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Editorial

Emerging directions in thermal physics, materials science, and data-driven modeling

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The articles presented in this issue collectively illustrate the increasingly interdisciplinary character of contemporary physics research, where classical physical principles are being complemented by advanced computational techniques, artificial intelligence, and materials engineering. Although each contribution addresses a distinct scientific problem, together they demonstrate how modern approaches are reshaping the study of thermal phenomena across multiple length scales and application domains.

The issue opens with an investigation of building energy demand and energy systems, highlighting the importance of heat transfer analysis for improving energy efficiency in the built environment. As global efforts continue toward sustainable development and carbon reduction, accurate thermal modeling remains essential for optimizing building performance and supporting evidence-based engineering decisions.

The second contribution explores defect-mediated charge transport in anisotropic two-dimensional semiconductors using machine-learning-assisted modeling. This work exemplifies the growing integration of data-driven methodologies with condensed matter physics, demonstrating how artificial intelligence can accelerate the understanding of complex electronic transport mechanisms while reducing computational cost.

Artificial intelligence also plays a central role in the third article, which presents the application of Physics-Informed Neural Networks (PINNs) to model heat diffusion in anisotropic solids. By embedding governing physical laws directly into neural network architectures, PINNs represent a promising alternative to conventional numerical methods, offering new opportunities for solving complex inverse and forward problems in heat transfer and continuum physics.

The next contribution investigates the thermal stability and fire resistance of vinyl ester resin composites containing various fillers. By examining the influence of filler composition on thermal degradation mechanisms and flame-retardant performance, the study contributes to the development of safer, more durable composite materials capable of operating under demanding thermal conditions. Such investigations highlight the continuing importance of materials engineering in improving both the performance and reliability of advanced structural systems.

The final contribution in this issue presents a comprehensive experimental investigation of β-Ga_2O_3 thin films, focusing on the role of oxygen-vacancy engineering in determining their structural, electrical, and dielectric properties. By combining X-ray diffraction, electron microscopy, X-ray photoelectron spectroscopy, Raman spectroscopy, Hall-effect measurements, temperature-dependent electrical transport, dielectric spectroscopy, and impedance analysis within a unified experimental framework, the study establishes quantitative relationships between defect chemistry and functional material performance. The reported results demonstrate how controlled post-deposition annealing can simultaneously influence crystallographic ordering, carrier mobility, electrical conductivity, dielectric response, and thermally activated transport, providing valuable guidance for the optimization of ultra-wide-bandgap oxide semiconductors intended for next-generation power electronics, ultraviolet optoelectronics, and dielectric devices.

Taken together, the contributions published in this issue highlight several important directions that are shaping contemporary physical research. Advanced numerical simulations continue to deepen our understanding of heat transfer and energy-related processes, while machine learning and physics-informed artificial intelligence are emerging as powerful tools for solving complex problems in computational physics. At the same time, experimental studies on wide-bandgap semiconductors and thermally resistant composite materials demonstrate the continuing importance of defect engineering, advanced characterization techniques, and materials design in developing next-generation electronic and structural systems. Collectively, these studies illustrate how the integration of experimental investigations, computational modeling, and data-driven methodologies is driving innovation across modern physics and materials science.

The Editorial Board hopes that the contributions presented in this issue will encourage further interdisciplinary collaboration among physicists, materials scientists, computational researchers, and engineers. The convergence of physics-based modeling, artificial intelligence, and materials innovation is expected to remain one of the defining directions of scientific progress in the coming years.

Finally, we invite our readers to actively engage with the research presented in this issue. Scientific progress is driven by the careful exchange of ideas, critical discussion, and the appropriate acknowledgment of previous work. We hope that the articles published in Technobius Physics will serve as valuable references for future investigations and contribute to the continued advancement of physics and related disciplines. We also encourage readers to share these contributions within their professional networks, helping to expand their visibility and foster new scientific collaborations.

We sincerely thank all authors for their valuable contributions and the reviewers for their careful evaluations, constructive recommendations, and commitment to maintaining high scientific standards. Their collective efforts ensure the quality and integrity of every issue published by Technobius Physics.

We trust that the research published in this issue will stimulate further scientific discussion, inspire new investigations, and contribute to the continued advancement of thermal physics, condensed matter research, computational modeling, and materials science.

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