Investigation of Spin-on Organic Thin Film Transistor

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Abstract

Recently, with the development of organic semiconductor materials, Organic Thin Film Transistors(OTFTs) have been widely investigated for low-cost, low-temperature and flexible display devices. In this thesis, we chose poly-3-hexylthiophene or P3HT as the active layer, SiO_2 as the gate insulator, and deposited the organic thin film by spin coating process, organic thin film transistors have been successfully fabricated with "bottom contact" structure.

First, we studied the possibility of low-temperature process. We deposited SiO_2 as gate insulator by Plasma-Enhanced Chemical Vapor Deposition(PECVD) and Liquid-Phase Deposition(LPD). The advantages of LPD process include low-temperature, large coverage area, and low-cost. The performance of OTFT with LPD SiO_2 as gate insulator is comparable with that with PECVD SiO_2 except for the gate leakage current. To ameliorate the gate leakage current, we demonstrated a stacked structure which additional SiO_2 was deposited by Selective LPD(S-LPD) as an isolation layer under source and drain electrodes. The gate leakage current was successfully reduced about one order, but the ON-current was reduced about half due

to extra channel length.

Next we studied how various plasma treatments on gate insulator affected device performance. We tried O_2 plasma, N_2O plasma, and NH_3 plasma to remove residual contaminant on gate insulator, improving the performance of devices. With various plasma treatment time, we found that field-effect mobility and threshold voltage showed irregular variation with plasma exposure time, obviously shown with on current. In our experiment of plasma treatment, we also obtained the optimal condition according to various plasma sources and exposure time. Compared with devices with HMDS treatment, both mobility and threshold voltage of devices with plasma treatment have been improved.