Electrical Properties of Bottom-Contact Organic Thin-Film-Transistors with Double Polymer Gate Dielectric Layers

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Abstract : We fabricated a pentacene thin-film transistor with a Polymer/SiO_2 Double Gate Dielectrics and obtained a device with better electrical characteristics. This device was found to have a field-effect mobility of 0.04cm^2/Vs, a threshold voltage of -2V, an subthreshold slope of 1.3 V/decade, and an on/off current ratio of 10^7.

1. Introduction

Poly-vinylalcohol(PVA) can be a good candidate as a gate insulator because it has many merits such as a pentacene suface alignment effect by rubbing process, enabling lift-off process, high dielectric constant and spin coating process[1]. In spite of its merits, PVA has a fundamental molecular structure as a gate insulator, i.e it easily absorbs moisture due to the hydroxyl radical (-OH) even after baking. So in this study, it is considered to using double insulator[2].

2. Experiment

All our devices were fabricated on glass substrates, which was the staggered-inverted structure, the 100 nm-thick indium-tin-oxide (ITO) as a gate electrode was sputtered and the 0.2 ㎛-thick SiO_2 as gate insulator was deposited by plasma enhanced chemical vapor deposition (PECVD). To improve the quality of the organic semiconductor/dielectric interface, PVA(Poly Vinyl Alchol) film as adhesion layer was spin-coated from the PVA/Diwater solution on the SiO_2 for 1wt%, 3wt%, 5wt%, respectively. A 60nm thick pentacene active layer (Aldrich, without purification) was pattern deposited through a shadow mask onto both dielectrics at a rate of 0.3Å/sec by thermal evaporation at 5×10^{-7} torr. The drain and the source contacts were formed after thermal evaporation of pentacene through a shadow mask to form 60nm thick gold (Au). The fabricated OTFT has a channel length of 50μm and width of 1.25mm (W/L=25).

3. Results and Discussion

We fabricated bottom-contact transistor structures. The leakage current density was about 4.6×10^{-9} A/cm^2 at 1.5 MV/cm. The pentacene OTFTs show the typical p-type characteristics and good saturation behavior. We have performed an experimental and theoretical investigation of the grain size and the energy barrier dependence of the OTFTs electrical characteristics. The OTFT with bottom-contact configuration showed the typical accumulation enhancement mode and the transfer characteristic curve. We have obtained a mobility value of about 0.04 cm^2/Vs as saturation mobility. The on-off current ratio ($I_{on/off}$) is about 10^7 in a gate voltage sweep between 20 and -40 V while the drain voltage set at -30 V.

4. Acknowledgements

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