

Electronic and structural properties at the interface between pentacene and polymer dielectrics

Seung Jin Han^{1,2}, Jae-Hoon Kim¹, Yongsup Park³, Kyu-Ha Beak⁴, Gi-Heon Kim⁴,
Lee-mi Do⁴, Sa-Hwan Hong², Dal-Hyun Kim², Jeong Won Kim²

¹Department of Electronics and Computer Engineering, Hanyang University

²Korea Research Institute of Standards and Science (KRISS)

³Department of Physics, Kyung Hee University, 1 Hoegi-dong, Dongdaemun

⁴Electronics and Telecommunications Research Institute (ETRI)

Since the performance of pentacene-based organic thin film transistors (OTFTs) is comparable to that of hydrogenated amorphous silicon thin film transistor, a growing interest has been focused on the process of OTFTs for the applications to low-cost and large-area flexible displays. As the characteristics such as mobility and on/off ratio of the OTFTs are greatly influenced by the interfacial structure formed between organic semiconductor and gate dielectrics, the preparation of the underlying dielectrics and deposition of semiconductor layer are critical steps to improve the performance. Here we examine the electronic properties of interfaces formed by pentacene deposited on a polymer-based dielectrics pre-coated on a Si substrate. The interface region between the pentacene and the PMMA-derivative polymer (K1) is investigated using x-ray photoelectron spectroscopy (XPS), ultraviolet photoelectron spectroscopy (UPS), atomic force microscopy (AFM), and contact angle (CA) measurements. In particular, a UV/Ozone treatment of the K1 polymer causes a large influence on the energy level alignment of the pentacene/K1 interface. From C 1s XPS spectra, it is shown that the deposition of pentacene brings about chemical reactions with the K1 polymer, which induces strong charge redistribution at the interface. Such reactions are followed by the rearrangement of interface dipoles, causing a large work function change. However, the UV/Ozone treatment of the K1 polymer reduces such interface reactions so that the band bending and interface dipole change are much weaker. These different behaviors are consistent with smaller water-contact angle on the K1 and larger grain size of pentacene deposited on the top, when the K1 is treated by the UV/Ozone. It is expected that the OTFT performance will be enhanced by inserting the UV/Ozone treated K1 as a dielectric layer below the pentacene film.