Photosensitive-Polymer Insulators for Organic Thin-Film Transistors

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Organic thin-film transistors (OTFTs) have been extensively studied for organic electronics such as smart cards, identification (ID) tags, sensors and active-matrix flat panel displays. They can offer the advantages of lightweight, low cost and low-temperature process as compared with amorphous silicon (a-Si) and polycrystalline silicon TFTs. OTFTs fabricated with p-type semiconductor (usually pentacene) have reached mobilities of above 1 cm^2/Vs and Ion/off ratio of 10^6, which is close to those of amorphous silicon TFTs.

Polymer materials such as polyimide (PI), poly(vinyl phenol) (PVP), poly(vinyl alcohol) (PVA) and parylene, poly(methyl methacrylate) (PMMA) are used as gate insulators for OTFTs because of their simplicity and reliabilities in handling. However, these polymers do not chemical stability, which do undergo dissolution when brought into contact with various organic solvents such as PR developers and metal etchant. Moreover they result in non-patternable polymer films so that they severely limit the fabrication and application of OTFTs.

In this study, we have synthesized photosensitive polymers as a gate insulator and explored their physical and chemical properties. They exhibit good adhesion to various substrates. By AFM, the surface of the films appears almost completely unstructured. These films possess the rms roughness of about 1nm. Photo-crosslinking reaction was initiated using a high-pressure mercury lamp (at 366 nm). The fabricated polymer films are insoluble to common organic solvents and alkaline solution. The photosensitive polymers provide chemical and physical properties necessary to obtain proper electrical properties of OTFTs. Typical electrical properties of photo-crosslinked polymer films (KP-1) are given in Fig.1. Figure 2 shows optical images of photosensitive polymer (KP-1) after lithography.

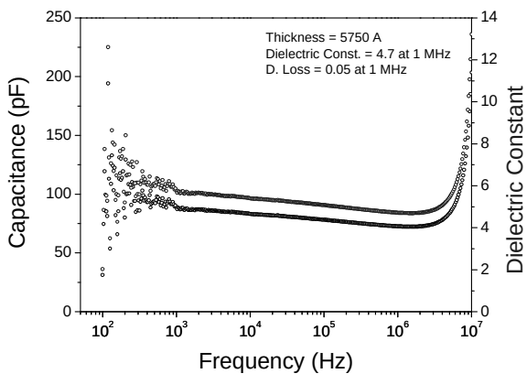

Fig.1 (a) Leakage current density-voltage (J-V) profile of photosensitive polymer (KP-1). This measurement is examined at room temperature.

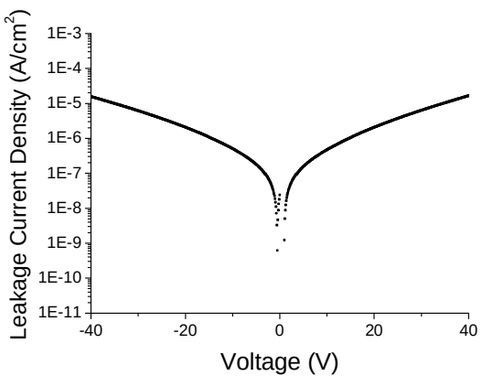

Fig.1 (b) Capacitance-frequency (C-F) profile of photosensitive polymer (KP-1).

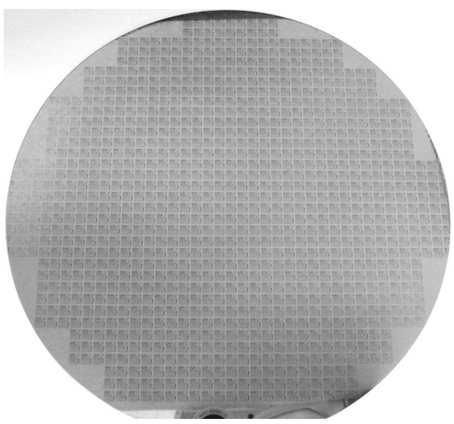

Fig.2 Optical image of photosensitive polymer (KP-1).