Fabrication of Organic TFT Array using Ink-jet Printing and Laser Processing

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In recent years, printed electronics have attracted much attention because of their potential for low cost, low environmental impact and large area fabrication. Various electronic devices including organic thin-film transistors(OTFTs) [1-3], RF-ID tags [4], printed circuits [5], sensors [6], displays [7-10] have been reported using some of printing methods like ink-jet printing, screen printing, offset printing and others. Ink-jet printing method has advantages of on-demand process, non-contact printing process and its scalability. However, typical resolution using a conventional ink-jet printing method is limited around 50 µm. Therefore various methods have been proposed to improve resolution of printing using bank structures [2], self-assembled monolayer [11] and laser irradiation during ink-jet printing [12].

In previous work, we have developed a surface energy controlled ink-jet printing technique with UV irradiation on a novel polyimide for high-resolution electrode patterning [13-14]. We fabricated a 300ppi all-printed OTFT array on plastic substrate, which have pixel circuit with a single transistor and a storage capacitor (1T1C).

In this work, we have developed a new fabrication process of printed OTFT array using a surface energy controlled ink-jet printing and laser processing. Figure1 shows a 150 ppi printed OTFT array which have pixel circuit with two transistors and one storage capacitor (2T1C), and Figure2 shows a cross sectional view of the OTFT array. The gate electrodes of both two transistors were fabricated using Ag nanoparticles ink by the surface energy controlled ink-jet printing technique. The gate insulator was a novel polyimide film fabricated by spin coating. Via hole was made by selective removal of the polyimide film using an excimer laser, and diameter of via hole was about 20 µm. The source/drain (S/D) electrodes of both two transistors consist of Ag were also fabricated by surface energy controlled ink-jet printing method, and during this step, the drain electrodes of the switching transistor (Tsw) was electrically connected to the gate electrode of the driving transistor (Tdr) through via hole. A minimum width of the source electrode was 15 µm, channel length was 5 µm. After fabrication of the S/D electrodes, small-molecule OSC was fabricated by conventional ink-jet printing under ambient conditions. All of these layers were fabricated under ambient conditions, and maximum process temperature was 180°C. A field-effect mobility of both transistors were over 0.1 cm^2/Vs respectively, which was almost the same value as those of the 300 ppi all-printed OTFT which have pixel circuit with 1T1C.

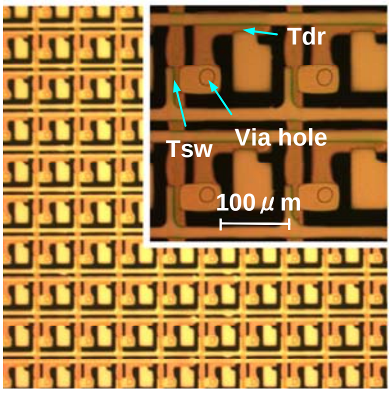

Fig.1. Optical micrograph of a 150 ppi printed OTFT array which have pixel circuit with 2T1C (after S/D electrode fabrication).

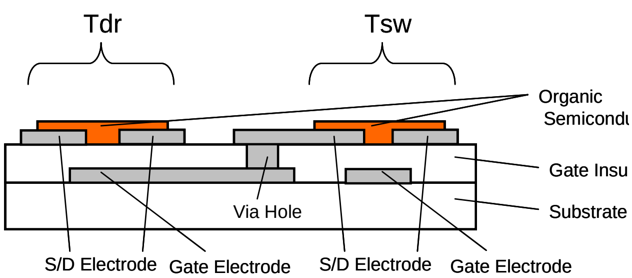

Fig.2 Schematic cross-section of a printed OTFT array.

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