Optimizing $BaTiO_3$ Content in Flexible PVDF Films for Enhanced Piezoelectric Nanogenerator Performance

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ABSTRACT

This study addresses the underutilization potential of harvesting mechanical energy from routine human activities, while also addressing environmental and flexibility concerns associated with conventional lead-based piezoelectric materials. With increasing demand for sustainable and eco-friendly energy solutions, lead-free piezoelectric technologies have emerged as a promising alternative, particularly in the development of flexible nanogenerators. In this study, the flexible PVDF/$BaTiO_3$ composite films fabricated via drop casting with variation of $BaTiO_3$ filler loadings (1 wt%, 3 wt%, and 5 wt%) were analyzed for their influence on piezoelectric performance. Characterization techniques included contact angle, FESEM, XRD, FTIR, and piezoelectric output. Results showed that 1 wt% $BaTiO_3$ yielded the highest output voltage (8.24 V), attributed to optimal β-phase formation. However, loadings beyond 3 wt% led to void formation and particle agglomeration, reducing β-phase crystallinity and overall performance. The findings demonstrate that controlled $BaTiO_3$ loading enhances energy harvesting efficiency while promoting environmental safety and device flexibility.

Keywords: *Lead-free piezoelectric, PVDF,* β-phase formation*, $BaTiO_3$, Flexible nanogenerator*