

2026 HBCU CHIPS Network Conference

Contribution ID: 13

Type: ORAL

Multi-layered Porous PVDF 2D Heterostructure Nanofillers as High-Density Capacitive Energy Storage

Thursday, April 2, 2026 1:05 PM (20 minutes)

The increasing demand for high-performance energy storage devices has intensified interest in dielectric polymers for electrostatic capacitive applications due to their high-power density and compatibility with thin-film architectures. Among these materials, poly(vinylidene fluoride) (PVDF) is particularly attractive because of its high dielectric constant, low cost, mechanical flexibility, and biocompatibility. The piezoelectric response of PVDF originates from its electroactive β -phase; however, its output performance remains inherently limited. Recent studies have demonstrated that introducing controlled porosity into polymer thin films can substantially enhance their dielectric and piezoelectric properties.

In this work, we systematically investigate the dielectric behavior, electric polarization, and energy density of PVDF, Porous PVDF, PVDF/MoO₃ nanocomposite capacitors. Exfoliated two-dimensional MoO₃ nanofillers are incorporated as interfacial layers within multilayer PVDF thin films, forming capacitor heterostructures with configurations of PVDF/MoO₃/PVDF (PMP) and Po-PVDF/MoO₃/Po-PVDF (Po-PMP). Porous PVDF films are fabricated via nonsolvent induced phase separation (NIPS), producing polymer-rich and polymer-poor domains that yield a well-defined porous morphology. The synergistic effects of porosity and interfacial MoO₃ nanolayers lead to enhanced dielectric polarization and improved energy storage performance, highlighting the potential of porous PVDF-based heterostructures for advanced capacitive energy storage applications.

Academic or Professional Status

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Session Classification: Technical Session 3

Track Classification: Power Microelectronics