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Title :
Enhancement of Dielectric Properties of Pmma:TiO_2 Nanocomposite for Organic Field Effect Transistors

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In this thesis, a composite between poly (methyl methacrylate) (PMMA) with titanium dioxide (TiO_2) films were synthesized, fabricated and characterized using sol-gel spin coating technique. The dielectric, electrical and physical properties of PMMA:TiO_2 nanocomposite films was were investigated, to be used as the dielectric layer in the metal-insulator-semiconductor (MIS) device and organic field effect transistors (OFET) application. The goal of this study is to enhance the dielectric properties of PMMA with the influence of TiO_2nanopowder (high-*k*) material in the PMMA. Another goal is to overcome the leakage current (tunnelling current) and high operating voltage in MIS and OFET devices. PMMA:TiO_2 nanocomposite dielectric films deposition parameters were optimized resulting in good dielectric, electrical and physical properties. Results from the parameter optimization showed that the dielectric properties of PMMA:TiO_2 nanocomposite film, which is focusing on the real permittivity, ε', imaginary permittivity, ε'' and capacitance were improved. The real permittivity, ε' of PMMA:TiO_2 nanocomposite film was 12 and 10 measured at 1 kHz and 1MHz, respectively. These valuesare higher than pure PMMA film which was 4.6 and 2.9, respectively measured at the same frequency. The capacitance value for PMMA:TiO_2 nanocomposite film increased drastically from 296 pF/cm^2 (for pure PMMA) to 457 nF/cm^2. The leakage current density for PMMA:TiO_2 nanocomposite film was ~ 10^{-8} A/cm^2 under small electric field of 0.25 MV/cm is due to the addition of TiO_2 nanoparticles. Metal-insulator-semiconductor (MIS) structure was used to investigate the compatibility of PMMA:TiO_2 nanocomposite film to be used as dielectric layer with ZnO and P3HT semiconductor layers. The capacitance-voltage (*C-V*) characteristics indicated that density of interface of trapped charge was found to be 9 x 10^9 $eV^{-1}cm^{-2}$. In addition, the MIS exhibited leakage current of 10^{-6} A/cm^2 at 1V and relatively high breakdown voltage (2.05MV/cm). Small hysteresis was observed in *C-V* and *I-V* characteristics which were associated with ion drift and polarisation of the PMMA:TiO_2 nanocomposite dielectric film. Finally, OFET devices with PMMA:TiO_2 nanocomposite as gate dielectric were demonstrated. The OFET performance proved that PMMA:TiO_2 nanocomposite dielectric films were compatible with organic and inorganic semiconductors. Low threshold voltage, V_{TH} was obtained for n-type and p-type OFET was around 2 V and -3 V respectively, due to the increment in the ε' and capacitance value of the PMMA:TiO_2nanocomposite dielectric film. The fabricated OFET using PMMA:TiO_2 as dielectric layer showed almost comparable characteristics reported by other researcher.