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High mobility bottom-contact top-gate organic field effect transistors: Device fabrication and simulation

Organic field effect transistors (OFET's) have been fabricated based on hybrid materials such as polymeric nanocomposites. Organic/inorganic materials, polyvinyl alcohol (PVA) embedded with titania nanoparticles (NP's), are used as gate dielectric. PVA was cross-linked with ammonium dichromate (PVAad) for better immunity against moisture. The cross-linking occurred under ozone treatment/ultraviolet (UV) irradiation. Metal-insulator-semiconductor (MIS) structures were fabricated based on Gold (Au)/PVA+TiO₂ad/Fluorine doped tin oxide (FTO) prior to FET fabrication. Rutile phase of TiO₂ NP's was prepared using the solvothermal method and embedded into the polymer matrix to enhance the dielectric constant of the host matrix. The composite films of PVA crossed linked with ammonium dichromate (PVAad)+TiO₂ were deposited using spin-coating technique and irradiated to UV light and then the gold was thermally evaporated on top of the films through a shadow mask. Prior to the deposition of copper phthalocyanine (CuP_{cc}) as an active layer, the devices were treated with a self-assembled monolayer (SAM) of octadecyltrichlorosilane (OTS). The electrical features such as output and transfer characteristics of the untreated and treated FET's with OTS were measured using a semiconductor parameter analyzer. The device treated with a SAM of OTS illustrated higher saturation mobility (μ_{sat}), the on-off current ratio (ION/IOFF), and lower threshold voltage (V_{Th}) than the device without a SAM of OTS treatment. Additionally, the simulation was performed to elucidate the growth mechanism of gate layer on FTO substrates and its contribution to the enhancement in the electrical properties of the fabricated device in terms of high mobility (fast operation) and low current leakage (low power consumption)/sub-threshold voltage.

Biography

Davoud Dastan is a research associate at Georgia Institute of Technology. Prior to his appointment at George Tech., he was a post-doc. fellow at Cornell University, Ithaca, New York, USA. His research area includes polymeric nanocomposites, nanostructured materials, photoresists, hybrid materials, organic/inorganic nanocomposites, photocatalysis, solar cells, field effect transistors, surface chemistry and nano-sized ionic materials (NIM's), metal-insulator-semiconductor structures, thin films, nanoparticles, synthesis and characterization of various materials etc. He has published more than 20 papers in reputed journals and has been serving as an editorial board member of repute.

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