

SPECIAL ISSUE ON AI-DRIVEN SUSTAINABLE SENSOR MATERIALS, PROCESSES, AND CIRCULAR ECONOMY APPLICATIONS

PREFACE



The rapid convergence of AI, advanced sensor technologies, sustainable materials engineering, and circular economy principles is reshaping the future of manufacturing, environmental monitoring, energy systems, and smart infrastructure. AI-driven approaches are increasingly enabling researchers and engineers to design intelligent materials, optimize manufacturing processes, improve predictive maintenance, enhance resource efficiency, and accelerate the transition toward sustainable and circular industrial ecosystems.



This Special Issue, “AI-driven Sustainable Sensor Materials, Processes, and Circular Economy Applications,” brings together multidisciplinary contributions that demonstrate how data-driven methodologies, intelligent sensing systems, advanced functional materials, and sustainable manufacturing strategies can collectively address emerging technological and environmental challenges. The published papers highlight innovations spanning energy materials, sensor development, smart manufacturing, materials processing, predictive analytics, and sustainable engineering applications.

Several contributions focus on the development and optimization of advanced functional materials for sensing and energy applications. These include investigations on Ni-Fe layered double hydroxide electrodes for efficient water splitting with electrochemical impedance spectroscopy (EIS)-based performance monitoring, thermoelectric materials for low-temperature sensing applications, SnO₂-based thin films and multilayer transparent conductive films for optoelectronic sensors, conductive coatings for graphite-carbon felt composites in flow batteries, and bio-based polymethyl methacrylate (PMMA) composites for sustainable microwave sensor applications.

This issue also showcases significant advances in intelligent manufacturing and process monitoring. AI-assisted approaches are applied to welding defect detection and resistivity validation, real-time property prediction in heat treatment systems through virtual sensor frameworks, optimization of grinding wheel dressing based on acoustic emission signals, and stress-based predictive indicators for springback characterization. These studies demonstrate how machine learning, data-driven modeling, and advanced sensing techniques can improve manufacturing precision, productivity, and resource utilization while minimizing waste generation.

In addition, several papers address sustainable materials processing and characterization. Topics include laser sintering of ceramic coatings on stainless steel substrates, characterization of magnetostrictive behavior under mechanical loading, and the influence of processing parameters on material performance. Collectively, these works provide valuable insights into the integration of advanced sensing technologies with sustainable materials engineering.

A common theme across all contributions is the utilization of intelligent monitoring, predictive analytics, and sustainable material design to support more efficient, resilient, and environmentally responsible engineering systems. By integrating AI-driven decision-making with advanced sensor materials and circular economy concepts, the studies presented in this issue contribute to reducing resource consumption, enhancing system performance, extending product lifecycles, and enabling smarter industrial operations.

We sincerely thank all the authors for their valuable contributions, the reviewers for their rigorous evaluations and constructive feedback, and the editorial team for their dedication and support throughout the publication process. We hope that this Special Issue will serve as a useful reference for researchers, engineers, industry practitioners, and policymakers working at the intersection of AI, sustainable materials, sensor technologies, and circular economy innovations.

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