics, thin film transistors.

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IL - Silicon carbide : Processing, properties, and critical applications

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Abstract:

Silicon carbide (SiC) - an outstanding non-oxide ceramic, exhibits mostly covalent bonding ($\approx 88\%$ covalent characteristics), and possess three principal crystallographic phases namely cubic (3C), hexagonal (4H,6H), and rhombohedral (21R). Silicon carbide finds applications in many critical areas ranging from satellite telescope mirror, detector head assembly (DHA), high temperature thruster template for roll control nozzle in missile system, hard armor inserts for light weight body armor, and many more. The present paper discusses the SiC powder recipe formulation to product development through powder metallurgy route followed by high temperature sintering ($2100-2150^\circ\text{C}$). The densification of SiC component performed through solid state sintering route using C and B/B₄C as sintering aids. The C acts as an oxygen scavenger and B/B₄C reduces the grain boundary energy by positioning itself at the grain boundary. Thus, self-diffusion coefficient increased during solid state sintering of SiC [1]. Further, to obtain the optical reflective surface, theoretically dense SiC coating applied on this pressureless sintered thermo-mechanically compatible SiC substrate with the help of CVD technique, followed by its judicious several stage polishing. The properties of pressureless sintered SiC are promising where density is 3.17 g.cm^{-3} ($\approx 98.5\%$), and mechanical properties such as $E_m \approx 410 \text{ GPa}$, $HV_{0.5} \approx 26 \text{ GPa}$, $KIC \approx 3 \text{ MPa.m}^{1/2}$, $\sigma_f \approx 500 \text{ MPa}$, high specific stiffness ($E/\rho \approx 12.8$), and excellent thermal properties (thermal conductivity (λ) $\approx 110 \text{ W/(m.K)}$), thermal stability ($\alpha/\lambda \approx 1.49 \times 10^{-8} \text{ m.W}$) are obtained. The CVD SiC coating exhibits almost nil porosity, and surface roughness of $\approx 4 \text{ nm}$ (polished surface) obtained for space optics application [2]. In addition, the fabrication of complex shaped SiC thruster template which is produced by cold isostatic pressing (CIP)-sintered route is also discussed. Further, a limited ballistic testing results are discussed for UHMWPE lined SiC light weight armor assembly, carried out according to NIJ standard.

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IL - “Energy Efficient Ceramic Tile Bodies Using Calcined Colemanite”

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Abstract:

This study investigates the role of calcined Colemanite (CALCOL C) in enhancing the energy efficiency and firing performance of glazed vitrified tile (GVT) bodies. Industrial spray dried porcelain tile powder from Morbi was modified with CALCOL C additions of 0.25, 0.50, 1.0, 2.0, and 3.0 wt.% over the base composition. The prepared samples were fired at 1100, 1120, 1140, 1160, and 1180 °C for 60 minutes in a laboratory roller kiln, followed by characterization of physical, mechanical, mineralogical, and morphological properties.

Thermal analysis confirmed proper calcination of Colemanite, with the absence of characteristic dihydroxylation peaks and the presence of crystallization and melting transitions at 737 °C and 933 °C, respectively. The decomposition of Colemanite into amorphous CaO and B₂O₃ provided highly reactive fluxing species, though partial conversion to hydroxides or carbonates during storage was noted.

The addition of CALCOL C influenced slurry rheology, requiring higher deflocculant dosage, but compressibility and unfired strength of dust pressed bodies improved significantly. Trial bodies exhibited reduced water absorption and apparent porosity, with maximum bulk density achieved at 20–40 °C lower firing temperatures compared to the reference body. Mechanical strength (MOR) of CALCOL C containing tiles exceeded that of the control, with maturity attained at progressively lower temperatures (1160 °C → 1140 °C → 1120 °C) as CALCOL C content increased. XRD analysis confirmed effective vitrification at reduced firing temperatures, while TG/DTA indicated a slight lowering of melting onset with higher CALCOL C levels.

Although minor changes in tile color aesthetics were observed, no significant loss in visual quality occurred. Overall, CALCOL C demonstrated a powerful fluxing effect, enabling lower firing temperatures, reduced energy costs, and suitability for faster firing cycles in porcelain tile manufacturing.

» **Keywords:** Calcined colemanite, CALCOL C, porcelain tiles, fast firing, energy efficiency, vitrification

Graphs

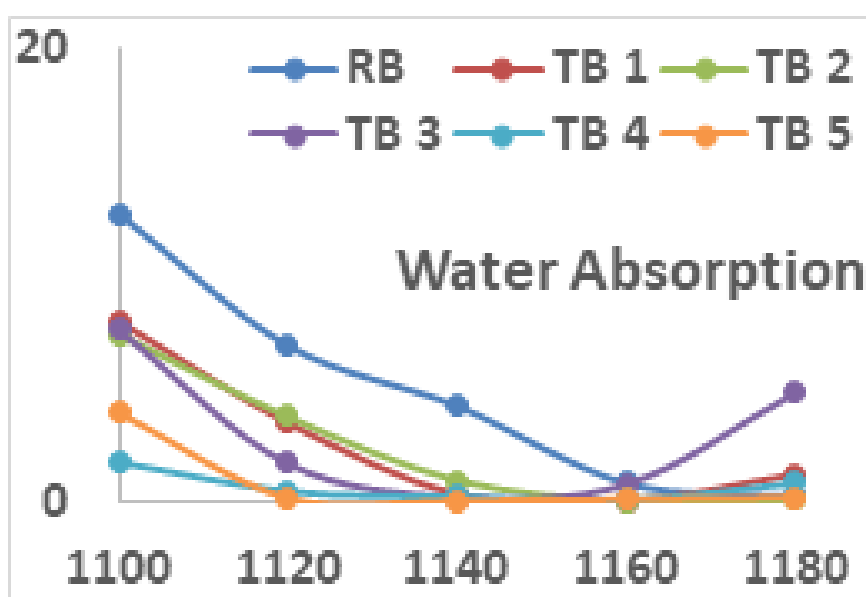


Fig. 1 : Effect of CALCOL C on water absorption of GVT ceramic tiles

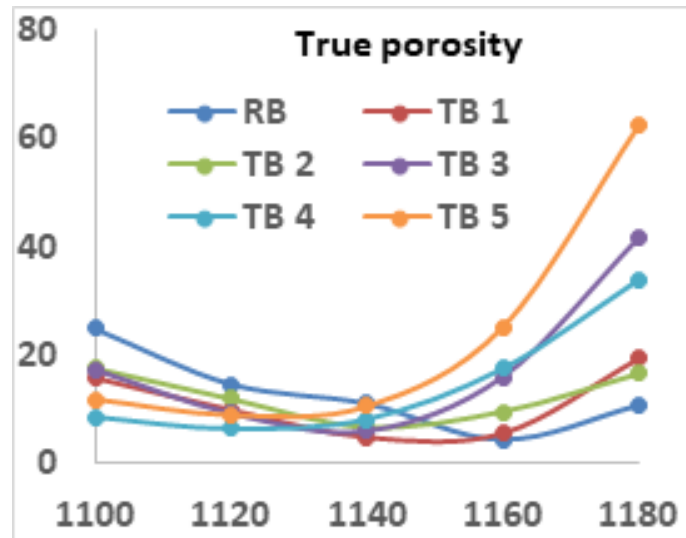


Fig. 2 : Effect of CALCOL C on true porosity of GVT ceramic tiles

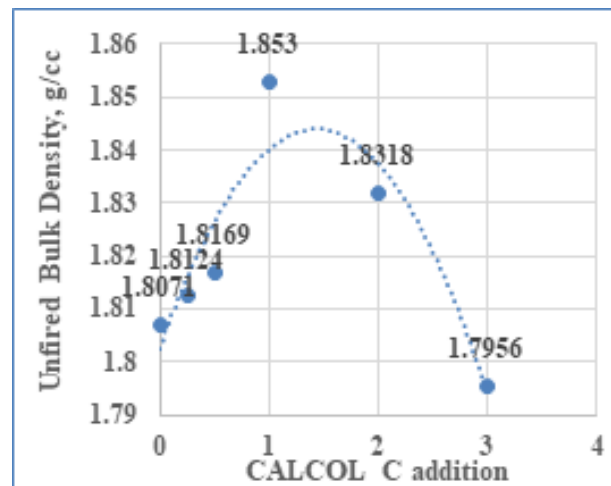


Fig. 3 : Effect of CALCOL C on unfired Bulk Density of GVT ceramic tiles.

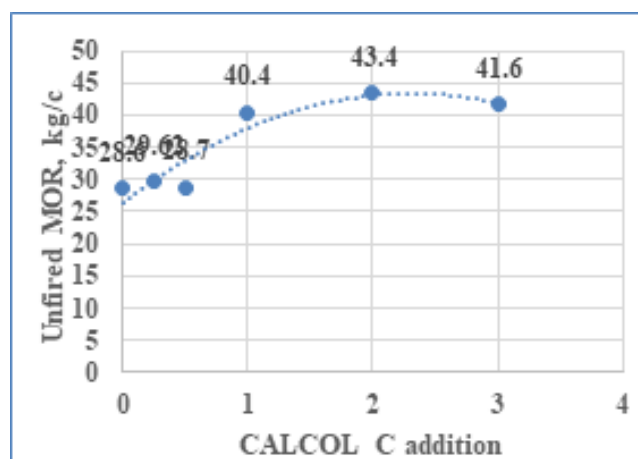


Fig. 4 : Effect of CALCOL C on unfired MOR of GVT ceramic tiles



IL - Oxidation behavior of ZrB₂-SiC-AlN ultra-high temperature ceramics

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Abstract:

Ultra-High Temperature Ceramics (UHTCs) are strategic materials which can be potentially used for thermal protection systems for high temperature applications (e.g., in the leading edges of hypersonic glide vehicles). The extreme temperatures ~ 2000oC result in rapid oxidation with the formation of a complex oxide scale. We will present the oxidation behavior of these materials over a range of 1,400-2,100oC and investigate the underlying scale formation mechanisms. Primarily, we demonstrate that the oxide scale is a glassy scale whose viscosity can be tuned through controlled AlN additions (which upon oxidation forms Al₂O₃). The experimental results will be distilled into a phenomenological model. This model, coupled with thermodynamic modeling for construction of volatility diagrams will be employed for understanding the scale formation at extremely elevated temperatures under both isothermal and cyclic conditions. The study uncovers the design principles for tailoring the UHTC compositions as a function of temperature regimes

» **Keywords:** UHTC, oxidation, silica scale.

IL - High-Resolution Analytical Transmission Electron Microscopy of Advanced Ceramics and Thin Films

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Abstract:

The development of advanced ceramics and composites with novel properties relies greatly upon critical evaluation of microstructure and nanostructure coupled with space resolved composition analysis, since such information help explore further scope of improvement to obtain the desired properties through suitable engineering of the microstructure or nanostructure of the material. Evaluation of microstructure, nanostructure and local chemistry by High-resolution Transmission Electron Microscopy coupled with energy-dispersive x-ray spectrometer (EDXS) local composition analyser plays a crucial role in critical characterization of advanced ceramics, nano-structured composites, thin films and specialty glasses. The presentation covers case studies based on analytical TEM characterization of SiAlON ceramics and PZT thin films.

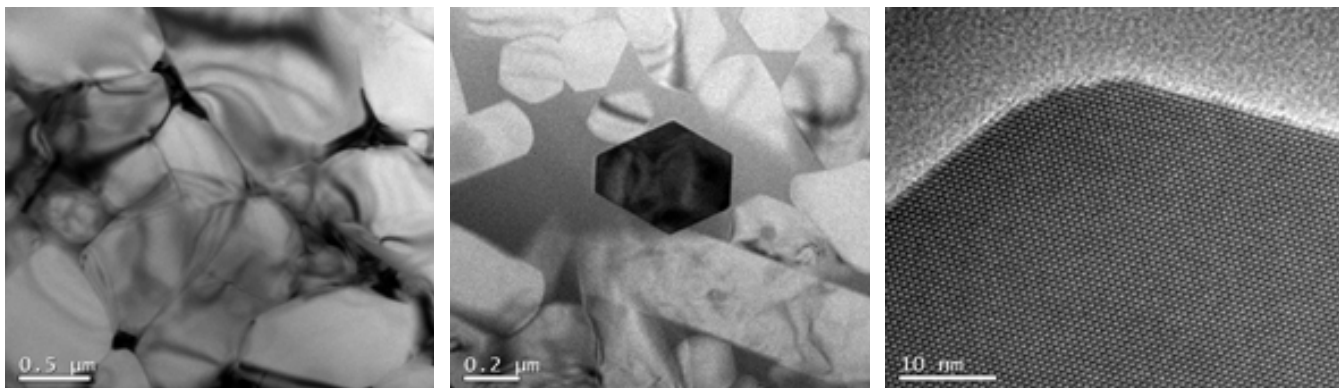


Figure 1: TEM of SiAlON ceramics. (a) Y₂O₃ doped SiAlON shows Y-rich intergranular nanocrystalline phase. (b) Y₂O₃+Pr₂O₃ doped SiAlON shows large amount of intergranular glass rich in Pr and Y and a-Si₃N₄ grains. (c) High-Resolution TEM image of a-Si₃N₄ crystal surrounded by intergranular glass

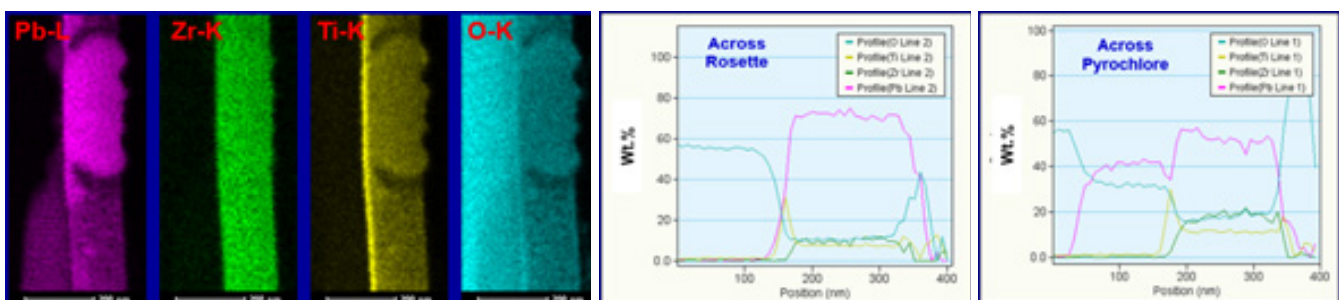


Figure 2: STEM-EDS mapping of PZT/TiO₂/Glass thin film cross-section showing elemental distribution among the Perovskite crystals and Pyrochlore nano-crystalline phase

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IL - Materials and Manufacturing Advances in Scaffold for Bone Tissue Engineering

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Abstract:

Synthetic scaffolds with enhanced osteogenic and angiogenic properties are in high demand for the regeneration of large-sized bone defects. Phosphate based bioceramics, especially Hydroxyapatite (HAp, $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$), are one of the most extensively used materials for bone graft application owing to their excellent biocompatibility, osteoconductivity and osteointegration properties. However, calcium phosphate based ceramics presented low mechanical properties and high brittleness. On the other hand, poly(lactic acid) (PLA) based polymeric scaffold shows good ductility but poor load bearing capability and hydrophobicity. Therefore, there is a need for alternative materials or combinations of materials to enhance the mechanical properties of existing bioactive ceramics and to slow the release of essential ions to promote osteogenic and angiogenic properties.

One of the works we will discuss is on SrTiO_3 as a novel biomaterial. The synthesis of the SrTiO_3 -HAp scaffold showed improved mechanical properties. The in vitro cell-material interaction showed cytocompatibility of sintered SrTiO_3 and the SrTiO_3 -HAp composite. In another work, hybrid scaffolds integrating alginate-bioglass with a 3D printed poly(lactic acid) (PLA) porous structure were developed for bone regeneration. The results showed that hydrogel can integrate well with surface-modified PLA scaffolds where the PLA scaffold provided shape and mechanical rigidity for the alginate-bioglass hydrogel. In vitro cytocompatibility tests carried out with human fetal osteoblast cells (hFOB) indicated good cell viability and proliferation of cells on the scaffolds. Alizarin red assay showed that the bioglass-containing hybrid scaffold promoted osteogenic differentiation and calcium mineralization. The good mechanical stability and shape retention of the hydrogel due to the PLA skeleton suggest that these hybrid scaffolds can be applicable for large bone regeneration.

» **Keywords:** Composite, Scaffold, 3D printing, Biocompatibility,



IL - Refractory Research at CSIR-CGCRI: A 75-Year Legacy

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Abstract:

Refractory research has been one of the cornerstones of CSIR–Central Glass and Ceramic Research Institute (CSIR-CGCRI) since its establishment in 1950. Over the past 75 years, the Refractory & Traditional Ceramics Division (RTCD) has made significant contributions to the development of indigenous refractory materials and technologies for the steel, cement, glass, non-ferrous metal, power, and other high-temperature industries.

A defining strength of the Division has been its emphasis on the scientific utilization of Indian refractory raw materials to reduce dependence on imports. Extensive research on magnesite, bauxite, limestone, dolomite, and beach sand minerals has led to the development of synthetic refractory aggregates, high-alumina products, magnesia-based refractories, monolithic refractories, cement-free castables, induction furnace ramming masses, wear-resistant ceramics, refractory pots for corrosive glass melting, and hydration-resistant lime refractories. Many of these technologies have been successfully transferred to major refractory manufacturers, contributing to the country's self-reliance in refractory technology.

RTCD has established expertise in refractory raw material characterization, phase evolution, sintering, creep, corrosion, thermo-mechanical behaviour, and high-temperature performance evaluation. The Division has also emerged as a national centre for refractory testing, consultancy, industrial problem-solving, and human resource development, while successfully executing numerous projects sponsored by industries, PSUs, and government agencies.

Sustainability has remained an important focus through refractory recycling and the utilization of industrial solid wastes from steel, mining, and power sectors. Today, the Division is advancing research on synthetic refractory aggregates, oxide–non-oxide composites, nano-bonded unshaped refractories, hydrogen–refractory interactions, plasma processing, and high-temperature emissivity coatings. Building on its rich legacy of scientific excellence and industrial partnership, RTCD continues to develop next-generation refractory materials that support India's vision of technological self-reliance and sustainable high-temperature manufacturing.



IL - Porous alumina based membrane development at CSIR-CGCRI

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Abstract:

CSIR-CGCRI is the pioneering R & D organization in India for research and development on alumina based ceramic membranes. The basic process of synthesis and manufacturing of porous inorganic support tubes as a membrane precursor were developed. These are widely utilized for use as an early range microfiltration process. As the separation performance was reasonably good, efforts were made to develop suitable process technologies and apply these technologies in practical fields. To showcase some suitable applications of these porous ceramic tubes, technologies pertaining to Iron, Arsenic and particulate removal from groundwater have been developed and efforts have been made to propagate these technologies through technology transfer to few companies. These licensees have achieved Major success in propagating these application technologies through installations of 500 water purification plants of various capacities mainly through financial assistance from DST, Govt. of India, direct orders from PHED, Govt. of West Bengal and also through private individual funding. This has been achieved through proper process design, scale up and continuous improvement in application design with a concerted efforts from CSIR-CGCRI and licensees. Followings are some details of the process development and technology implementation:

- » Multi-element modules upto 55 element modules were fabricated using the ceramic membrane elements for removal of water contaminants.
- » Modular and compact design with easy operation and maintenance, easy scale up options.
- » High level of purification efficiency achieved
- » Sustainable and cost effective technology for removal of suspended particulate matters, Iron and Arsenic
- » One ceramic membrane based plant of 80000 LPD capacity coupled with reverse osmosis plant of 30000 LPD capacity has been handed over to the Chairman, Taki Municipality on 27th August, 2013.
- » One 10000 LPD capacity plant coupled with Brackish water reverse osmosis unit has been installed at Bally, Howrah West Bengal.
- » 106 Iron and Arsenic removal plants installed.
- » 23 S.S.I based plants installed for private entrepreneurship development.
- » One 8000 LPH capacity Arsenic and Iron removal plant has been installed at Malda

CSIR-CGCRI has also contributed significantly in developing ceramic ultrafiltration membranes, nanofiltration membranes, nanoparticle embedded ceramic polymer membranes, hydrophobic membranes and researched upon the applicability of these membranes for addressing niche area needs. For addressing the national requirement, the research group initiated in depth R & D with partners towards inorganic membrane synthesis having higher flux and to provide tailor made membranes for various applications. In addition, CSIR-CGCRI and other partners are continuing with development of application oriented research for wastewater treatment, membrane bioreactor, CO₂ capture, membrane contactor, vegetable oil processing, sugar cane juice clarifications and water purification to showcase the applicability of alumina based membranes in diversified fields in India and develop a national market.

Acknowledgement: DST, Govt. of India, PHED, Govt. of West Bengal, CSIR for financial support



IL - From Laboratory to Market: Lessons in Technology Commercialization and Entrepreneurship

Rashmi Dharmadhikari

Director *Metwiz Materials Private Limited*

Abstract:

Technology commercialization requires bringing together research, engineering, manufacturing, business, and customer needs. In this talk, I share my entrepreneurial journey through the establishment of Metwiz Materials Pvt. Ltd., incubated at SINE, IIT Bombay, and later Elementa Research, a technology translation company.

Drawing on experiences of working with researchers, start-ups, MSMEs, and industry, this presentation is an honest reflection on my journey of translating laboratory innovations into market-ready technologies. I will share the challenges, difficult decisions, failures, and small victories that have shaped this journey, along with the lessons I continue to learn as an entrepreneur.

IL - Tailoring Multifunctional Nanocomposites for Smart and Sustainable Technology

Shrabanee Sen

Functional Materials and Devices Division

CSIR-Central Glass and Ceramics Research Institute, 700032

Abstract:

The increasing demand for self-powered electronics in wireless technology, low power devices and sensors have caused an extensive amount of research into power harvesting devices over the last decades. Harvesting clean and renewable energy holds great promises for powering small electronics and achieving self-powered electronics devices. Energy harvesters employ one of the technologies that are developed to harvest mechanical energy with different frequency and amplitude in our environment by way of piezoelectric effect. The next generation application such as wearable energy harvesting system may require the piezoelectric materials to be flexible and lightweight. But the main drawbacks of these polymers are that the piezoelectric coefficient (d_{33}) which is responsible for energy conversion is very low. Composites can be considered as a potential candidate especially due to the possible tailoring of its properties by a judicious/logical selection of constituent components and their volume ratio.

Piezoelectric ceramic-polymer composites are promising materials for energy harvesting because of their excellent properties. These composites combine superior properties of both polymer and ceramic phases, which offers many advantages over those of the constituent materials. Different ceramic fillers embedded within polymer matrix has been fabricated. The incompatibility between the ceramic and polymer phase may lead to degradation of the electrical properties of the fabricated composites. Hence, surface modification or addition of fillers has been introduced to enhance the compatibility.

The composites were fabricated by tape casting followed by hot press technique. The structural, microstructural and detailed electrical characterization of the developed composites was studied. The energy storage density of the composites was also evaluated. Finally, the piezo response was studied by making EPE (Electrode-Polymer-Electrode) stacks and the output power was measured. The generated power was also used for different applications like lighting LEDs, flank array sensors, human motion sensors.

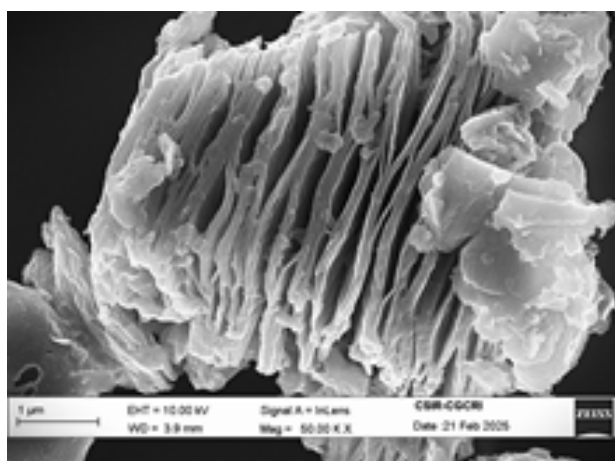
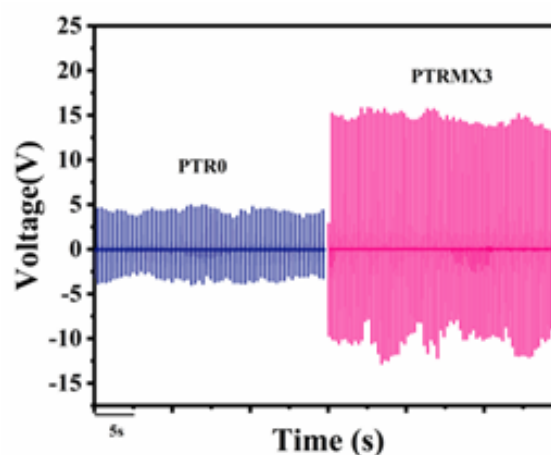


Fig (a): layered structure of MXene;



Fig(b): generated voltage by neat P(VDF-TrFE) and P(VDF-TrFE)/3wt% MXene composite film



IL - Development of Hydroxyapatite Coated With Silk Reinforced Polycaprolactone Bio-Composites for Bone Applications

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Abstract:

Hydroxyapatite (HA) coated silk-fabric / PCL biocomposites: deposition of HA onto the optimised silk fabric via an alternate soaking method, fabrication of HA coated silk fabric/PCL composites by compression moulding, and analyses of mechanical, chemical and biological effects of the HA coating. SEM and FTIR confirm HA coverage; mechanical testing shows that HA coating alters interfacial adhesion and in some cases reduces tensile interlayer cohesion while changing modulus behavior, and TGA quantifies thermal effects. In vitro biodegradation, SBF apatite formation, haemolysis, MTT cell viability, ALP activity and Alizarin Red S staining demonstrate enhanced bioactivity and osteogenic response for HA coated composites despite some interfacial bonding changes, supporting their potential for orthopaedic use.

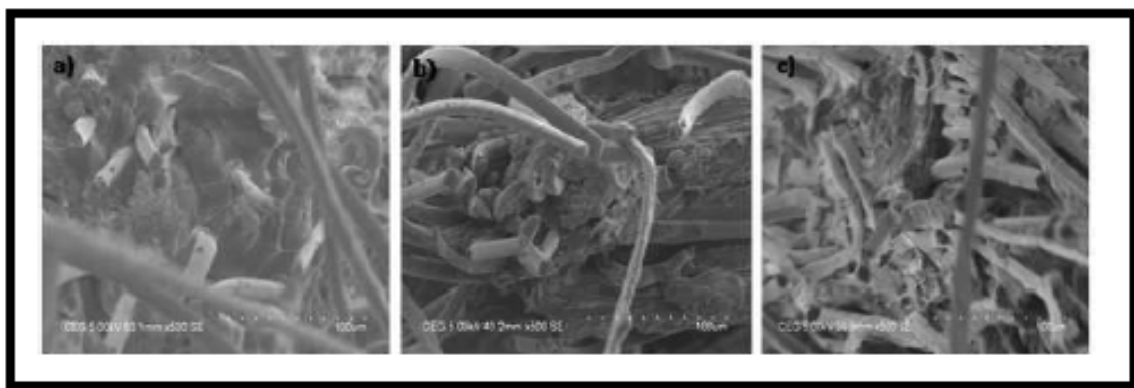


Figure: SEM micrographs of the fractured surface on silk yarn/PCL composites



IL - Indian Institute of Ceramics Title: Ceramics in Automobiles: Emerging Opportunities for Advanced Alumina Materials in Conventional and Electric Mobility

Shekhar Nath

Speciality Alumina Business, Hindalco, Mumbai

Abstract:

The automotive industry is undergoing a rapid transformation driven by electrification, stringent emission regulations, digitalization, enhanced thermal management requirements, and the demand for improved reliability. Advanced ceramics have become critical engineering materials owing to their resistance, high-temperature stability, and lightweight characteristics. Consequently, ceramic materials are increasingly employed in both conventional internal combustion engine (ICE) vehicles and next-generation electric vehicles (EVs) in applications such as spark plug insulators, oxygen sensors, catalytic converter substrates, diesel particulate filters, bearings, seals, electronic substrates, power electronics, thermal management systems, and advanced sensing devices. Among engineering ceramics, alumina-based materials constitute the largest and most versatile segment due to their favorable balance of performance, reliability, and cost. The rapid growth of EVs has accelerated demand for high-purity alumina, alumina-based substrates, battery separator coatings, thermal interface materials (TIMs), and high-voltage insulation components. These materials play a vital role in heat dissipation, electrical insulation, thermal runaway mitigation, and long-term durability of advanced automotive systems. As India's leading integrated producer of specialty alumina products, Hindalco Industries Ltd. offers a comprehensive portfolio of advanced materials for automotive applications, including specialty and calcined aluminas, low-soda high-purity alumina (3N and 4N), boehmite, aluminum trihydrate (ATH), and spherical alumina. These materials find applications in brake and friction systems, spark plug components, electronic substrates, metallized ceramics, automotive sensors, battery separator coatings, thermal interface materials, heat dissipation components, flame-retardant polymer systems, and automotive electronics. Specialty aluminas continue to serve as key raw materials for friction and brake applications, while high purity aluminas are increasingly utilized in advanced ceramic substrates and sensor packages requiring superior purity and reliability. Boehmite presents significant opportunities in lithium-ion battery separator coatings by enhancing thermal stability and safety. Spherical alumina is emerging as a strategic material for EV battery packs, power electronics, charging infrastructure, and advanced driver assistance systems (ADAS) owing to its excellent thermal conductivity, high packing density, and electrical insulation characteristics. This invited talk will provide an overview of ceramic technologies in modern automobiles, discuss the growing role of alumina-based materials in conventional and electric mobility, and highlight emerging opportunities for the Indian ceramic industry. The presentation will also showcase Hindalco's specialty alumina portfolio and its contribution toward the development of safer, more efficient, and thermally resilient automotive systems, supporting the transition to next-generation mobility solutions. Keywords: Automotive Ceramics, Alumina, High Purity Alumina, Spherical Alumina, Boehmite, Thermal Interface Materials, EV Batteries, Advanced Ceramics, Automotive Electronics.



IL - Alumina in Healthcare: Enabling Advanced Medical Technologies

Somya Vashishtha

Specialty Alumina, Hindalco Industries Ltd., Mumbai

Abstract:

Healthcare is a vital contributor to economic growth and quality of life. As the demand for advanced medical solutions increases, specialty alumina and aluminium hydroxide (ATH) are becoming important materials for enhancing the performance, safety, and reliability of healthcare products and devices.

Specialty alumina (high-purity aluminium oxide) combines excellent mechanical strength, chemical inertness, thermal stability, electrical insulation, and biocompatibility. These properties make it suitable for a wide range of medical applications. A major use is in ceramic hand glove moulds, where durability and dimensional stability enable efficient, high-volume production.

In healthcare, alumina is widely used in orthopaedic and dental implants because of its superior wear resistance and tissue compatibility. It also plays a key role in pharmaceutical glass used for syringes, vaccine vials, and drug containers, improving strength, chemical durability, and product safety.

Alumina is equally important in diagnostic and medical electronic equipment. Applications include ceramic-to-metal seals, X-ray tube components, vacuum feedthroughs, metering valves, image intensifier housings, and sapphire windows. These components must withstand demanding conditions such as high voltage, vacuum environments, and frequent sterilization.

The material is also used in surgical instruments and medical handling equipment, including scalpel blades, endoscopic components, cutting guides, crucibles, and sterilization trays. Modern manufacturing methods such as ceramic injection molding and 3D printing have further expanded its use in complex and customized medical components.

Aluminium hydroxide (ATH) complements alumina through its pharmaceutical and safety-related applications. It is widely used as a vaccine adjuvant to strengthen immune response and as an effective antacid. ATH also serves as a flame-retardant additive in electronic components used in CT scanners, MRI systems, and other diagnostic equipment.

As healthcare technologies continue to evolve, demand for high-performance ceramic materials is expected to grow. Through continuous innovation, strict quality standards, and a sustainable mine-to-market approach, Hindalco is developing specialized alumina and high-purity ATH solutions for emerging medical and pharmaceutical applications.

The unique combination of biocompatibility, durability, chemical resistance, and thermal stability makes alumina and ATH indispensable materials for modern healthcare, supporting both current technologies and future medical innovations.

» **Keywords:** Alumina, Aluminium Hydroxide, Bioceramics, Orthopaedic Implants, Dental Implants, Pharma Glass, Hand Glove Moulds, Vaccine Adjuvant, Antacid, Medical Devices, Feedthroughs, Flame Retardants, Surgical Instruments, Advanced Ceramics, Healthcare Innovation



IL - Role of Ceramic Materials and Process Engineering in High Temperature Electrolyser towards Deep Decarbonization

Jayanta Mukhopadhyay

Abstract:

As per the report of National Green Hydrogen, published by Ministry of New and Renewable Energy (MNRE), India currently imports over 40% of its primary energy requirements, worth over USD 90 billion every year. This necessitates a shift towards technologies that enable enhanced share of renewable sources in the energy mix, and progressively reduce the reliance on fossil fuels. R&D projects will be goal-oriented, time bound, and suitably scaled up to achieve quantifiable returns. Blue Sky Projects having a long term (0-7 years in the first phase field trials and 8-12 years down the line for commercialization) horizon is planned with a focus on establishing global IP and competitive advantage for the Indian industry which will aim to develop capabilities of the Indian R&D sector within an array of subjects like 18 development of 3rd generation electrocatalysts, **reversible Solid Oxide Electrolysers (SOECs) and Solid Oxide Fuel Cells (SOFCs)**, seawater electrolysis, thermo-catalytic pyrolysis, plasma pyrolysis, salt cavern surveys, high entropy alloys for reversible hydrogen storage etc.

Solid oxide cell technology has the potential to deep decarbonize the eco-system by suitably converting the commercial grade H₂ for the usage along with methane, reformat gases, syn gases, bio gases including the flare gases from petroleum industries. **Solid oxide cells (SOCs)** play a major role in strategic visions to achieve decarbonization and climate-neutrality. With its multifuel capability, this technology has received rapidly growing amount of attention from researchers worldwide. Due to the great flexibility of SOCs with respect to the fuels that can be used, not only hydrogen, but also biogas, natural gas, diesel reformates and many other conventional and alternative fuels can be used. This makes it possible to couple SOCs with diverse sustainable fuel sources to generate electricity or to generate valuable fuels such as syngas when utilizing renewable electricity. The steel sector is one of the most carbon-intensive industries, and the sustainable strategies to reduce CO₂ emission on integrated mill plants are being discussed globally.

Ceramic materials and processing play a major important role towards the performance. Complex perovskite oxide, ABO₃-type electrodes have emerged as focal points in Reversible Solid Oxide Cells (R-SOC) technology due to their outstanding electrocatalytic activity. The efficacy of perovskites in electrocatalysis is intricately linked with the presence of oxygen vacancies within their structure, which can be induced by cation substitutions at the A-site or the B-site of the perovskite lattice. In addition to the single perovskite, double perovskites with exsolved materials enhances the performance of the SOC in reversible mode of operation. The role of phase boundary engineering has also been discussed in conjunction with air and fuel electrodes and the performance thereof.



CL - STRUCTURE - PROPERTY RELATIONSHIP OF TAILORED CALCINED ALUMINA FOR OPTIMIZED POLISHING APPLICATIONS

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Abstract:

Calcined alumina is widely employed in polishing applications such as metals, granite, pipes, and utensils due to its high hardness and wear resistance. Its performance can be effectively tailored during processing to meet specific application requirements. In this study, a systematic structure–property relationship was established by evaluating the influence of microstructure, particle size (0.5–15 μm), particle size distribution, and specific surface area (1–20 m^2/g) on cutting effect and polishing performance. The role of mineralizers was also examined by comparing samples prepared with two mineralizers (M_1 , M_2) and without mineralizer. Characterization was performed using PSD, BET, SEM, XRF, and XRD techniques.

Polishing efficiency was assessed through buffing wheel trials using formulated polishing bars. The results show that soft calcined alumina exhibits superior polishing performance (rating ~9/10), particularly at higher SSA (10–20 m^2/g), due to enhanced surface interaction and defect minimization. Conversely, hard-calcined alumina demonstrated higher cutting efficiency but lower polishing effectiveness. Particle morphology including platy, roundish, and mixed forms significantly influenced material removal behaviour and finish quality. Overall, the study highlights the critical role of calcination conditions, microstructural characteristics, and mineralizer addition in governing the cutting and polishing performance of calcined alumina

» **Keywords:** Calcined Alumina, Microstructure, Polishing Efficiency, Surface area, Particle Size



CL - Transforming Low-Cost Kaolin into a High-Flux Zeolite Interlayer: A Hierarchical Composite Membrane Strategy for Sustainable Ethanol Dehydration

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Abstract:

The development of cost-effective and energy-efficient technologies for bioethanol purification remains a critical challenge due to the ethanol–water azeotrope. In this work, a novel hierarchical NaA zeolite composite membrane was engineered via the in-situ transformation of a kaolin clay interlayer during secondary hydrothermal synthesis, thereby creating a multifunctional microporous–mesoporous architecture for enhanced pervaporation performance. The membrane design integrates the low cost, abundance, and thermal robustness of kaolin with the molecular sieving capability of zeolite NaA, enabling improved interfacial adhesion, tailored pore structures, and superior mass transport characteristics.

Comprehensive structural investigations confirmed successful zeolite formation and the evolution of a highly porous hierarchical network. The kaolin-modified membrane exhibited significantly higher porosity (36.8%), lower activation energy for permeation (17.3 kJ mol⁻¹), and nearly threefold higher steady-state flux compared with the conventional polymer-interlayered counterpart. Long-duration pervaporation studies demonstrated stable operation and efficient ethanol dehydration, achieving azeotropic enrichment with enhanced flux retention and reduced diffusion resistance. The transition from solution–diffusion transport to a mixed Knudsen–viscous flow mechanism further highlights the unique role of the transformed kaolin interlayer.

» **Keywords:** Hierarchical porosity, Biofuel purification, Activation energy, Pervaporation membrane



CL - Challenges in the Fabrication of Cordierite-based Ceramic Monolith Catalytic Converters for Flue Gas Treatments

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Abstract:

Cordierite-based monolith catalysts are widely applied in automobiles for flue gas treatment to meet environmental norms and mitigate air pollution. The cordierite monolith catalyst substrate consists of 100-1600 cells per square inch (cpsi) through channels, through which the flue gases (NO_x, CO, hydrocarbons (HC)) are converted into N₂, CO₂, and H₂O with the help of catalysts like platinum group of metals (PGM), coated inside the channels. The fabrication process of these cordierite monolith catalysts is extremely challenging; the major challenges involved are such as (a) high precision die making, (b) extrusion and drying of green body with high cell density and extremely thin walls, (c) producing ≥90 wt% cordierite phase due to formation of mullite and amorphous phases, (d) precise temperature control due to extremely narrow sintering window of cordierite, (e) washcoating the narrow channels of the substrate with γ-Al₂O₃ containing PGM, etc. This talk will discuss these in detail.



CL - Rational Construction of Direct Z-Scheme $\text{Zn}_{0.5}\text{Cd}_{0.5}\text{S}/\text{SrTiO}_3$ Heterojunction for Superior Charge Separation and Hydrogen Evolution

Dipendu Sarkar,^{a,b} Srabanti Ghosh^{*a,b}

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Abstract:

Photocatalytic H_2 production offers a sustainable solution to global energy challenges, but its efficiency remains limited by rapid charge recombination. Herein, $\text{Zn}_{0.5}\text{Cd}_{0.5}\text{S}/\text{SrTiO}_3$ (ZCST) were synthesized via a one-step hydrothermal method, with intimate interfacial contact between $\text{Zn}_{0.5}\text{Cd}_{0.5}\text{S}$ (ZCS) nanospheres and SrTiO_3 (STO) nanoplates. The optimized ZCST₃₀ photocatalyst achieved a superior H_2 evolution rate of $13.3 \text{ mmol g}^{-1} \text{ h}^{-1}$, representing ~416- and ~8-fold enhancements over pristine STO and ZCS, respectively. Moreover, apparent quantum yield for heterostructures increased by ~8.4 times compared to bare ZCS under 420 nm irradiation. Enhanced charge separation yielded a photocurrent density of $5.64 \mu\text{A cm}^{-2}$, ~12 and ~6 times higher than STO and ZCS, respectively. Spectroscopic and electrochemical analyses revealed that the direct Z-scheme charge-transfer mechanism promoted rapid carrier migration, suppressed recombination, and enabled efficient photocatalytic hydrogen production. This work demonstrates an effective strategy for designing high-performance photocatalysts for solar-driven hydrogen production.

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CL - Effect of Nickel Doping on LSM Cathodes for Intermediate-Temperature SOFC Applications

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²Vellore Institute of Technology (VIT), Vandalur – Kelambakkam Road, CHENNAI – 600127, Tamil Nadu, India

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Abstract:

Nickel-doped lanthanum strontium manganite cathode materials with composition $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{O}_3$, where $x = 0.1, 0.2$, and 0.3 , were synthesized by the solution combustion method and studied for application in YSZ-based solid oxide fuel cells. The synthesized powders were calcined at 1200°C to obtain phase-pure perovskite structures. Different characterization techniques such as TG-DTA, XRD, SEM-EDX, BET, Raman spectroscopy, and FTIR were used to evaluate the thermal behaviour, phase formation, microstructure, surface area, and defect chemistry of the prepared cathode materials. The results confirmed successful Ni incorporation at the Mn-site, porous nanopowder morphology, and oxygen-vacancy-related defect formation.

Among the investigated compositions, LSMN_{2V} , corresponding to $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_3$, showed the most favourable properties, including better crystallinity, fine and uniform particles, interconnected porosity, and homogeneous elemental distribution. Electrochemical impedance spectroscopy of symmetric cells using YSZ electrolyte showed that polarization resistance decreased with increasing temperature for all samples. The 20 mol% Ni-doped LSMN_{2V} cathode exhibited the lowest polarization resistance, indicating improved oxygen reduction reaction activity. DRT analysis further suggested that LSMN_{2V} has balanced charge-transfer and diffusion processes. The enhanced performance is attributed to optimized Ni doping, which modifies the $\text{Mn}^{3+}/\text{Mn}^{4+}$ redox balance, generates oxygen vacancies, and improves ORR kinetics. Therefore, 20 mol% Ni-doped LSM can be considered a promising cathode material for intermediate-temperature SOFC applications.

CL - Atomic Pair Distribution Function (APDF): Screening tool to have the insight into the local structure of complex perovskites

Kanchan Kumar Kole^{a,b} and Jiten Ghosh^{a,b,#}

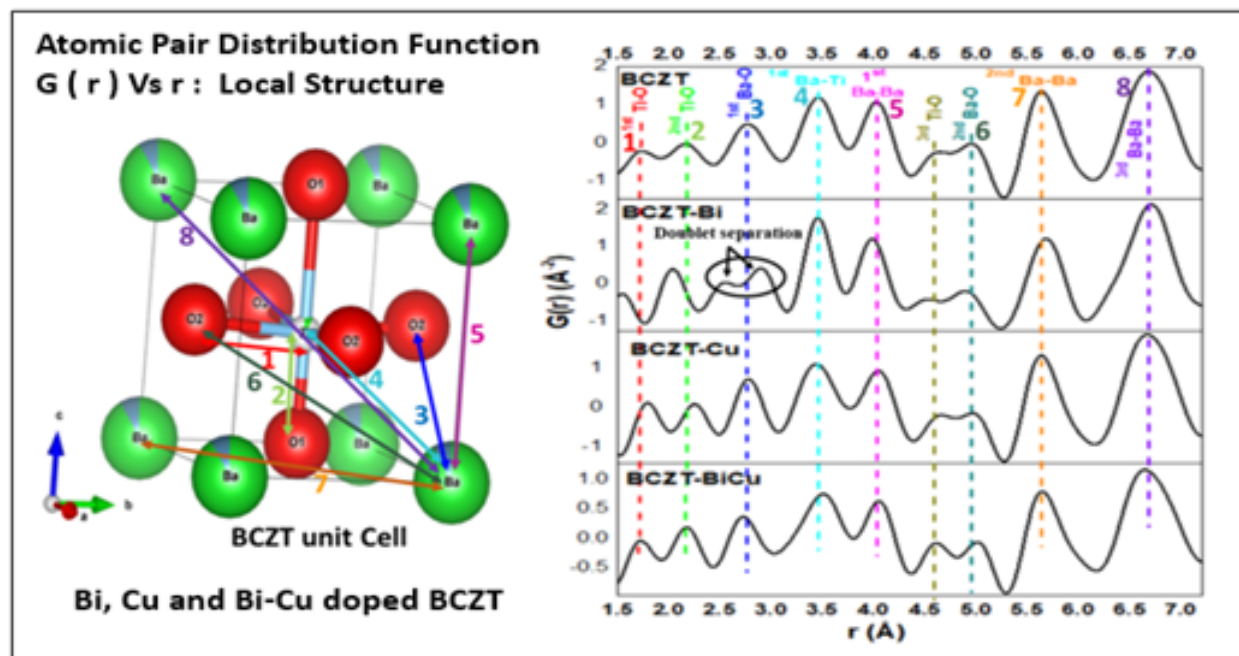
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Abstract:

Distribution of dopants in BaTiO₃ perovskite (ABO₃) plays an important role on the structural and electrical properties of BaTiO₃ perovskite. Understanding the distributions of dopant atoms in BaTiO₃ lattice at atomic scale is extremely important to control the dielectric performance of the Ba-based perovskites because these local atomic arrangements around dopant ions and local neighbouring host ions helped to get more insight on the atomic scale structure of these perovskites due to local distortion. Atomic Pair Distribution Function (APDF) analysis based on the local atomic arrangements from total scattering experiments was used to extract short range localized structural information in Complex Perovskites. In the present study, X-ray Diffraction (XRD), Atomic Pair Distribution Function (APDF), High Resolution Transmission Electron Microscope (HRTEM), RAMAN spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR) will be used to investigate average and local structures to correlate the structures with dielectric properties. The short-range local structure has significant effect on the dielectric performance due to modifications of the lattice structure resulting in the local electric fields. The pair-distribution function will be provided with in-depth information of the distribution of the atoms for better understanding the structure of dopants incorporated BaTiO₃ perovskite from atomic structural point of view.





CL - High-Purity Aluminas: Enabling Advanced Technologies Through Tailored Properties

Sourojit Pal, Shankha Chatterjee

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Abstract:

High-Purity Alumina (HPA) has emerged as a critical material for advanced technologies owing to its exceptional purity, thermal stability, chemical inertness, electrical insulation, and mechanical robustness. Typically exhibiting purity levels above 99.8%, HPA provides a unique combination of properties that enables reliable performance in demanding environments. Its applications span a wide range of industries, including semiconductor manufacturing, power electronics, biomedical implants, energy storage systems, optical components, and advanced ceramics.

In electronic and communication technologies, HPA is valued for its low dielectric loss, excellent electrical insulation, and thermal conductivity, which support efficient operation at high frequencies and elevated power densities. The rapid growth of electric mobility, renewable energy systems, and high-performance computing has further increased the demand for engineered alumina solutions. In particular, specialized alumina fillers are increasingly incorporated into thermal interface materials (TIMs) to improve heat dissipation in power modules, battery packs, and semiconductor devices, where effective thermal management is essential for performance and reliability.

Beyond electronics, HPA offers outstanding wear resistance, corrosion resistance, and thermal durability, making it suitable for mechanical, chemical, and optical applications exposed to harsh operating conditions. As industries continue to pursue higher efficiency, longer service life, and reduced environmental impact, specialty high-purity alumina is positioned as a versatile material platform that supports innovation, reliability, and sustainable product development across a broad spectrum of technologies.

SL - Exsolution-Engineered LMN-GDC as a Durable Reforming Layer for Solid Oxide Fuel Cells

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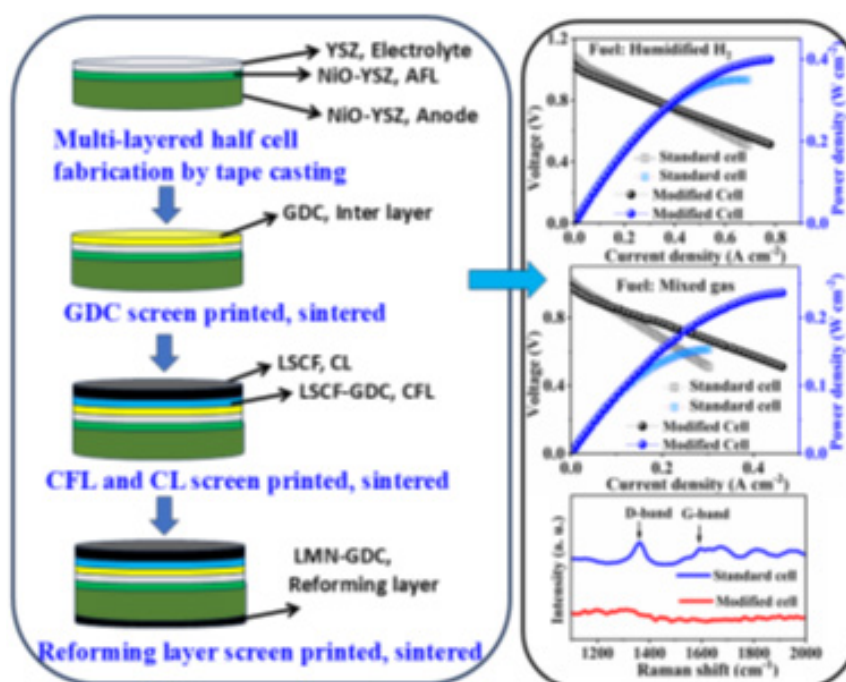
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Abstract:

Direct utilization of hydrocarbon fuels in solid oxide fuel cells (SOFCs) is a promising approach for sustainable power generation but is limited by carbon deposition and catalyst degradation. Herein, an A-site-deficient perovskite, $\text{La}_{0.9}\text{Mn}_{0.8}\text{Ni}_{0.2}\text{O}_{3-\delta}$ (LMN), was synthesized via solution combustion and combined with gadolinium-doped ceria (GDC) to develop a stable reforming layer for SOFCs. Under reducing conditions, controlled exsolution of Ni nanoparticles generated highly active catalytic sites while GDC enhanced structural stability and oxygen ion transport. The LMN-GDC reforming layer achieved 85% CH_4 conversion at 800 °C. Integrated into an SOFC single cell, it delivered current densities of 0.785 A cm^{-2} with humidified H_2 and 0.462 A cm^{-2} with simulated coal-derived syngas at 800 °C. The modified cell also exhibited improved resistance to carbon deposition during long-term operation with simulated coal-derived syngas. The synergistic interaction between exsolved Ni, GDC, and the perovskite framework enables efficient and durable internal reforming for practical SOFC applications. These findings demonstrate the potential of exsolution-engineered perovskite-ceria composites as durable reforming catalysts for high-performance SOFC systems operating on practical hydrocarbon fuels.

Scheme 1: Schematic illustration of step-wise fabrication of reforming catalyst modified SOFC and the corresponding electrochemical performance.





SL - Facile Synthesis of Orthorhombic LaFeO_3 Perovskite Nanoparticles: A Promising Adsorbent for Efficient Cr(VI) Remediation

Krishnendu Ghorui¹, Sabarno Majumdar¹, Neelanjana Bag², Monotosh Bhattacharjee³, Chandan Kumar Mandal³, Tanmoy Basak¹, Rohit Mohanty¹ and Prasanta Kumar Sinha^{*1}

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Abstract:

The LaFeO_3 perovskite nanoparticles were successfully synthesized via a facile room-temperature co-precipitation route, followed by annealing at 750°C. X-ray diffraction analysis confirmed the formation of a single-phase orthorhombic perovskite structure [1], with phase identification verified using X'PertHighScore software. The average crystallite size was estimated to be ~19.2 nm using the Debye-Scherrer equation. Field-emission scanning electron microscopy revealed uniformly distributed nanosized particles with a porous surface morphology, providing abundant active sites that are favourable for enhanced surface-mediated applications. Zeta potential analysis revealed a positive surface charge of +16.5 mV for LaFeO_3 at pH ~3, indicating favourable electrostatic interactions under acidic conditions. At this pH, Cr(VI) predominantly exists as negatively charged oxyanions, promoting their adsorption onto the positively charged LaFeO_3 surface through strong electrostatic attraction [2]. Heavy metal removal studies demonstrated efficient Cr(VI) removal within 2 hours under acidic conditions by the adsorption method, highlighting the excellent adsorption capability of LaFeO_3 . These findings suggest that LaFeO_3 is a promising adsorbent for the effective removal of Cr(VI) and other anionic heavy metal contaminants from acidic wastewater [3]. The combination of facile synthesis, favourable surface charge characteristics, and high removal efficiency makes LaFeO_3 a strong candidate for sustainable and practical wastewater remediation technologies for making non-oxide composite matrix for high temperature, high Mach application as well as formation of heterojunction semiconductor by the functionalization of the BNNS that can be used for photocatalytic application.

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Keywords for Poster Abstract:

LaFeO_3 Perovskite; Heavy Metal Removal; Adsorption; Zeta Potential.



SL - High-Entropy $\text{La}_x\text{Sr}_{1-x}(\text{CoCrFeMnNi})\text{O}_{3-\delta}$ Perovskites as Bifunctional Air Electrodes for Solid Oxide Cells Applications

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³Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India

Abstract:

High-entropy oxides (HEOs) specially perovskites are known for its tuning of structure and electrocatalysis through multi-cation synergy. In this work we have synthesized $\text{La}_x\text{Sr}_{1-x}(\text{CoCrFeMnNi})\text{O}_{3-\delta}$ ($x = 0.5, 0.7, 0.9$) high-entropy perovskites by solution combustion method. The Powder XRD analysis of which shows rhombohedral phases for LSHEO 0.5 and LSHEO 0.9, whereas LSHEO 0.7 exhibited a quasi-cubic structure, indicative of Sr solubility limit. The HRTEM images of Bright Field suggests that the resolved lattice fringes have d-spacing of 0.272 nm indexed by (110) plane in the XRD and EDS revealed the uniform cation dispersion in the perovskite matrix. The XPS displayed mixed-valence B-site cations having variable lattice and surface oxygen. The O_2 -TPD and H_2 -TPR revealed the vacancy mobility particularly in LSHEO 0.7. Electrochemical studies of asymmetric cell configuration of Pt/GDC/LSHEO+GDC/LSHEO was done for the three different compositions and LSHEO 0.7 demonstrated greater bifunctionality possessing exchange current densities values of 49.352 mA cm⁻², 14.154 mA cm⁻² for OER and ORR and low value of R_p (~0.16-0.17 Ω cm²), and a stable chronoamperometry in the range of 0.6-0.8 V. The excellent OER performance leads to heteroatomic redox coupling, oxygen vacancy enrichment, lattice flexibility, creating LSHEO 0.7 as a promising bifunctional air electrode. The findings highlight the future scope of achieving desirable on cell performance in Solid Oxide Cell (SOC) operation in both electrolyzer as well as fuel cell mode.

» **Keywords:** High entropy oxides, Bifunctionality, OER/ORR, Air electrode, Solid oxide cell.

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SL - Engineering Advanced Perovskite Electrocatalysts for Green Ammonia Production

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Abstract:

Ammonia (NH₃) is a vital chemical feedstock for industry and clean fuel; however, its conventional production through the energy-intensive Haber-Bosch process contributes significantly to global carbon emissions. Electrocatalytic nitrogen reduction reaction (NRR) and nitrate reduction reaction (NO₃RR) have emerged as promising sustainable alternatives for green NH₃ synthesis under ambient conditions.¹ In this work, ceramic-based perovskite electrocatalysts were engineered to enhance catalytic activity, charge transfer, and reaction kinetics for NH₃ production. A layered Ruddlesden-Popper perovskite Sr₃FeCoO_{6.72}, was hydroxylated to generate surface hydroxyl groups and oxygen vacancies, improving N₂ adsorption and proton-coupled electron transfer. Further modification with TiO₂ produced composites that facilitated interfacial charge separation and increased active-site accessibility, achieving an NH₃ yield rate of 12.8 μg h⁻¹ mgcat⁻¹. In addition, a Mg-doped double perovskite, La₂Ni_{0.85}Mg_{0.15}O₃, modified with Fe₃O₄ nanospheres demonstrated outstanding nitrate reduction performance, delivering an NH₃ yield rate of 68.8 μg h⁻¹ mgcat⁻¹. These results highlight the potential of advanced ceramic perovskite functional materials in sustainable energy conversion and environmental remediation. The study underscores the opportunities, challenges, and innovations required to advance ceramic-based electrocatalysts for a sustainable future.

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SL - Engineering La-Doped $\text{Sr}_2\text{FeMoO}_6$ with Oxygen Vacancies for Efficient Ambient Electrocatalytic Nitrogen Fixation

Swapnil Mohanty¹

5th Year, B.TechM.Tech Dual Degree, Department of Ceramic Engineering, National Institute of Technology Rourkela

Abstract:

The rising need for eco-friendly energy storage technologies has led to the emergence of affordable new batteries in the place of lithium-ion batteries. Sodium-ion batteries (SIBs) are now considered one of the promising emerging technologies because of the availability, low cost and global distribution of sodium resources. But the commercial potential of SIBs hinges on the discovery of advanced cathode materials that have stable crystal structures, rapid ion diffusion, and excellent cycling stability. In this paper, compositionally optimized and hydrated Fe/Mn Prussian Blue Analogs (PBAs) cathodes were systematically engineered and studied for next-generation sodium-ion batteries.

A series of six cathode materials were prepared by a controlled aqueous co-precipitation method: Fe/Fe-Mn/Mn PBA and corresponding dehydrated framework (DH) analogs. Detailed studies of the structure, composition, thermal and electrochemical properties were conducted by XRD, FESEM-EDX, FTIR, Raman spectroscopy, BET surface area, DSC TGA, ICP-OES, cyclic voltammetry, galvanostatic charge-discharge, and impedance spectroscopy. XRD analysis confirmed the successful synthesis of PBA frameworks, while ICP-OES and thermal analysis revealed the influence of metal species and thermal treatment on sodium occupancy, vacancy, and crystal water content. BET studies revealed elevated surface area in mixed-metal PBAs, suggesting an increase in porosity and electrochemically accessible sites. Electrochemical tests showed different $\text{Fe}^{2+}/\text{Fe}^{3+}$ and $\text{Mn}^{2+}/\text{Mn}^{3+}$ redox reactions with reversible Na^+ insertion/extraction. Overall, in comparison with dehydrated analogues, the as prepared Fe- and Mn-based PBAs demonstrated more stable cycling performance and reduced capacity decay, and increased interfacial resistance in mixed-metal PBAs subjected to excessive dehydration. A key implication of this work is that dehydration is not always beneficial, but can depend on the composition and optimum electrochemical performance is achieved by judicious control of sodium occupancy, framework stability, vacancy concentration, and water content. This study sets design rules for next-generation Prussian Blue Analog cathodes, and suggests their great promise for low-cost electric vehicles.

» **Keywords:** Sodium-ion batteries, Prussian Blue Analogues, Cathode materials, Composition tuning.

SL - Tailoring the Mechanical, Tribological, and Electromagnetic Properties of β -SiAlON Ceramics through h-BN and Graphene Nanoplatelet Reinforcements

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Abstract:

β -SiAlON ceramics are frequently utilized in structural applications because of its superior mechanical strength, oxidation resistance, and thermal stability.¹ However, the tribological and electromagnetic (EM) characteristics of β -SiAlON ceramics reinforced with functional second phases have not been thoroughly studied. This study effectively synthesized β -SiAlON and β -SiAlON composites reinforced with hexagonal boron nitride (h-BN) and graphene nanoplatelets (GNPs) using spark plasma sintering (SPS) at 1800°C. Microstructural characterization revealed a dense matrix of elongated β -SiAlON grains, while the incorporation of h-BN and GNPs suppressed grain growth and altered the fracture behaviour. Although the reinforcements caused only a marginal reduction in Vickers hardness, they significantly enhanced fracture toughness and flexural strength through crack deflection, crack bridging, and pull-out mechanisms. The tribological performance was assessed at a load of 10 N by quantifying the coefficient of friction (CoF) and wear rate. The β -SiAlON–BN and β -SiAlON–GNP composites exhibited increases in the coefficient of friction (CoF) of 72.82% and 62.34%, respectively. In contrast, the incorporation of 30 Wt % h-BN resulted in a reduction of the wear rate from 5.525×10^{-2} to $2.725 \times 10^{-2} \mu\text{m}^2/\text{N}$, representing a 50.67% decrease, attributed to the development of a lubricious h-BN tribolayer and enhanced crack resistance. Dielectric measurements in the Ku-band (12–18 GHz) revealed that while GNP reinforcement increased the dielectric constant by $\approx 26\%$ (7.3 to 9.2), improving EMI shielding performance, while h-BN decreased the dielectric constant from 7.3 to 5.9 ($\approx 19\%$) with lower dielectric loss, rendering the composites appropriate for EM-transparent applications. These findings establish h-BN- and GNP-reinforced β -SiAlON as promising multifunctional ceramics for advanced aerospace, radar, communication, and other high-temperature engineering applications.

» **Keywords:-** : β -SiAlON; Tribological property; EM property

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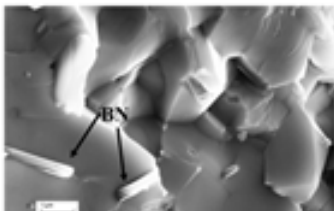
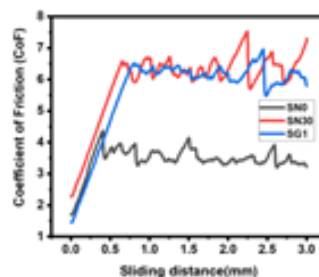
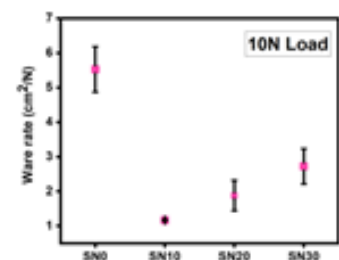


Figure 1: FESEM microstructure



2: CoF and



3: wear rate of β -SiAlON–BN composites

SL - Effect of LaB₆ Addition in BN System as Radar Adsorbing Applications

Rakhi Bhattacharya^P, Shirshendu Chakraborty^{*}

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Presenter: rakhibhattacharya02@gmail.com

Abstract:

Hexagonal boron nitride (h-BN) is a promising ceramic material for electromagnetic (EM) wave absorbing applications because of its low density, excellent thermal stability and chemical inertness [1-2]. However its low dielectric constant and relatively poor mechanical properties limit its performance in advanced radar absorbing materials (RAM). Radar absorbing material should have an moderate dielectric constant along with good impedance matching to maximize electromagnetic wave absorption and minimize reflection. In the present study electrically conductive ultra high temperature lanthanum hexaboride (LaB₆) was incorporated into a BN matrix to simultaneously enhance the dielectric and mechanical properties of the composite. The enhancement is attributed to the conductive nature of LaB₆, which promotes dielectric polarization and improves electromagnetic energy dissipation while simultaneously reinforcing the ceramic matrix. BN-LaB₆ composites containing 5 wt% and 10 wt% LaB₆ were successfully fabricated using the spark plasma sintering (SPS) technique. The prepared composites were characterized for their microstructure, mechanical properties, tribological behaviour and electromagnetic properties. The experimental results revealed that the addition of LaB₆ significantly improved the hardness, wear rate, coefficient of friction and also increase the dielectric properties of the BN composites compared to pure BN. Fig.1: shows the XRD patterns of BN with different weight percentage of LaB₆. The sample without LaB₆ exhibited the highest coefficient of friction. After adding LaB₆, the COF decreased significantly (62%) and reached its lowest value at optimal 5 wt% LaB₆ addition (Fig.2). This indicates that the addition of LaB₆ improves the tribological performance of the BN composite. These finding demonstrate that BN-LaB₆ composites possess a balanced combination of mechanical strength, tribological performance and dielectric characteristics making them promising candidates for next generation radar electromagnetic wave absorbing applications.

» **Keywords:** Radar absorbing; Hypersonic; SPS; Lanthanum Hexaboride

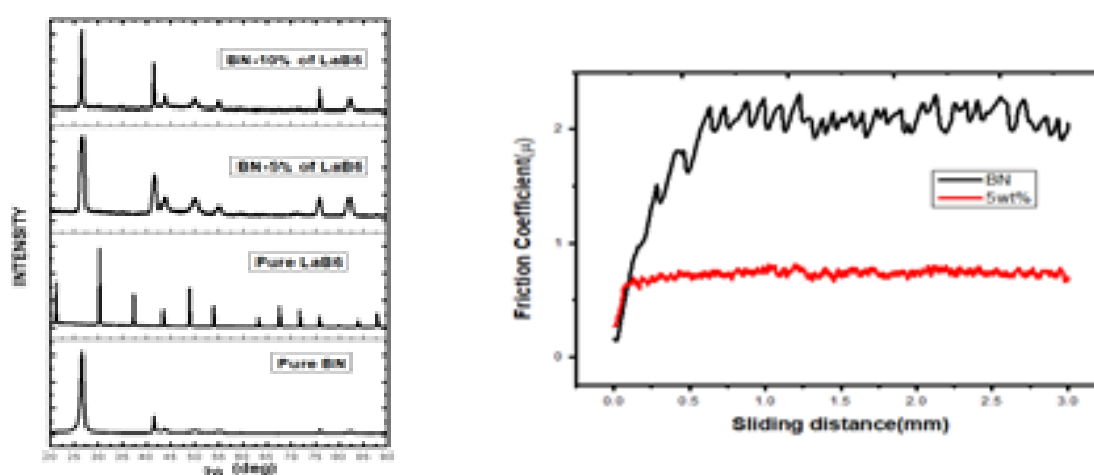


Figure 1 and 2: XRD patterns and COF values of BN and BN-LaB₆ composites, respectively.

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SL - Development and Characterization of a Vermiculite-Based Compressive Sealant for High-Temperature Solid Oxide Fuel Cell Applications

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Abstract:

Solid oxide fuel cells (SOFCs) require chemically stable, gas-tight sealants capable of accommodating thermal expansion mismatch during repeated thermal cycling. Conventional rigid glass-ceramic sealants often suffer from cracking and interfacial failure, highlighting the need for compliant sealing materials. Vermiculite, a naturally occurring layered phyllosilicate, has emerged as a promising compressive sealant owing to its high thermal stability, anisotropic lamellar structure, and excellent

mechanical compliance. In this study, a vermiculite-based compressive sealant was developed through exfoliation, dispersion, and solution-casting to obtain a flexible sheet with compressibility. The layered microstructure facilitates stress relaxation while maintaining intimate interfacial contact under compressive loading, thereby improving sealing efficiency. The prepared sealant is expected to exhibit high compressibility, thermal resilience, and dimensional stability under SOFC operating

conditions (600–800 °C). Structural and phase evolution were investigated using Xray diffraction, while morphological characteristics were examined by scanning electron microscopy. The compressive behavior and thermal stability of the fabricated sheets were evaluated to assess their suitability for high-temperature sealing applications. The developed vermiculite sealant offers a cost-effective, environmentally benign, and mechanically compliant alternative to conventional sealants, demonstrating significant potential for durable SOFC stack integration and other high-temperature energy conversion systems.

SL - Enhancing the Wear Resistance of Boron Nitride Ceramics via 2D Material Nano-Inclusion

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E mail id: shirshendu.cgcri@csir.res.in (Shirshendu Chakraborty), Presenter: MrsShaona Chatterjee

Abstract:

Hexagonal boron nitride (h-BN)-based materials have attracted significant attention as lightweight, thermally conductive, and wear-resistant materials for hypersonic aerospace applications. In the present work, the structural, thermal, and tribological performances of pristine h-BN, boron nitride nanosheet BNNS-BN composites, and graphene nanoplatelet GNP-BN hybrid composites were systematically investigated and compared. The composites were fabricated using a suitable processing route to evaluate the influence of nanoscale reinforcement on the microstructure and functional properties. XRD confirmed the crystal structure and phase purity, while FESEM revealed the surface morphology and dispersion of the reinforcing phases. Thermal conductivity was significantly enhanced in the composites, increasing from $14.88 \text{ W m}^{-1} \text{ K}^{-1}$ for pristine h-BN to $19.79 \text{ W m}^{-1} \text{ K}^{-1}$ for the GNP-BN composite, indicating the formation of efficient heat-conducting pathways. The tribological behaviour was evaluated using wear and scratch resistance tests. The BNNS and GNP reinforced BN composites exhibited lower coefficients of friction, reduced wear rates, smaller wear volumes, narrower scratch widths, and lower maximum penetration depths than pristine h-BN, demonstrating superior resistance to wear degradation. Specifically, the wear rates were 0.37 , 0.048 and $0.06 \mu\text{m}^2\text{N}^{-1}$, while the coefficients of friction were 2.8 , 1.42 and 1.18 for h-BN, BNNS, and GNP-BN composites respectively which is shown in Figure 1. BNNS-BN and GNP possess lower CoF than pure h-BN which means improvement of wear resistance after adding BNNS and GnP. The improved performance is attributed to the synergistic effects of exfoliated BN nanosheets and graphene nanoplatelets, which promote efficient phonon transport, enhance stress transfer, reduce crack propagation. Overall, the BNNS-BN composite exhibited the most balanced combination of thermal conductivity and tribological performance, highlighting its potential as a multifunctional material for thermal protection systems and structural components operating under the extreme thermal and mechanical conditions encountered in hypersonic aerospace vehicles.

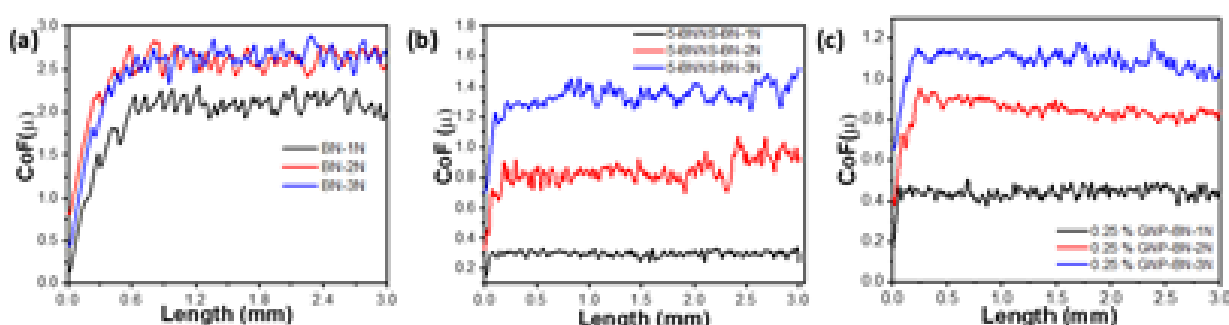


Figure 1: Coefficient of Friction values of (a) h-BN, (b)BNNS-BN and (c) GNP-B composites

Reference:

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SL - Low carbon Al₂O₃-C refractories containing nanocarbon (N220) as the sole carbon source: Processing and Performance

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Abstract:

The flow control devices used in the continuous casting process of the steel fabrication such as slide gate plates, ladle shrouds, monoblock stopper rods, and sub merged entry nozzles are made-up of alumina (Al₂O₃) - carbon (C) based refractories. Generally, these refractories contain up to 30 wt% residual carbon after coking, with graphite as the primary source of carbon. However, with ongoing technological advancements aimed at producing cleaner steel, achieving higher productivity, and reducing CO_x emissions, there is an increasing need to lower the carbon content in refractory materials. Moreover, a high carbon content presents several challenges, including carbon pickup in steel, increased heat loss, and elevated CO_x emissions. Consequently, the development of low-carbon refractories has become an important focus in modern steelmaking. The present work addresses this challenge by developing a low-carbon Al₂O₃-C refractory using nanocarbon as a substitute for conventional graphite. The physical, mechanical, and thermomechanical properties, phase evolution, microstructure, and oxidation resistance of the developed refractories were evaluated by varying the nanocarbon content from 1 to 4 wt%. Nanocarbon promoted the formation of ceramic bonding phases at lower temperatures due to its high reactivity, enhancing the refractory properties. However, nanocarbon additions above 2 wt% adversely affected the overall performance of the developed refractories.



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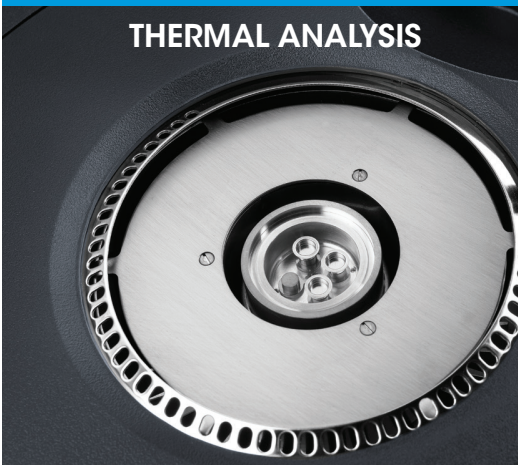
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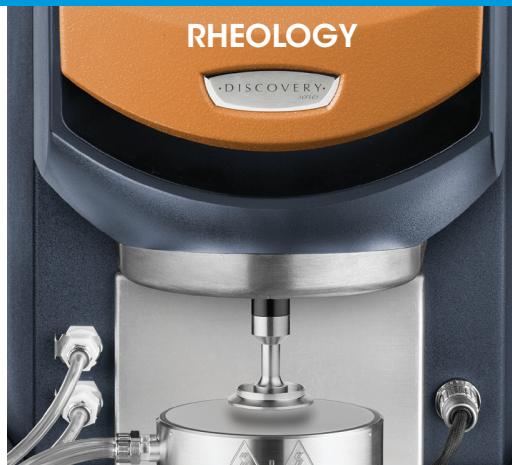
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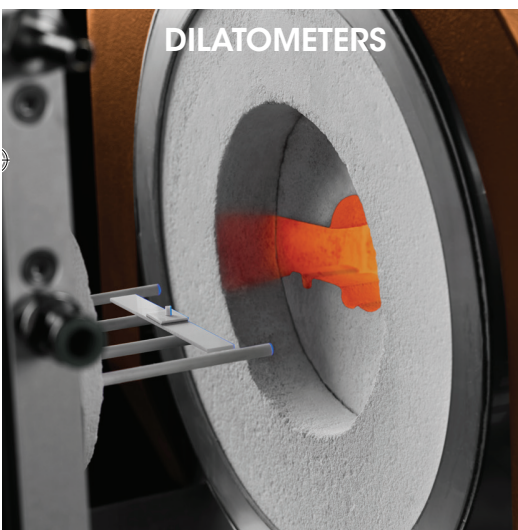
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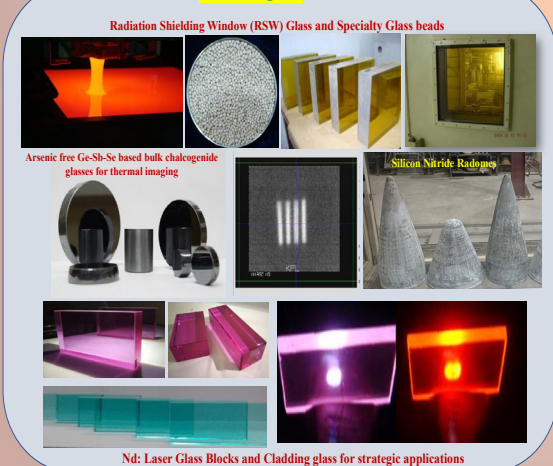


Alignment with National Missions

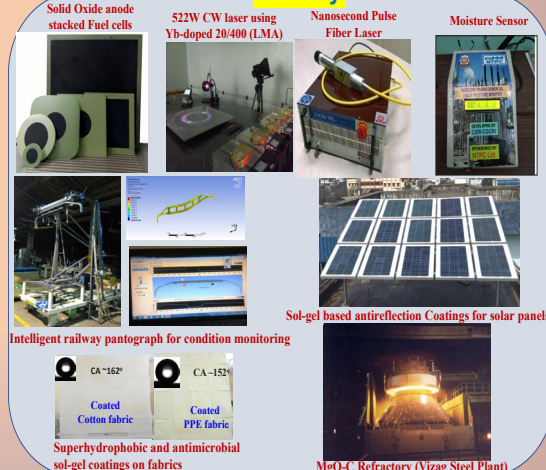


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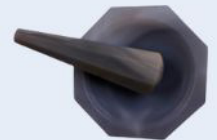
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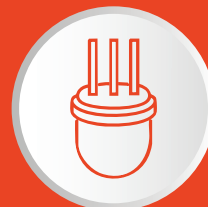
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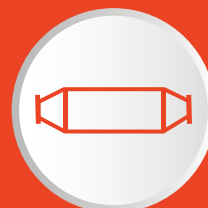
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