The Effect of Poly(4-vinylphenol-co-methyl methacrylate)/Titanium Dioxide Nanocomposite Gate Insulator in Solution-Processed 6, 13-Bis(triisopropylsilyethynyl)-Pentacene Thin-Film Transistors

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Organic thin-film transistors (OTFTs) are attracting considerable attention, from both academic and commercial sectors, because of their potential for low-cost manufacture and compatibility with glass or plastic substrates. Over recent years, the performance of OTFTs (e.g. field-effect mobility, threshold voltage, and subthreshold swing) has significantly improved. Some devices currently possess superior characteristics to those of amorphous silicon transistors [1–3]. In the case of gate insulators, polymeric materials are evident candidates for solution-processed organic TFTs because these also facilitate large-area and low-temperature processes. Nevertheless, there is a critical paucity of research on polymeric insulator, probably owing to the complexity of processing polymeric insulators with soluble organic semiconductors. It should be emphasized, however, that the chemical resistance of polymeric insulator against the chemical solvent of organic semiconductors would engender their compatibility during device fabrication. Moreover, high-dielectric-constant(high-k) polymers are very favorable for low-voltage operation of these TFTs. Accordingly, Nanocomposite insulators consisting of chemically cross-linkable polymers and high-k nanoparticles are promising materials for solution-processed organic TFTs. It must be noted that minimizing insulator thickness is a challenge owing to pinhole defects, although it also allows the dielectric capacitance to increase.

In this study, we investigated the effect of poly(4-vinylphenol-co-methyl methacrylate)/Titanium dioxide (TiO_2) Nanocomposite gate insulators in 6,13-bis(triisopropylsilylethynyl) Pentacene (TIPS-Pentacene) Thin Film Transistors(TFT). The capacitors were fabricated to analyzed the Nanocomposite insulator characteristic, and the capacitance was measured. The measurement results showed that the capacitance increased with increasing content of high-dielectric-constant TiO_2 nanoparticles. Nevertheless, TiO_2 nanoparticle aggregates were invariably produced in the insulator at higher TiO_2 content. TiO_2 nanoparticle aggregates augmented the gate leakage current during device operation, while the rough surface of the Nanocomposite insulator obstructed charge transport in the conducting channel of TIPS-Pentacene TFT. These results suggest that the surface morphology characteristics of Nanocomposite insulator influenced their dielectric properties and TFT performance. The Naocomposite insulator were also studied upon TiO_2 content change of the Naocomposite insulator. These results will be presented.

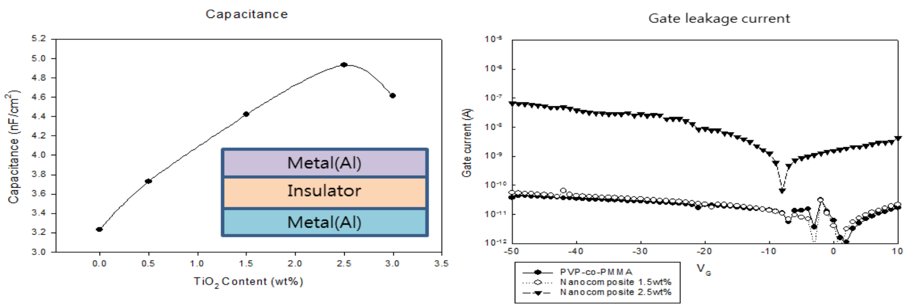

Fig. 1. Capacitance of Nanocomposite insulator and Gate leakage current

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