Interfacial Electronic and Magnetic Structure between Pentacene and Co Layers

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Organic conjugated materials have been used as an active layer in electronic devices such as organic light-emitting diodes (OLED), organic field-effect transistors (OFET), and photovoltaic cells for their compatibility with plastic substrates. A recent growing interest has been attracted in spin and magnetic field effects in devices by building the "organic spin valve" with using organic conjugated materials which has a long spin relaxation time. Since the interface features between organic films and metal layers determine the carrier transportation properties in organic electronic devices, to understand the possible interplay between interfaces is important in organic/magnetic hybrid structures. Here we study the interfacial properties of Co/Pentacene/Co/Cr/Si(100) in a vertical pseudo spin-valve structure.

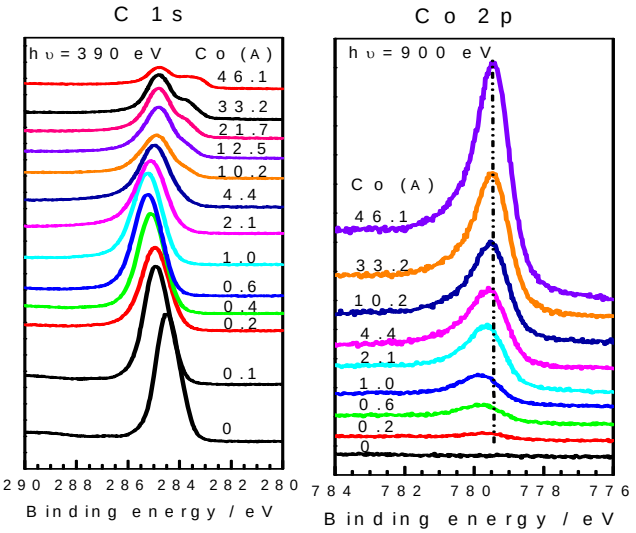

Fig. 1: (a) C *1s* PES recorded as a function of Co adlyer thickness on pentacene; The additional shoulder appearing near 283.7 eV corresponds to the formation of cobalt carbide. (b)The correponding Co *2p* PES recorded as a function of Co adlyer thickness; the dependence of energy shifts on coverage observed for both spectra indicate the presence of a reactive interface.

To manufacture "organic spin valve" successfully, the chemical stability, packing orientation and energetic match between the interface of organic and ferromagnetic layer has to be examined. We characterized the surface bonding, orientation geometry and electronic structure at the interface of pentacene/Co and Co/pentacene by utilizing X-ray photoemission spectroscopy (XPS), ultraviolet photoelectron spectroscopy (UPS), polarized near-edge X-ray absorption spectroscopy (NEXAFS) and magneto-optical Kerr effect (MOKE).

The experimental results reveal an asymmetrical interface is existed between cobalt and pentacene on top and bottom ferromagnetic electrode contact. The interface of Pentacene/Co might be stable chemically with a dipole layer and has a hole injection barrier of 0.96 eV. Pentacene molecules prefer to lie flatly on Co surface at low coverage(about 1~4 Å). With thickness increasing(at least 8 Å), the packing orientation turns to tilt up on surface. When the Pentacene(1 Å) is deposited on Co(34Å), the coercivity becomes a little small.

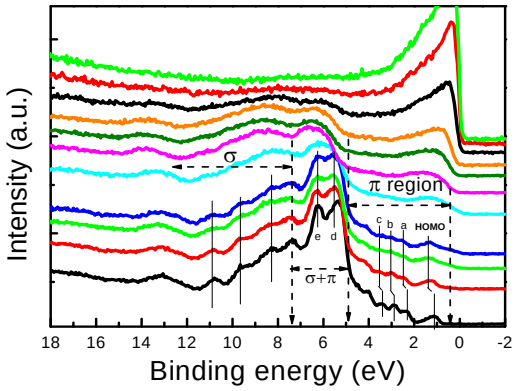

Fig. 2: Ultraviolet photoemission of top cobalt contact with pentacene as a function of Co adlayer thickness.

The result of the study of Co layer on Pentacene show that：Co diffuses into Pentacene. When third layer of Co is deposited on Pentacene. Then, Co interacts with Pentacene leading to a formation of chemical bond which destroy the well-order orientation of Pentacene. The resulting Coblat Carbide has a small coercivity (about 11~13 Oe). In summary, these two interfacial properties for Co/Pentacene and Pentacne/Co are different not only in structure but also in electronic properties.

[1] Z. H. Xiong, D. Wu, Z. V. Vardeny, and J. Shi, Nature **427**, 821 (2004).
[2] M. V. Tiba, W. J. M. de Jonge, and B. Koopmans, J. Appl. Phys. **100**, 093707 (2006).