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Solution-Processible Thin Film Transistors Using Surface-modified BaTiO3/Polymer Nanocomposites as Gate Insulators

PHILSEOK KIM, Georgia Institute of Technology, XIAOHONG ZHANG, PETER HOTCHKISS, BENOIT DOMERQ, SIMON JONES, SETH MARDER, BERNARD KIPPELEN, JOSEPH PERRY — Polymer/ceramic nanocomposites (NC) can exhibit high k and easily processible materials suitable for gate insulators in organic field-effect transistors (OFET). To obtain high k NCs, high volume fractions (>30 %) of dielectric nanoparticles (NP) are needed. However, due to NP agglomeration at such high volume fractions, poor quality films with high leakage current are obtained. Recently, we have reported that phosphonic acids can strongly bind to $BaTiO_3$ (BT) NPs and provide enhanced dispersability of NPs in polymer hosts allowing increased volume loading. We report the use of phosphonic acid-modified BT NPs (30∼50 nm) in poly(4-vinyl phenol) (PVP, k = 3.9) as gate insulators in OFET, which can be readily processed to high quality thin films by simple solution techniques. BT NPs modified with a phosphonic acid bearing a hydrophilic group afforded high quality NC thin films at high loading (up to 75 wt. %) in PVP. Bottom-gate pentacene OFET devices were fabricated on the NC gate insulators. The improved film quality and increased capacitance density (∼50 nF/cm^2, k ∼14) were reflected in a low threshold voltage (∼1.1 V), a high on/off ratio (∼2x10^5) and ∼10^5 fold decrease in leakage current as compared to that of unmodified BT.

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