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in Surface Engineering & Additive Manufacturing

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"Sustainability through
engineered Surfaces and Additive Innovation"

Book of Abstracts

Department of Metallurgical & Materials Engineering , IIT Kharagpur
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ভারতীয় প্রযুক্তিবিদ্যা প্রতিষ্ঠান খড়গপুর
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অধ্যাপক সুমন চক্রবর্তী, অধিকর্তা
प्राध्यापक सुमन चक्रवर्ती, निदेशक
Professor Suman Chakraborty, Director
Institute Chair Professor & Sir J. C. Bose National Fellow

January 14, 2026

Message from the Patron

It gives me immense pleasure to extend my warm greetings to all participants of the **1st International Conference on Frontiers in Surface Engineering and Additive Manufacturing (FSEAM-2026)** being organized at the Indian Institute of Technology Kharagpur.

Surface Engineering and Additive Manufacturing are rapidly transforming the landscape of modern manufacturing by enabling enhanced performance, sustainability, and design freedom across sectors such as aerospace, biomedical, marine, energy, and advanced infrastructure. The convergence of materials science, processing technologies, and digital manufacturing presents exciting opportunities as well as challenges that demand collaborative research and interdisciplinary dialogue.

FSEAM-2026 provides an excellent platform for researchers, academicians, industry professionals, and students from across the globe to exchange ideas, present cutting-edge research, and explore future directions in these evolving fields. I am confident that the deliberations during this conference will foster meaningful collaborations and contribute significantly to scientific advancement and technological innovation.

I am particularly happy to note that this Conference is devoted to felicitate Professor Indranil Manna, for his distinguished contributions as a teacher, mentor, researcher, administrator, and a pioneer in this country in the area of Surface Engineering and Additive Manufacturing, the domain that he was principally involved with in the last couple of decades.

I commend the organizing committee for their dedicated efforts in bringing together such a distinguished gathering of experts and wish the conference every success. I also hope that the delegates will find their academic engagement at IIT Kharagpur both enriching and memorable.

With best wishes for a fruitful and inspiring conference.

Suman Chakraborty

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SECT-15

Sustainable Upcycling of Scrap Metal Sheets via Hydroforming with Digital Control and Simulation

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Abstract

The growing generation of scrap metal problems need eco-friendly solutions and hydroforming offers a promising approach to upcycle scrap into high-value, lightweight components. The physical process was simulated in ABAQUS finite element software, wherein sheet deformation, stress distribution and parameter optimization for recycled alloys could be simulated systematically. In this work, simulation results were utilized to optimize pressure profiles and determine the formability and safety limits for different sheet geometries. Furthermore, a specially constructed hydroforming control application have been designed as a part of the present work. This newly developed digital platform supports different features of hydroforming like accuracy, user-specified pressure control (500 - 2000 bar), real-time process triggering, emergency stop capability, simultaneous observation of pressure cycles, etc. In this research study, an attempt has been made to monitor real-time embedded graphing module, matching industrial and monitoring practices, various material recovery and preprocessing procedures such as de-coating, surface cleaning, and thickness calibration, addressed typical contamination and alloy consistency problems. A comparative life cycle assessment is also numerically determined in this present study where the embodied energy savings and greenhouse gas emissions reductions have been compared to virgin feedstock fabrication. An effort has been made in this recent work to combine the ABAQUS simulation and digital control not only to verify the experimental results but also to demonstrate a scalable, data-driven solution for deploying closed-loop circular manufacturing. These synergies further reflect in this proposed study how digital process control and advanced simulation tools can complement the state-of-the-art resource efficient forming technology in favour of industrial-scale upcycling and circular economy goals.

Keywords: Hydroforming, ABAQUS simulation, Scrap metal upcycling, Digital process control, Sustainability.

SECT-16

Dry Sliding Wear Behaviour of AA6061/B_4C–Gr Hybrid Nanocomposites Fabricated via a Combined Stir–Ultrasonic–Squeeze Casting Process

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Abstract

This study presents the fabrication and tribomechanical performance evaluation of AA6061-based hybrid nanocomposites reinforced with boron carbide (B_4C) and graphite (Gr) nanoparticles, produced via a combined stir-ultrasonic-squeeze casting technique. The hybrid fabrication approach was employed to enhance nanoparticle dispersion and interfacial integrity within the aluminium matrix. B_4C content was varied at 0, 2, 3, and 4 wt.%, while Gr content was maintained constant at 2 wt.%. Hardness and dry sliding behaviour were systematically investigated. The results indicate a hardness improvement of 27% for AA6061-(2 wt.% B_4C+2 wt.% Gr), 30% for AA6061-(3 wt.% B_4C+2 wt.% Gr) and 13% for AA6061-(4 wt.% B_4C+2 wt.% Gr) compared to the as-cast AA6061 alloy. Among all compositions, the hybrid nanocomposite containing 2 wt.% B_4C exhibited the lowest coefficient of friction and wear rate, attributable to effective load transfer, grain refinement, and the solid lubricating action of graphite. Conversely, a deterioration in tribological performance was observed at 4 wt.% B_4C, likely due to particle agglomeration and increased third-body abrasion. The findings establish AA6061-(2 wt.% B_4C+2 wt.% Gr) as the optimal reinforcement combination for achieving a favourable balance between mechanical hardness and tribological performance in AA6061 hybrid nanocomposites.

Keywords: Aluminium metal matrix hybrid nanocomposites, AA6061, boron carbide, graphite, hardness; tribological behaviour, stir-ultrasonic-squeeze casting.

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