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EDITED AND REVIEWED BY
Lei Zhu,
Case Western Reserve University,
United States

*CORRESPONDENCE
Peng Wang,
wang.peng.ncepu@foxmail.com

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Editorial: Advanced technologies for electrical engineering - volume II

Zinan Wang[1], Junwei Zha[2], Peng Wang[1,2,3]*, Qing Xie[4,5] and Donghong Yu[6]

[1]School of Energy, Power and Mechanical Engineering, North China Electric Power University, Baoding, China, [2]School of Chemistry and Biological Engineering, University of Science and Technology Beijing, Beijing, China, [3]Hebei Key Laboratory of Electric Machinery Health Maintenance & Failure Prevention, North China Electric Power University, Baoding, China, [4]State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, North China Electric Power University, Beijing, China, [5]Department of Electrical Engineering, North China Electric Power University, Baoding, China, [6]Department of Chemistry and Bioscience and the Faculty of Engineering and Science, Aalborg University, Aalborg, Denmark

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Editorial on the Research Topic
Advanced technologies for electrical engineering - volume II

Introduction

The rapid evolution of modern electrical systems demands continuous innovation in material science, driven by the need for higher efficiency, sustainability, and adaptability. Advanced electrical materials—engineered through novel synthesis methods, computational modeling, and multifunctional design—are redefining the boundaries of energy storage, electronic manufacturing, infrastructure safety, and environmental resilience. These materials exhibit tailored properties that address critical challenges in electrical engineering, enabling breakthroughs in superconducting technologies, corrosion mitigation, precision microelectronics, and fire-safe composites. By integrating structural and functional complexity at micro- and nanoscales, advanced electrical materials empower unprecedented control over electrical, thermal, and mechanical behaviors, paving the way for next-generation applications.

This Research Topic highlights interdisciplinary studies that bridge theoretical insights, computational simulations, and experimental validations to optimize material performance and address real-world challenges. From superconducting magnets for renewable energy grids to trenchless corrosion diagnostics and flame-retardant polymers, the contributions herein demonstrate how tailored material architectures can enhance reliability, safety, and efficiency across diverse domains.

Key advances in advanced electrical materials

Cong et al. explore the design of high-temperature superconducting (HTS) solenoid magnets using finite element methods. By simplifying pancake coil models into bulk-like conductors, the authors significantly reduced computational complexity while maintaining accuracy. Their simulations revealed that trapezoidal cross-section solenoids exhibit superior critical current density (22.4% higher than rectangular designs) and uniform magnetic flux distribution, minimizing overheating risks. This work provides a blueprint for developing efficient superconducting energy storage systems, crucial for renewable energy grids.

Wang et al. propose a novel corrosion assessment method integrating thermal stability, power frequency, and impulse characteristics. By employing fuzzy evaluation models and finite element simulations, the authors established a corrosion index C to predict residual lifespan. Their results showed that impulse characteristics are critical for accurate diagnosis—ignoring them could lead to a 30% overestimation of safety in high-resistivity soils. This approach enables non-destructive trenchless detection, enhancing the reliability of power transmission systems.

Zou et al. investigate the impact of viscosity on droplet deposition in electronic packaging. Through computational fluid dynamics and experimental validation, they demonstrated that high-viscosity adhesives require optimized dispensing times (0.07–0.08 s) and slower needle retraction speeds (1 mm/s) to avoid tailing defects. Post-optimization, droplet diameter variability decreased by 15%, and shear strength improved by 30%, offering a pathway for high-precision microelectronic assembly.

Hu et al. synthesize melamine-formaldehyde microencapsulated piperazine pyrophosphate (MFPAPP) to improve the fire resistance of thermoplastic polyurethane (TPU). With 30 wt% MFPAPP loading, the composite achieved a limiting oxygen index (LOI) of 38.8% and a V-0 UL-94 rating. Remarkably, the char residue at 800°C increased by 89% compared to pure TPU, while peak heat release rate (PHRR) and total smoke production decreased by 53% and 47%, respectively. The microencapsulation strategy also enhanced water resistance, maintaining a V-0 rating after 20 days of immersion.

These studies exemplify the interdisciplinary nature of advanced electrical materials research. From optimizing superconducting coils through computational models to developing smart corrosion diagnostics and precision manufacturing techniques, each contribution addresses real-world challenges with innovative solutions. Future work should focus on scaling these technologies for industrial applications, integrating machine learning for predictive maintenance, and exploring eco-friendly material alternatives.

Author contributions

ZW: Writing–original draft. JZ: Methodology, Writing–review and editing. PW: Resources, Writing–review and editing. QX: Resources, Writing–review and editing. DY: Validation, Writing–review and editing.

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