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Surface-selective deposition for organic transistor

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1. Introduction

Rapid progress of information technology now requires development of interfaces and displays that are both user and environment friendly. The goal of ubiquitous electronics has been supported by recent advances in semiconductor fabrication using flexible support materials with silicon, metal oxide, and organic semiconductor materials. The solution processed formation of organic semiconductor devices is a particularly promising fabrication method that offers lower production cost, reduced energy consumption, and smaller environmental burden. The most critical requirement for the commercialization of flexible electronics is the development of a manufacturing technology that allows the large-area integration of devices at low cost. OFETs still have several shortcomings with respect to such large-area fabrication. A fabrication methodology that allows the local patterning of devices and achieves high device performance has therefore yet to be established.

2. Experiment

We have developed the surface selective deposition technique as a bottom-up fabrication method for the preparation of OFETs, which allows large area integration of OFETs from solution. This technique exploits the effect of patterned surface wettability, which leads the selective crystallization of soluble organic semiconductors on a desired area. The self-organized organic films deposited selectively in this manner grow to form the channels of OFETs and circuits. The proposed method satisfies several important requirements of printable electronics.

The proposed fabrication method is based on patterning of the surface of a polymer insulator with phenyl and alkyl functional groups as wettable and unwettable regions, respectively, which involves removal of the surface alkyl groups by irradiation under vacuum ultraviolet light, followed by the formation of phenyl self assembled monolayer in the regions that will form the channel region of the OFETs (Fig.1). The phenyl-modified surface is wettable by the organic semiconductor solution, likely due to π-π interaction between the surface and the solvent. The self-organized OFETs display an average mobility of 0.53 cm^2/Vs, on/off ratio of 10^9, and subthreshold slope of 0.18 V/dec, with near-zero and narrowly distributed threshold voltage. An inverter circuit prepared using these devices is demonstrated with high signal gain at low input voltage.

References

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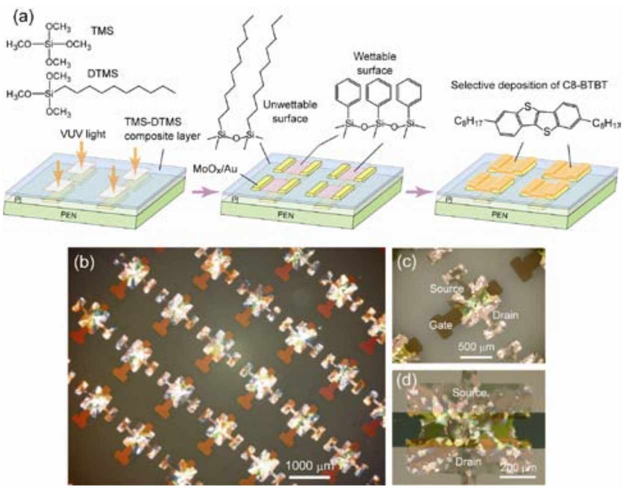

Fig.1 (a) Fabrication process for preparing arrays of self-organized OFETs on a flexible substrate. (b) Polarized optical micrograph of arrays of self-organized OFETs. (c) Optical micrograph of an individual OFET device. (d) Optical micrograph of channel region of an OFET.