**TITLE: High dielectric constant of polymer-inorganic nanocomposites as gate dielectrics for organic thin film transistor applications**

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## ABSTRACT

Organic thin film transistors (OTFTs) based on pentacene and hydroxyl-containing polyimide-zirconium dioxide (PI-$ZrO_2$) hybrid films were fabricated on silicon substrate in which the PI and $ZrO_2$ were as the semiconductor and the gate dielectrics, respectively. Zirconium butoxide ($Zr(OBu)_4$) was used as the precursor to synthesize nano-sized $ZrO_2$ colloid through the hydrolysis and condensation reaction in a sol-gel process. Then, PI-$ZrO_2$ hybrid solution was synthesized from a condensation reaction between hydroxyl-containing $ZrO_2$ and polyimide, followed by a spin coating to form the PI-$ZrO_2$ dielectric composites. Cyclic olefin copolymer (COC) was used as a modify layer to enhance the interface property between the semiconductor and the dielectric layer. In addition, PffBT4T-2OD was replaced by pentacene as semiconductor to expect a good performance on device. The thermal, optical, surface, dielectric, and electrical properties of the PI-$ZrO_2$ dielectric composites were investigated and correlated to $ZrO_2$ content due to the dispersion and aggregation behaviors of the nanoparticles. The PI-$ZrO_2$ hybrid dielectrics showed the tunable insulating properties, including high dielectric constants, high capacitances, and low leakage current densities. Besides, the bottom-gate top-contact OTFTs based on the PI-$ZrO_2$ hybrid dielectrics PZ30% and PZ30%-COC showed the best performance with the near zero threshold voltage and the field-effect mobility (μ) about 1.12 $cm^2V^{-1}s^{-1}$ and 3.25 $cm^2V^{-1}s^{-1}$ and the current on/off ratio ($I_{on}/I_{off}$) about $1.2x10^4$ and $1.2x10^6$, respectively. Based on the above results, PI-$ZrO_2$ hybrid dielectrics were synthesized and the OTFTs based on the PI-ZrO2 hybrid dielectrics and pentacene were fabricated successfully. The best performance for OTFTs was obtained when the ZrO2 content in hybrid films was 30%.

**Keywords**: polyimide, Zirconia, hybrid thin film, sol-gel method, modify layer