Fabrication of Ag-paste Source/Drain Electrodes in OTFTs using Micro-contact printing

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Abstract

We used micro-contact printing for source and drain electrodes of OTFTs. The proper solvent of Ag paste and baking temperature were extracted for PVP gate dielectric and pentacene semiconductor. The mobility was 0.025 cm2/V.sec and on/off ratio was 2x10^5.

1. Introduction

Recently, micro-contact printing has been used for Au S/D electrodes of OTFTs by using SAM on Au electrode stamped by PDMS stamp and the subsequently etching the un-SAMed Au area [1-2]. The other technique was to deposit SAM on substrate with PDMS stamp and evaporate Au and then lift-off SAM/Au layer [3-6]. These methods are characterized by the ability of nano-sized channel length fabrication but they are complicate and non-soluble processes which are essential for low cost fabrication.

The purpose of this paper is to develop a simple and soluble process by using micro-contact printing for S/D electrodes of OTFTs. We fabricated Ag-paste S/D electrodes using micro-contact printing. Though we can't fabricate OTFT which has nano-size channel length, we removed evaporation, etching and lift-off process for fabrication of S/D electrodes in OTFTs. Al is used for gate electrode, Micro-contact printed Ag-paste is used for S/D electrodes. We also used poly-4vinylphenol (PVP) for gate insulator and pentacene for active layer.

2. Experimental

The fabrication process is depicted in Fig1.2. The negative photoresist (THB151N) was spin-coated on a clean glass substrate to fabricate a master of PDMS stamp. The HMDS was coated on the master to make hydrophobic surface for peeling-off of PDMS stamp. The solution mixed with VDT-731 and HDT-301 (Gelest Int.) was poured on the master and cured for a hard PDMS stamp

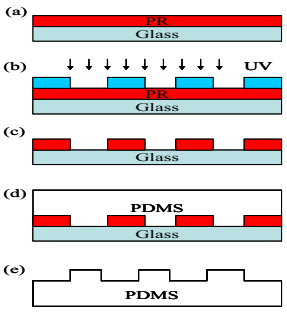

Fig1. The fabrication process of a hard PDMS stamp

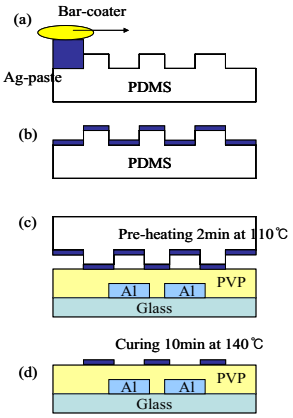

Fig2. The fabrication process of Ag-paste S/D electrodes

Al was evaporated on a clean glass for gate

electrode with the thickness of 1000 Å. The poly-4-vinylphenol (PVP), which was mixed by propylene glycol monomethyl ether acetate (PGMEA) and cross-linking agent of poly (melamine-co-formaldehyde), was spin-coated on gate electrodes for gate insulator. The PVP copolymer was spin-coated with 1000rpm for 30sec and then cured for 20min at 200℃.

Ag paste mixed by Isopropyl Alcohol (IPA) was stamped on PVP insulator by the hard PDMS stamp with 40g pressure for 2min at 110℃ for pre-heating and cured for 10min at 140℃ for S/D electrodes as shown in Fig3. Lastly, pentacene was evaporated with the thickness of 450 Å. The devices were analyzed by Kithley SCS4200 in dark atmosphere.

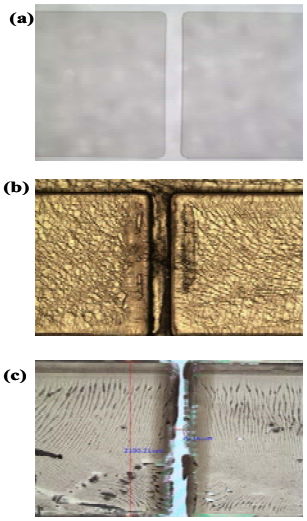

Fig3. The microscope picture of (a)master, (b) PDMS stamp coated by Au, (C) the printed S/D electrodes.

3. Results and discussion

The sheet resistance was varied by curing temperature and time as shown in Fig.4. The sheet resistance was drastically reduced from 233 MΩ/□ to 0.44 Ω/□. The electrical characteristics are presented in Fig5. The performance parameters are summarized in Table 1. The field-effect mobility is 0.025cm^2/V·s, on/off ratio is 1.82 x 10^5, threshold voltage is -9.34V, sub-threshold slope is 1.84V/dec and off-state current is 0.005pA/um.

The performance was not good because of the poor contact on channel caused by non-proper contact pressure and time. But, a machine specified to mico-contact printing is under development.

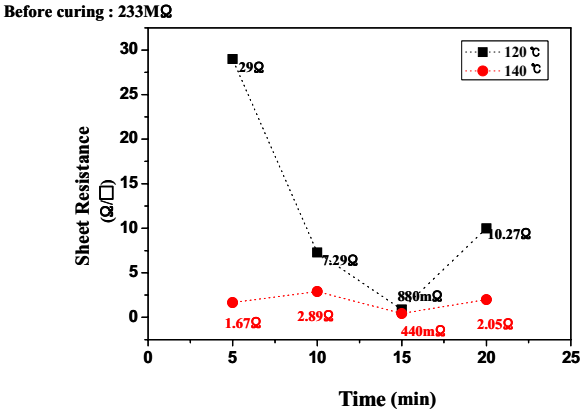

Fig4. The sheet resistance of Ag ink film fabricated by micro-contact printing process according to curing temperature and time.

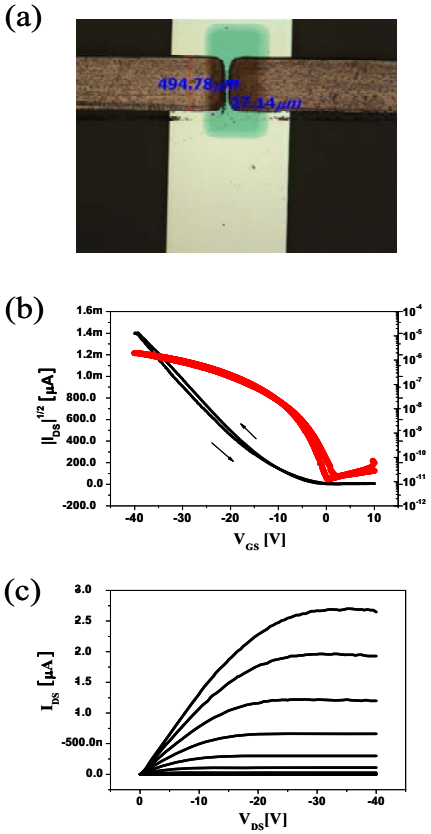

Fig5. (a) Microscope image of OTFTs
(b) The transfer characteristics
(c) The output characteristics of OTFTs with the micro-contacted S/D electrodes with Ag-paste.

Channel W/L (μ m)	Mobility ($cm^2/V·s$)	On/Off	V_{TH} (V)	SS (V/dec)	Off state current (pA/um)
494/27	0.025	1.82 X 10^5	-9.34	1.84	0.005

Table1. The performance parameters of OTFTS with the micro-contact printed S/D electrodes with Ag ink.

4. Summary

We developed a simple micro-contact printing process for S/D electrodes of OTFTs. The S/D electrodes were fabricated by the process with Ag-paste. The performance will be improved if specific equipment, which is being developed, would be used.

5. Acknowledgement

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6. References

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