

Magnetic Responses of an Ultrathin Cobalt Film upon the Presence of a Neighboring Pentacene Layer

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X-ray Photoemission Electron Microscopy (PEEM) and surface magneto-optical Kerr effect (SMOKE) were used to investigate how a ferromagnetic film would respond to the presence of an adjacent organic layer through microscopic and macroscopic investigations. Since a vertical spin-valve involves two interfaces, special attention was paid to examine the possible differences triggered by the opposite order of deposition. Our investigations showed that the cobalt (Co) bottom electrode has experienced little modification on its magnetic hysteresis response upon the adsorption of pentacene ($C_{14}H_{22}$; Pc) molecules. Neither the large magnetic domain (~ 10 's μm) commonly observed in cobalt (Co) film was found altered upon the presence of Pc adlayer. Following the concept of physisorption, we described the dominant perturbation caused by Pc adsorption is the van der Waals force originating from a rearrangement of the electron cloud between the adsorbate and the electron tail protruding from the substrate surface. As a result, the slightly decreased H_c as shown in Fig. 1(a) is likely to associate with physical processes such as relaxation of mechanical stress induced on adsorption or adsorption at the defect sites.

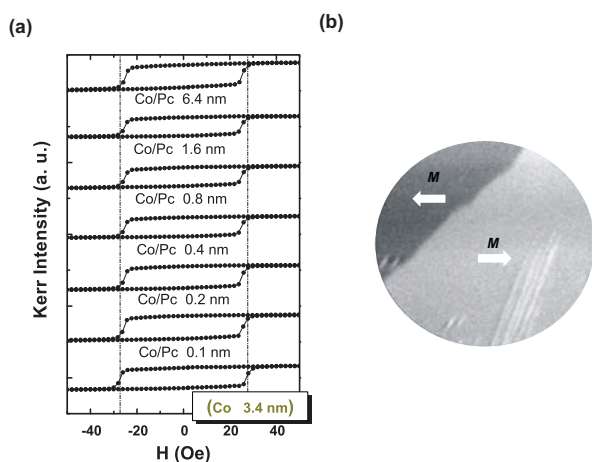


Fig. 1: (a) Magnetic hysteresis loops of Co layer recorded as a function of Pc adlayer thickness; Co(3.4 nm)/Pc. (b) Image of magnetic domain structure in Co layer; Co(2.4 nm)/Pc(2.0 nm).

When the order of deposition was reversed, the cobalt film showed distinct responses comparing to those found in Co/Pc bilayers. Figure 2 showed the magnetic responses of Co film deposited on a 6.4 nm Pc bottom layer. Unlike the thickness independent behavior shown in Fig. 1, the hysteresis loops displayed a strong dependence on the Co coverage. Such a distinct variation was due to the fact that we were actually detecting the onset of ferromagnetism. As the Co film formed over a 6.4 nm Pc appeared to be non-magnetic until its thickness reached 3.3 nm, our investigation indicated the need of further clarification on if the loss of ferromagnetic long range order is originated from the presence of magnetic dead layer or the finite size effect.

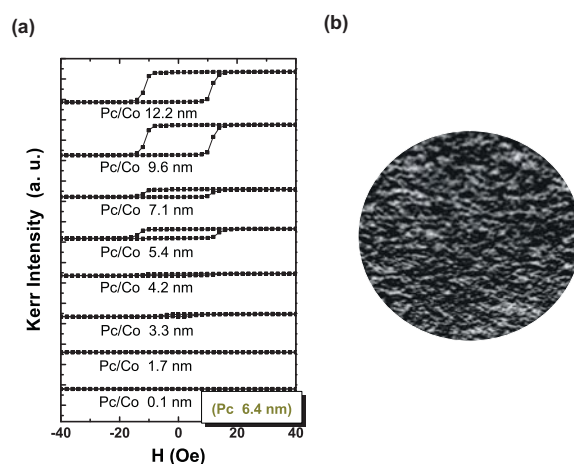


Fig. 2: (a) Magnetic hysteresis loops of Co layer recorded as a function of its thickness accumulated on 6.4 nm thick of Pc bottom layer. (b) Image of magnetic domain structure of Pc(1.8 nm)/Co(1.1 nm).

Similar conclusion was also drawn from the micromagnetic measurements. The images taken for Pc (1.8 nm)/Co bilayers indicated that there was no observable magnetic contrast until a 1.1 nm thick of Co was established. After the onset of ferromagnetic order, the images revealed a complicated domain configuration as depicted in Fig. 2(b).