Novel Approaches for Improvement of Ohmic Contact Properties between Organic Semiconductor and Source-Drain Electrode

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Organic thin-film transistors (OTFTs) have been researched for many applications such as sensors, smart cards, identification tags, and the display devices including flexible displays, because they have lots of advantages such as a low-cost manufacturing, low-temperature processing, and their compatibility with flexible substrates. In the case of organic semiconductor based device, it is well known that the formation of the metal/organic interface is one of the most important factors in determining the device performance, since the carrier injection into the semiconducting layer via the interface depends on the quality of the contact formed.

We present two kinds of new methods for reducing contact resistance between organic semiconductor and source-drain electrode in Bottom Contact-Organic Thin-Film Transistors (BC-OTFTs).

The first approach is by using metal oxide/metal double layer structures for reducing the contact resistance effectively with simple patterning process; metal oxide layers including nickel oxide (NiO_x/Mo) and molybdenum oxide (MoO_x) under molybdenum work as a high performance carrier injection layer. Step profiles of source-drain electrode can be easily achieved by simultaneously etching the double layers using the difference etching rates between metal oxides and metal layers.

The other one is totally new method based on the electroplating process for coating with the desired thin film selectively on pre-patterned source-drain electrode. The coated material is specially designed organic semiconducting or conducting polymers whose HOMO energy level might be aligned in-between the work-function of S/D metal and the HOMO energy level of p-type organic semiconductor for TFT channel.

As our first experimental achievement, bithely pentacene molecules adsorbed on source/drain electrode cause a significant effect to reduce the contact resistance between the Mo electrodes and the pentacene semiconductor depending on the energy barrier height at the interface. The overall performance of organic thin film transistors such as field effect mobility and on/off ratio can be improved by this selective electroplating process, named as Selective Self-assembled Treatment (SST).

We will present detail results of OTFTs with the double metal oxide structure and the SST process on the Mo source/drain electrode.

Keywords: Organic TFT, contact resistance, bottom-contact, metal oxide, double layer, electroplating, Work function.