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Significantly enhanced high-temperature energy storage capacity for polyetherimide-based nanocomposites via energy level modulation and electrostatic crosslinking

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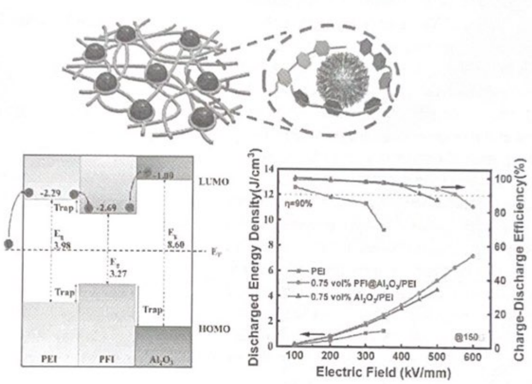
HIGHLIGHTS

- ●The dual interface layer reduces leakage current and suppresses conductive losses.
- ●The dual interface layer enhances the dielectric constant of the composite material.
- ●The electrostatic cross-linking improves the composite's breakdown strength.
- ●The synergistic effect enhances the composite's energy storage performance.

GRAPHICAL ABSTRACT



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ABSTRACT

In the field of electrostatic energy storage, polymers exhibit notable advantages, including high breakdown strength (E_b) and fast charge/discharge rates. However, at elevated temperatures, their discharge energy density (U_d) decreases due to reduced E_b and increased electrical conductivity losses. We herein integrate fluoro-functionalized polyimide (PFI) shell-modified Al_2O_3 nanoparticles (PFI@Al_2O_3) with polyetherimide (PEI) to form a trap-rich electrostatic crosslinked network. By energy level modulation and electrostatic crosslinking, the PFI layer enables to capture charges and acts as crosslinking sites, while the wide-bandgap Al_2O_3 introduces energy barriers that inhibit charge injection and migration. This sophisticated dual-interface design enhances E_b and facilitates dual capture of electrons and holes, thus effectively reducing leakage current and conduction losses. Surprisingly, the composites prepared using this method exhibit an energy density of 7.24 J/cm^3 at 150 °C, with a charging-discharging efficiency of 83.58 %. Moreover, it maintains stability even after 10^5

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