

PROCEEDINGS

Preparation, Characterization, and Thermal Management Applications of High-Thermal-Performance Hydrogel Composites

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ABSTRACT

To address the limitations of conventional hydrogels, such as poor thermal stability and low thermal conductivity, we designed and prepared a high-thermal-performance hydrogel composite. The composite was prepared via impregnation using carbon fiber felt as a three-dimensional scaffold and polyvinyl alcohol as the polymer matrix. Boron nitride nanosheets were incorporated as fillers to construct a three-dimensional thermally conductive network, improving heat conduction within the hydrogel. Thermal characterization and experimental results demonstrate that the hydrogel composite achieves a high phase-change latent heat of phase change of 284.65 J/g and a significantly enhanced thermal conductivity of 0.66 W/(m·K). In practical thermal management evaluations, the composite exhibits excellent heat absorption, energy storage, and heat transfer capabilities. It not only effectively suppresses temperature rise and maintains a low-temperature environment for extended periods in cold-chain transportation but can also be applied to the thermal management systems of individual lithium-ion cells and multicell battery packs based on the thermal cloak principle, significantly delaying and inhibiting the propagation of thermal runaway. This study provides experimental evidence for the design of novel high-thermal-conductivity phase-change materials and their use in advanced thermal management applications.

KEYWORDS

Hydrogel composites; thermal management; phase change; boron nitride nanosheets; thermal runaway

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