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Surface modified barium titanate for optimal dielectric properties in polymer-ceramic nanocomposite films

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High permittivity polymer-ceramic nanocomposite dielectric films leverage the ease of flexibility and processing of polymers and functional properties of ceramic fillers. Thus, they could be applied to advanced embedded energy storage devices for printed wired electrical boards. The incompatibility of the two constituent materials, hydrophilic ceramic filler and hydrophobic epoxy limits the filler concentration and therefore, dielectric properties of these materials. Use of surfactants and core-shell processing of composite fillers is traditionally used to achieve electrostatic and steric stabilization for adequate ceramic particle distribution. This work aims to understand the role of surfactant concentration in establishing meaningful interfacial layers between the epoxy and ceramic filler particles by observing particle surface morphology, dielectric permittivity and device dissipation factors. A comprehensive study of nanocomposites that were comprised of non-treated and surface treated barium titanate (BT) embedded within an epoxy matrix was performed. The surface treatments were performed with ethanol and 3-glycidyloxypropyltrimethoxysilan, where the best distribution, highest value of permittivity (~48.03) and the lowest value of loss (~0.136) were observed for the samples that were fabricated using 0.5 volume fraction of BaTiO3 and 0.02 volume fraction of silane coupling agent.

Recent Publications

1. S Banerjee, K A Cook-Chennault, W Du, U Sundar, H Halim, et al. (2016) Piezoelectric and dielectric characterization of corona and contact poled PZT-epoxy-MWCNT bulk composites. Smart Materials and Structures 25(11).
2. U Sundar, K A Cook-Chennault, S Banerjee and E Refour (2016) Dielectric and piezoelectric properties of percolative three-phase piezoelectric polymer composites. Journal of Vacuum Science & Technology B 34.
3. S Banerjee, W Du, L Wang, and K A Cook-Chennault (2013) Fabrication of dome-shaped PZT-epoxy actuator using modified solvent and spin coating technique. Journal of Electroceramics 31:148–158.
4. S Banerjee, J Torres, and K A Cook-Chennault (2015) Piezoelectric and dielectric properties of PZT-cement-aluminum nano-composites. Ceramics International 41:819–833.
5. K A Cook-Chennault, N Thambi, and A M Sastry (2008) Powering MEMS portable devices - a review of non-regenerative and regenerative power supply systems with special emphasis on piezoelectric energy harvesting systems. Smart Materials and Structures 17(4).

Biography

Kimberly Cook-Chennault is an Associate Professor in the Mechanical and Aerospace Engineering Department at Rutgers University. She holds BS and MS Degrees in Mechanical Engineering from the University of Michigan and Stanford University, respectively; and a PhD from the University of Michigan, Ann Arbor. Her research interests include design of integrated hybrid energy systems and investigation of the structure-property relationships in ferroelectric, dielectric and piezoelectric materials in the form of thin films and bulk composites for sensing/actuation and energy storage/harvesting applications. Her research group, the Hybrid Energy Systems and Materials Laboratory, conducts work towards understanding the fundamental mechanisms and processing parameters that allow for the control of physical material characteristics. In addition to this work, she is the Director of the Green Energy Technology Undergraduate Program (GET UP) Program which is funded by the National Science Foundation.

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