Preparation and Characterization of Amine-Imine Derivatives Used in Organic Thin Film Transistor

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ABSTRACT: In this report, synthesis and characterization of Amine-imine derivatives of BIP and NIP are presented. Amine-imine derivatives have more delocalization molecular orbits having excitation spectra with red shift. Additionally, the different distribution of molecular energy levels for BIP and NIP causes the emission and absorption of different wavelengths. In this study, both BIP and the NIP were used as the organic thin film transistor active layer deposited on a silicon wafer substrate and the surface morphology, structure of permutation as well as carrier mobility rate were discussed. [Journal of American Science 2010;6(4):189-192]. (ISSN: 1545-1003).

Keywords: molecular orbits, carrier mobility, surface morphology

Introduction

Recently, the synthesis and characterization of organic complex used for thin film transistor have been developed impressively [1, 2]. In order to improve the surface morphology and structural permutation, synthesis modification producing a new structure can drive a new feature. However, a meaningful modification of organic semiconductor material must have strong supports by valuable mechanism and the application. We develop a couple of new functional OTFTs [3] by using of Amine-imine derivatives BIP and NIP.

Materials and Methods

Active layer as well as the electrode is deposited to substrate by using different mask for defining the pattern where the channel width (W) is 10mm and the channel length (L) is 50μm. The design is depicted in Fig. 1. However, in the evaporation process, mask and substrate may cause the shift of the size of the channel width and length. The accurate channel size can be confirmed by using the optical microscope (Optical Microscope, OM). In Fig. 2., NIP and BIP structures are depicted.

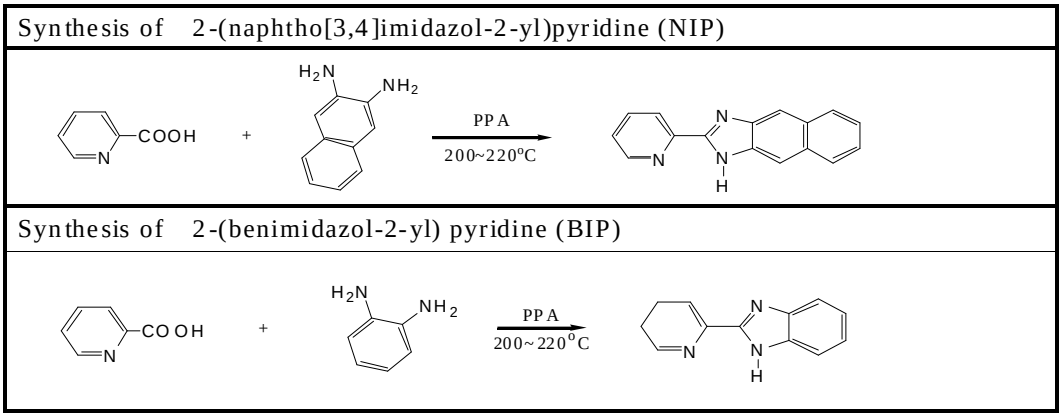


Fig. 2. Structures of NIP and BIP

Results and Discussion

The carrier displacement rate of organic semiconductor materials usually depends on the material purity and grain size. Since the surface is rough, each crystal growth will be interrupted. If the evaporation rate limited to 0.5 Å per second for deposition of film thickness of 100 nm, we can clearly observe the size of the grains and the surface roughness. Fig. 3 shows the SEM photos of NIP and BIP which was used as reference to pick up the optimized evaporation rate.

In this study, Amine-imine derivatives function as active material, the organic thin film transistor output characteristic curve (ID-VD) and the transduction curve (ID-VG) are depicted in Fig. 4. Amine-imine derivatives of BIP and NIP are basically p-type organic semiconductors. Due to intra-molecular Amine-imine hydrogen bonds tend to build their plane structure and associate with inter-molecular hydrogen bonds to turn into three-dimensional planar stack structure, inter-molecular π electrons and π orbital overlap caused by the effective intermolecular charge transfer therefore strengthen the carrier mobility. Since NIP carries one more benzene ring than BIP, it makes the carrier mobility about twice higher. The measured values of SS (Subthreshold Swing) are all in 10V/decade below and which means gate control for the channel current is significant.

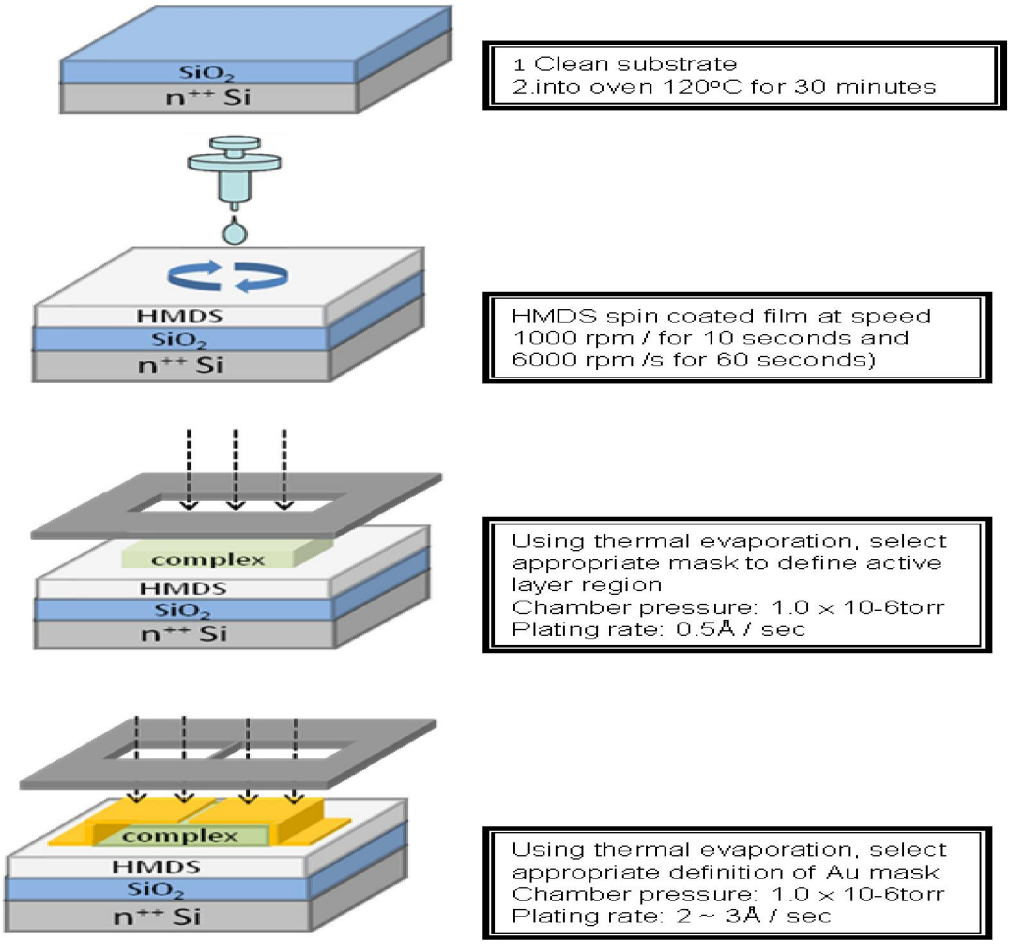
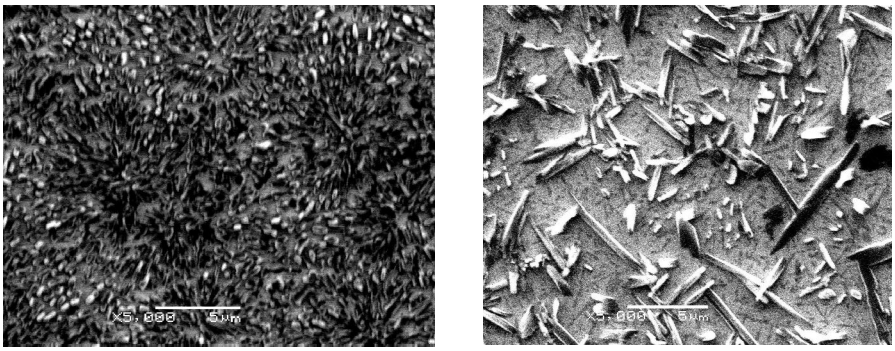


Fig. 2. Schematic drawing of the design of OTFT



(a) (b)

Fig. 3. SEM photos of (a) BIP and (NIP)

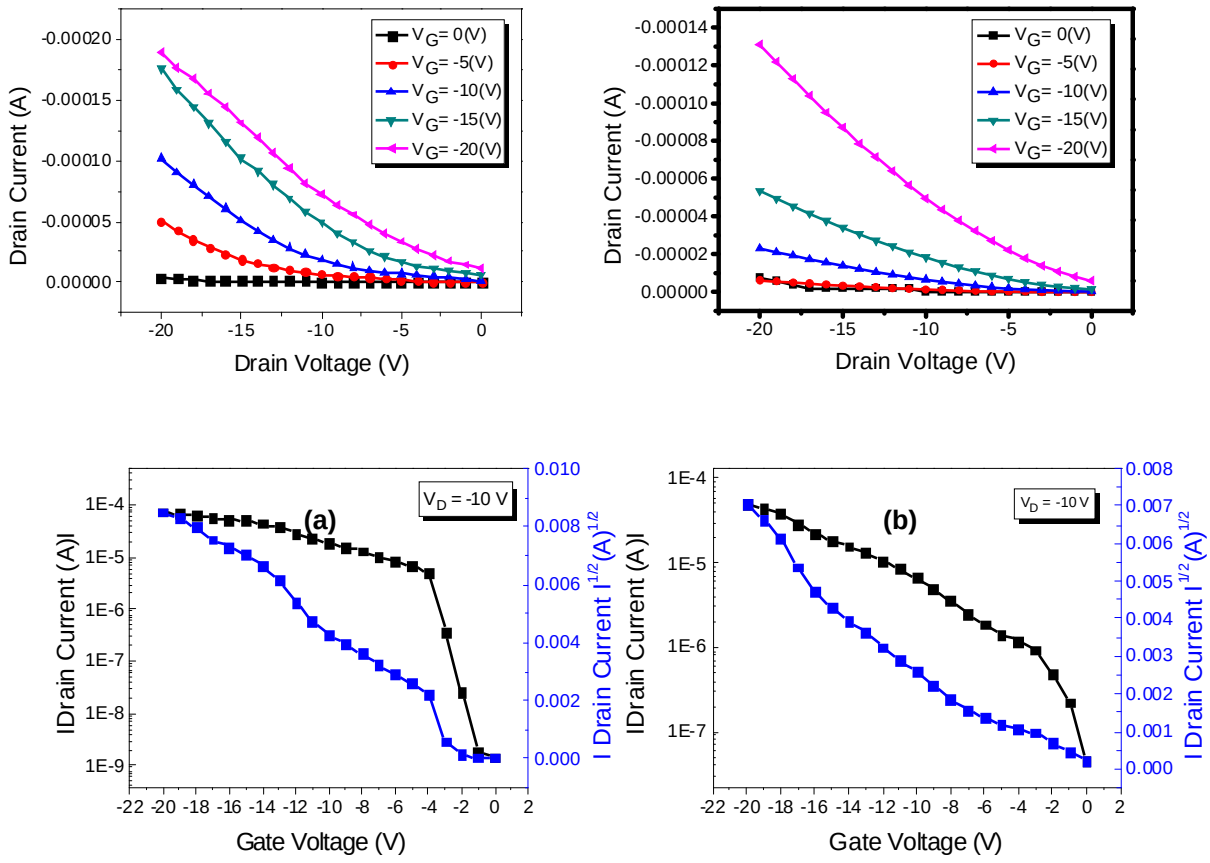


Fig. 4. (a) The OTFT ID-VD curve for BIP thin film as active layer (b) The OTFT ID-VD curve for NIP thin film as active layer (c) The OTFT ID-VG curve for BIP thin film as active layer (d) The OTFT ID-VG curve for NIP thin film as active layer

Table 1. Electrical characteristics under the atmosphere of the OTFT made by BIP and the NIP

Materials	μ_{FET} (cm^2/V_S)	V_{th} (V)	I_{ON}/I_{OFF} ratio	S.S (V/decade)
BIP	0.1173	-12	1.1×10^3	7.6525
NIP	0.2356	-10	2.3×10^4	5.0308

Conclusion

The hydrogen bonds in Amine-imine derivatives build three dimensional planar stack structures which therefore cause intermolecular π electronics and π orbital overlap to produce effective intermolecular charge transfer and strengthen the mobility rate followed enhancing the carriers' mobility. Comparatively, NIP has one more benzene ring than BIP so that to make the carrier mobility promotion from 0.1173 (cm^2/VS) to 0.2356 (cm^2/VS). Therefore, we can conclude that the structural variance of Amine-imine derivatives is the key to be responsible to the rate of carrier mobility in our designed OTFT and Electrical characteristics under the atmosphere of the OTFT made by BIP and the NIP is listed in Table 1.

2/2/2010

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