Website Information

Department of Physics

Dayananda Sagar University

Faculty details:

Item	Details
Faculty Name	Dr. Alesh Kumar
Room No	Cabin No: A 125, 1st Floor, School of Engineering
Designation	Assistant Professor
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Research Area	Biomaterial, Bioglass, Tissue Engineering, Bio-ceramics, Energy Storage Device, Li ion battery
Publications (Past 5 years)	1. **Alesh Kumar**, C.R. Mariappan, A review on embedding therapeutic nanoparticles in mesoporous bioactive glass-ceramics for biomedical applications, Inorganic Chemistry Communications, 179,2 (2025) 114855. 2. S Punj, R Mondal, S Chatterjee, DB Dhruv, A Kumar, **Alesh Kumar**, J Singh, Structural, magnetic, dielectric properties of double perovskite- La2NiFeO6 synthesized by wet chemical route. Applied Physics A, 131 (2025) 109. 3. **Alesh Kumar**, S. Banerjee, P. Roy, H. Xu, C.R. Mariappan, Osteogenesis and cytocompatibility compression of cerium and gallium nanoparticles doping in mesoporous bioactive glass-ceramics, Journal of Non-Crystalline Solids, 620(2023) 122598. 4. **Alesh Kumar**, S. Banerjee, P. Roy, H. Xu, C.R. Mariappan, Osteogenic commitment of strontium nanoparticle doped mesoporous bioactive glass-ceramics, Material Science & Engineering B, 286(2022) 116068. 5. **Alesh Kumar**, V. Gajraj, A. das, D. Sen, H Xu, C. R Mariappan, Silver, copper, magnesium and zinc contained electroactive mesoporous bioactive S53P4 glass-ceramics nanoparticle for bone regeneration: bioactivity, biocompatibility and antibacterial activity, Journal of Inorganic Organometallic polymer Material, 32(2022) 2309-2321. 6. J. Gu, S. Yagi, J. Meng, Y. Dong, C. Qian, D. Zaio, **Alesh Kumar**, T, Xu, A. Lucchetti, H. Xu High efficiency production of core–sheath nanofibers membrane via co-axial electro-centrifugal

	spinning for controlled drug release, Journal of Membrane Science, 654(2022) 120571. 7. V. Gajraj, **Alesh Kumar**, S., Indris, H. Ehrenberg, C. R. Mariappan, Influence of Al on structure and ion transport in garnet-type $Li_7La_{3-x}Al_xZr_2O_{12}$ solid electrolytes for Li-ion batteries, Ceramics International 48(2022) 29238-29246. 8. T. Xu, J. Gu, J. Meng, L. Du, **Alesh Kumar**, H. Xu Melt electro-writing reinforced composite membrane for controlled drug release, Journal of the Mechanical Behavior Biomedical Material, 132(2022) 105277. 9. **Alesh Kumar**, A. Mittal, A. Das, D. Sen, C. R. Mariappan, Mesoporous electro active silver doped calcium borosilicates: Structural, antibacterial and myogenic potential relationship of improved bio-ceramics, Ceramics International 47(2021) 3586-3596. 10. **Alesh Kumar**, C. R. Mariappan, A New Biocompatible Phosphate Free Mesoporous Calcium Borosilicate Glass-Ceramics for Medical Application, Material Letter, 305(2021) 130752. 11. V. Gajraj, **Alesh Kumar**, D. Ekta, R. Kaushik, D. A. Jose, A. Ghosh, C. R. Mariappan, Multifunctionality exploration of NiCo2O4-rGO nanocomposites: photochemical water oxidation, methanol electro-oxidation and asymmetric supercapacitor applications, Dalton transition, 50(2021) 18001-18015.
Profile Links Scopus and Orcid	**Scopus Author ID**: 57201692078 **Orcid :** https://orcid.org/ 0000-0002-7475-2104
Research Activities (Write about your best research results max of 2-3 pages including diagrams)	My current research primarily focuses on the development of advanced biomaterials, including bioactive glass, bioceramics, and stimuli-responsive scaffolds for applications in bone regeneration and tissue engineering. His work emphasizes therapeutic ion-doped and mesoporous bioactive glasses that enhance bioactivity, antibacterial properties, and tissue integration. Alongside his biomedical research, he is also engaged in developing nanostructured materials for energy storage, particularly for high-performance supercapacitor electrodes. His interdisciplinary approach bridges materials science with biomedical and energy applications.

1- Antibacterial and structural properties of mesoporous Ag doped calcium borosilicateglass-ceramics

The structural, electrical, bioactive, and antibacterial properties of mesoporous silver doped calcium borosilicate glass-ceramics have been thoroughly investigated. These multifunctional materials were synthesized using a cost-effective sol–gel method, followed by controlled thermal treatment. Nitrogen adsorption–desorption isotherms confirmed the mesoporous nature of the synthesized samples, indicating high surface area and uniform pore distribution, which are advantageous for biological interactions. In samples calcined at 600 °C, the presence of well-dispersed nanoscale metallic silver particles embedded in the glass matrix was confirmed through X-ray diffraction, UV–visible spectroscopy, and transmission electron microscopy. These structural characteristics suggest good thermal stability and homogeneity of the doped phase.

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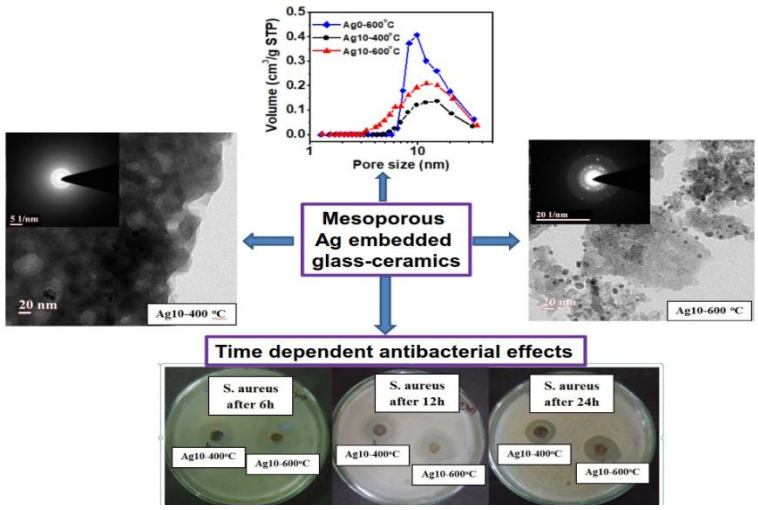

Figure 1 Ag doped calcium borosilicates 45.8 SiO2–(45.8-x)CaO–8.4B2O3 – xAg2O

conductivity studies were carried out to explore the electrical relaxation behavior of the materials. Glass-ceramics containing metallic Ag nanoparticles showed nearly constant loss behavior over a wide frequency range, attributed to the hopping of charge carriers. In contrast, samples containing silver ions displayed universal dielectric response, indicating different mechanisms of polarization and conduction. These findings highlight the impact of silver state (ionic vs. metallic) on the electrical performance of the glass-ceramics. Biological evaluation revealed that the Ag-doped glass-ceramics retained their ability to form a bone-like apatite layer when immersed in simulated body fluid, confirming their in vitro bioactivity. Additionally, antibacterial tests showed strong inhibition of both Gram-negative (*Escherichia coli*) and Gram-positive (*Staphylococcus aureus*) bacterial strains, with a more pronounced effect against *E. coli*. The enhanced antibacterial performance is attributed to the release of

Ag^+ ions and the presence of metallic Ag, both of which are known to disrupt bacterial cell membranes. Notably, the sample calcined at 600 °C showed the best overall performance, combining strong antibacterial efficacy, mesoporous structure, electrical responsiveness, and bioactivity. These results suggest that Ag-doped mesoporous calcium borosilicate glass-ceramics are promising candidates for biomedical applications, especially in bone tissue engineering and implant coatings.

2- Mesoporous electroactive silver doped calcium borosilicates: Structural, antibacterial and myogenic potential relationship of improved bio-ceramics

Electroactive mesoporous Ag-doped bioceramics (MBCs) engineered for advanced biomedical applications, combining structural integrity, electrical functionality, and biological activity. Synthesized through a sol–gel process, the materials exhibit well-defined mesoporosity and embedded silver in both ionic and metallic forms. Characterization confirms the formation of a stable glass-ceramic network with improved electrical conductivity and strong antibacterial properties. The materials support hydroxyapatite formation in simulated biological environments, confirming in vitro bioactivity. Antibacterial activity increases with silver content up to an optimal level, aligning with enhanced

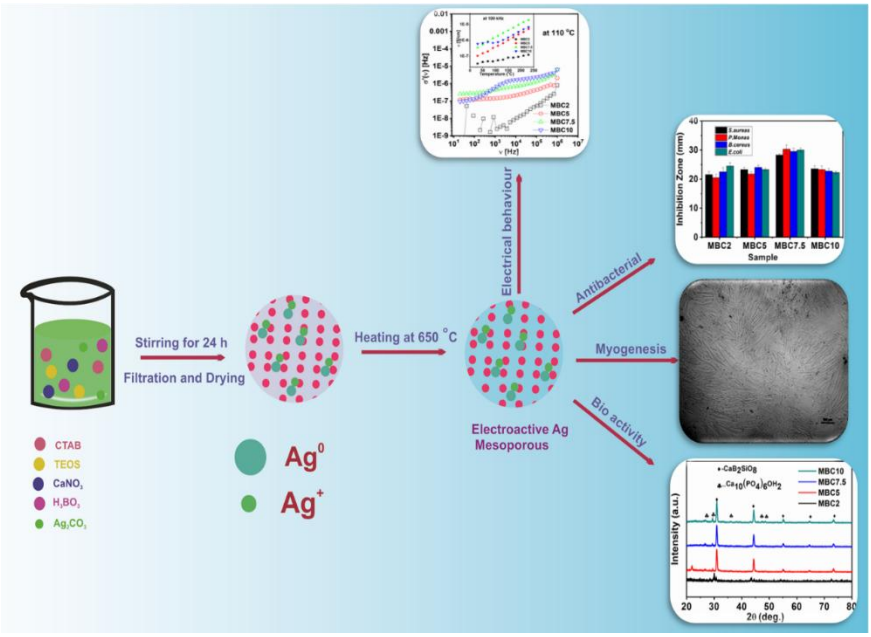

Figure 2 Mesoporous electroactive silver doped calcium borosilicates

electrical performance. Cell culture studies reveal excellent biocompatibility, with significant cell proliferation and myogenic differentiation. These multifunctional bioceramics are promising candidates for bone tissue engineering and antibacterial implant coatings.

3- Embedding Therapeutic Nanoparticles in Mesoporous Bioactive Glass-Ceramics for Biomedical Applications

Therapeutic ion-doped bioactive glass-ceramics are emerging as multifunctional materials for tissue engineering and regenerative medicine. By incorporating ions such as strontium, silver, copper, cerium, gallium, magnesium, and zinc, these BGCs offer enhanced osteogenic, antimicrobial, and antioxidant properties. Strontium boosts bone cell growth and is particularly useful for

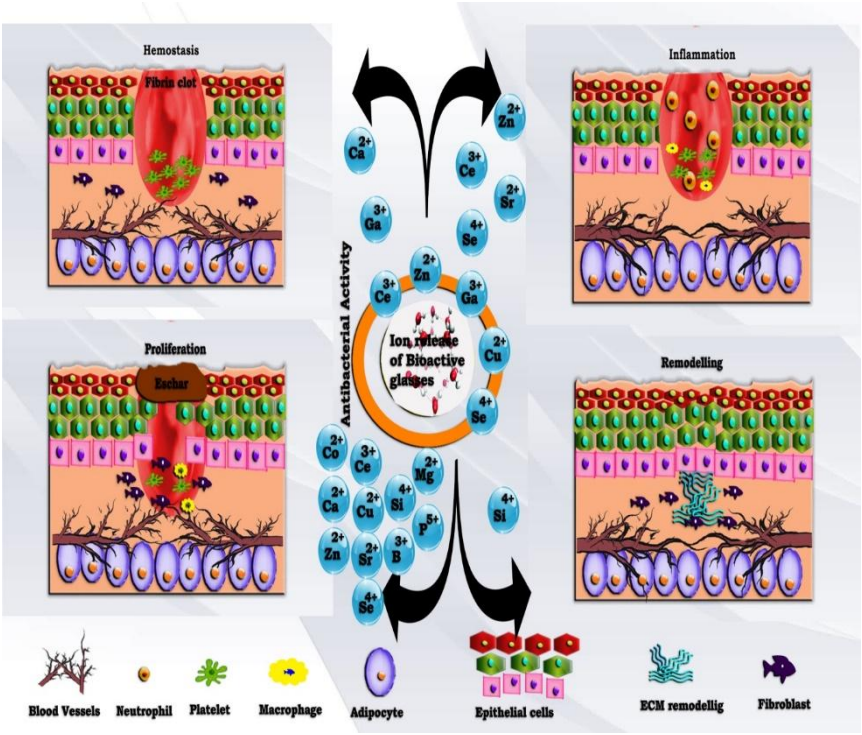

Figure 3 Pictorial illustration of ions doped bioactive glass and their application.

treating osteoporosis, while silver and copper provide strong antibacterial action for wound healing and infection prevention. Cerium and gallium contribute antioxidant and anti-inflammatory effects, supporting tissue repair. The controlled release of these ions enables sustained local therapy with minimal systemic toxicity. These multifunctional BGCs show great promise in bone regeneration, implant coatings, and scaffold-based therapies. Continued research will help refine ion-doping strategies and accelerate their clinical translation.

Collaborations	• Dr. Huaizhong Xu, Kyoto Institute of Technology, Kyoto, Japan. • Professor Hellmut Eckert, University of Sao Paulo Brazil. • Dr. C. R. Mariappan Pondicherry University Pondicherry India • Professor Partha Roy IIT Roorkee, India.

	• Professor Ashwani Mittal Kurukshetra University India.
Awards and Recognition	• Research Excellence Award for 2023 from Gautam Buddha University, Greater Noida. • Best Thesis award at Research conclave 2022 IIT Indore, India. • Best oral presentation award at NCNIT 2019 conference in NIT Kurukshetra.