Interfacial Properties and Coupling of Pentacene on Ni/Cu(100) Surface

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Recently there has been a growing interest to incorporate organic conjugated materials in organic spin-valve(OSV). The observations of magnetoresistance(MR) effects in organic semiconductors has open up the potential for spin-conserved transport. From literatures, we can find some central concerns with respect to the performance of organic spintronic devices. They include the enhancement of charge or spin-polarized carrier transport at interface and realization of coupling at interface of organic/magnetic heterostructures. Here, we studied the interfacial electronic properties and molecular orientation of pentacene (Pc) deposited on Ni/Cu(100) by utilizing photoemission spectroscopy (PES) and polarized carbon *K*-edge NEXAFS spectra. The pentacene film was vacuum in-situ deposited on Ni surface which was prior deposited on Cu(100).

From the analysis of UPS and XPS, the secondary electron cut-off is dramatically changed as Ni deposited on Cu and pentacene deposited on Ni/Cu(100). The work function of varied thickness of Pc on Ni and Cu (100) are shown in figure 1. The work function exhibits a remarkable alternation as pentacene deposited on both metal surface, but there are no further variation with increasing thickness of pentacene. Although no chemical bonding is discovered on the Pc/metal interface, the examination of valence electronic structure indicates a strong surface dipole is present on the interface. Besides, the interfacial dipole strength is stronger for Pc on Ni/Cu(100) than on Cu(100).

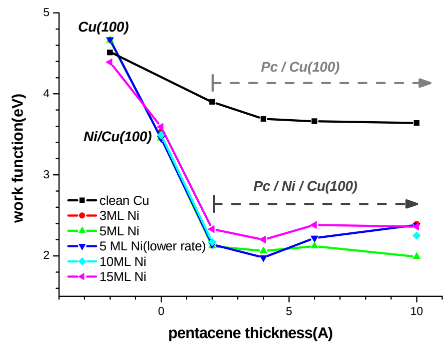

Figure 1. The work function shift as a function of pentacene thickness.

To determine the preferential orientation of pentacene on Cu(100) and Ni/Cu(100), we examined the polarized NEXAFS spectra. The linear polarized light is irradiated on sample with electric field perpendicular or parallel to surface as shown in figure 6. The polarized NEXAFS of Pc on Cu(100) at different temperatures are displayed in figure7 and the corresponding difference spectra is shown in figure8. The strong polarization dependence of π*/σ* absorption peaks reveal pentacene have a preferential lying-flat orientation on Cu(100) surface at lower temperature (223K) but stand-up at higher temperature (298-373K).

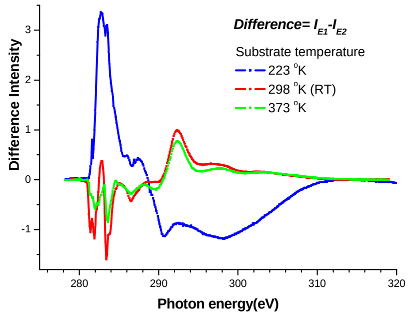

Figure 2. Corresponding difference spectra of Pc/Cu(100) at different temperature by subtraction NEXAFS spectra between E field perpendicular (phase 0) and parallel (phase 28) to sample.

However, no regular dichroism of (σ*–π*) for Pc on Ni/Cu(100) is detected as Pc on Cu(100). The difference spectra with varied Pc thickness show both σ*–π* orbital vectors have in-plane orientation. It indicates Pc have different orientation from Cu surface. It is with side-lying orientation on Ni/Cu(100) surface.

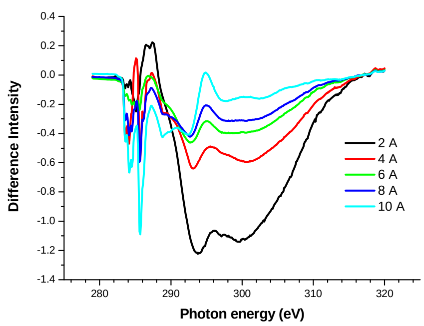

Figure 3. Difference spectra of Pc on Ni/Cu(100) with varied Pc thickness..

1. Frank-J. Meyer zu Heringdorf *et al.*, Nature **412**, 517 (2001).
2. S. D. Wang, *et al.*, J. Phys. Chem. B **109**, 9892 (2005).