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The Increase of Organic Field Effect Transistor Mobility by Copper Electrodes Deposition at High Background Pressure

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Organic field-effect transistor (OFETs) have been investigated for many years and it has been used widely in many applications such as flexible memory and sensors.[1] Superior performance of OFETs with high mobility (μ) and low threshold voltage (V_{TH}) has been important target in both academic and industrial research fields.[2] Optimizing the gate insulator surface,[3] using 2-layer S/D contact[4,5] or applying high-k materials as gate insulator were used in order to get its higher performances. In this paper, we reported that the background pressure during copper electrodes deposition significantly affects to the mobility of OFETs.

The top-contact OFETs using heavily doped n-type silicon wafers with a 50-nm-thick silicon dioxide were fabricated. A 10-nm layer of Cytop was spin-coated on the silicon dioxide in order to improve the insulating property and modify the surface energy. After that, pentacene layer (50nm) was deposited. Then, copper electrodes (50nm) were deposited at the pressure of 2.5×10^{-5} Torr. For comparison, OFETs using copper or gold electrodes were fabricated under lower pressure of 1.6×10^{-6} Torr.

At V_D = - 10 V and V_G = - 10 V, the drain current (I_{DS}) (-8.97 μA) of OFETs with copper electrodes fabricated at higher pressure is c.a. 10 times greater than I_{DS} (-0.88 μA) of devices using gold electrodes and 64 times greater than I_{DS} (-0.14 μA) of devices using copper electrodes fabricated at lower pressure (Fig. 1). To examine the charge injection behavior, total resistances of the channel were calculated from the linear region of output curves at various gate voltages. With the lowest total resistance, the OFETs fabricated under the high background pressure would have the lowest charge injection barrier and the highest μ than others. From transfer curves (Fig.2), μ, V_{TH}, and the on/off ratio were calculated and summarized in Table I. The mobility (1.32 $cm^2V^{-1}s^{-1}$) of the OFETs is over 2 times better than that (0.53 $cm^2V^{-1}s^{-1}$) of reported devices with similar structures.[5,6]

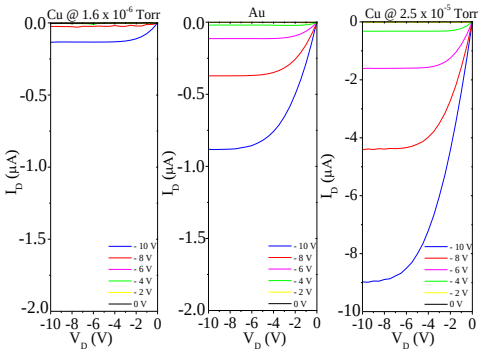

Fig. 1 The output curves of devices with different S-D electrodes

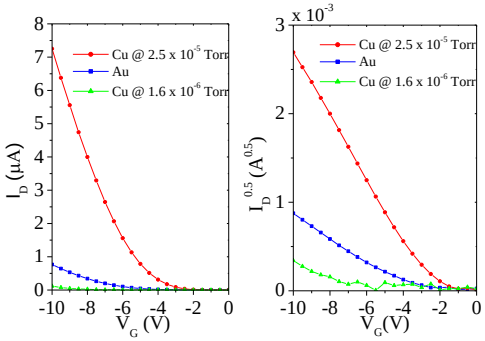

Fig. 2 The transfer curves of devices with different S-D electrodes

Table I. OFETs parameters

OFETs	μ ($cm^2V^{-1}s^{-1}$)	V_{TH} (V)	On/off ratio
Cu electrodes 2.5×10^{-5} Torr	1.32	- 2.56	8.13×10^4
Cu electrodes 1.6×10^{-6} Torr	0.42	- 8.10	6.05×10^3
Au	0.53	- 3.31	3.76×10^5

We concluded that the background pressure during copper deposition significantly affects to the mobility of OFETs. More details and an analysis will be reported in the presentation.

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