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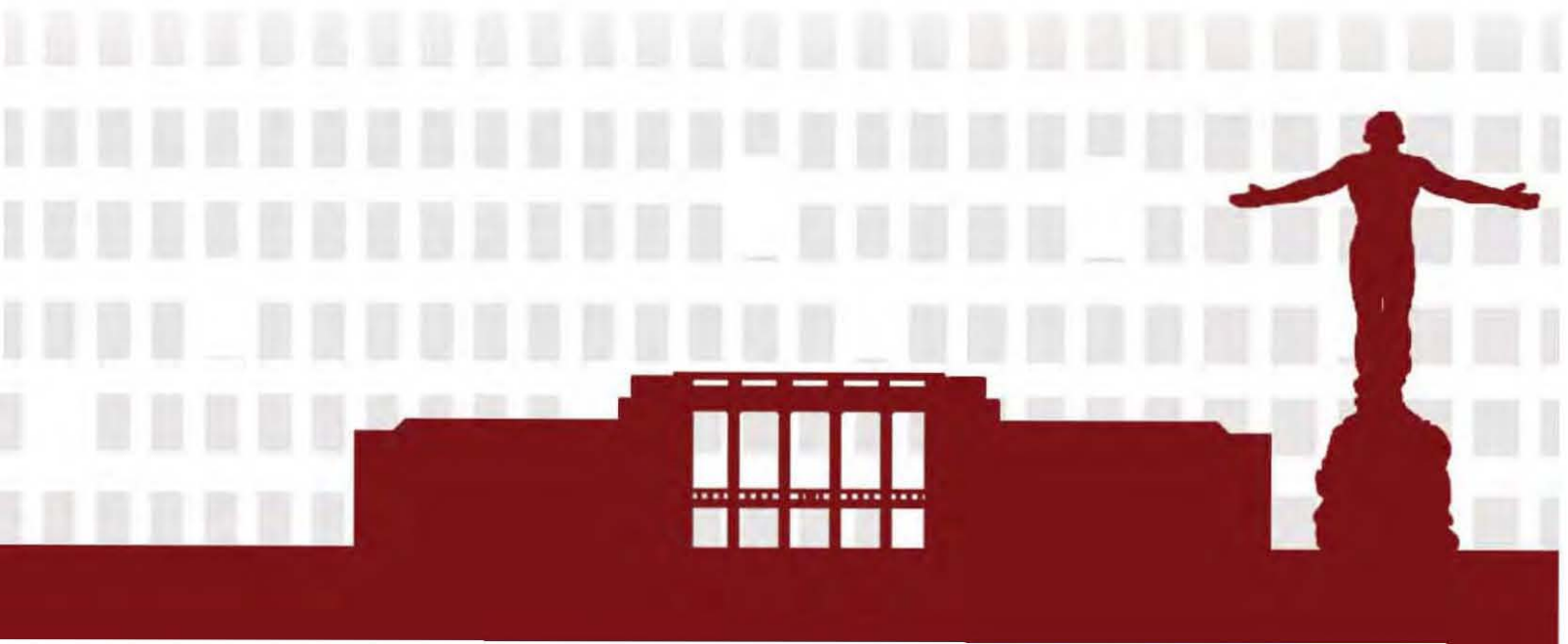
Metro Manila, Philippines



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INDUCED ROOM TEMPERATURE EXCHANGE BIAS EFFECT ON CoO/Fe NANOSTRUCTURED THIN FILMS

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ABSTRACT

Exchange bias effect is a phenomenon wherein anisotropy is formed at the interface between an antiferromagnetic (AFM) and a ferromagnetic (FM) material. This phenomenon is important in applications such as in permanent magnets, magnetic recording media and giant magnetoresistance [1]. One of the most promising AFM materials is cobalt (II) oxide (CoO); however, it only displays antiferromagnetism below 16°C. This study reports for the first time (to the knowledge of the authors) an induced exchange bias effect at room temperature on a CoO/Fe multilayered nanostructured thin film system by inserting ultrathin Fe films (about 5Å) in between the CoO layer. Also, the effect of post-annealing on the exchange bias effect was also observed. The multilayered thin films were deposited onto pure Si (111) wafers by RF magnetron sputtering technique. Argon gas pressure in the vacuum chamber was maintained at 4.2x10-3 Torr during deposition. Generated RF powers for CoO and Fe targets were 50 and 40 W, respectively. First, a Ta buffer layer was deposited onto the Si substrate. Then, CoO and Fe were alternately deposited to form ten bilayered films, followed by a thicker Fe layer, and finally a thin Ta passivation layer. The schematic diagram of the nanostructured multilayers is shown in Figure 1. To determine the effect of post-annealing, one sample was annealed in a vacuum oven under a magnetic field at 150°C for 1 hr. These samples were characterized using X-ray diffraction (XRD) and Vibrating Sample Magnetometer (VSM). X-ray diffraction patterns reveal the presence of β-Ta (111), Si (111) and Fe (111) in both the unannealed and annealed samples, as shown in Figure 2. However, peaks appeared sharper after annealing, which suggests that post-annealing significantly improved the crystallinity of the sample. VSM hysteresis loops reveal a shift of 10.25% (with respect to the coercivity) for the unannealed sample, while it increased to 20.05% after post-annealing. These hysteresis shifts indicate that an exchange bias effect occurred on the CoO/Fe systems. Under a magnetic field at room temperature, the ultrathin Fe films influenced the alignment of the magnetic moments in the AFM layer, which led to the exchange bias effect. Hence, the possibility of inducing an exchange bias effect at room temperature in CoO/Fe systems was proven.

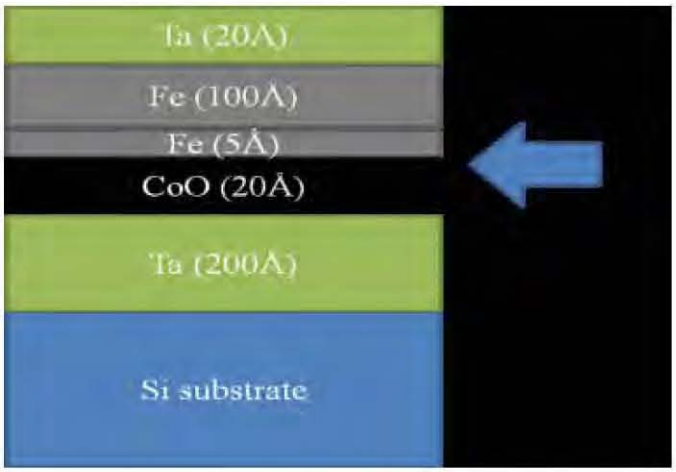

Figure 1. Schematic diagram of the nanostructured multilayered thin films.

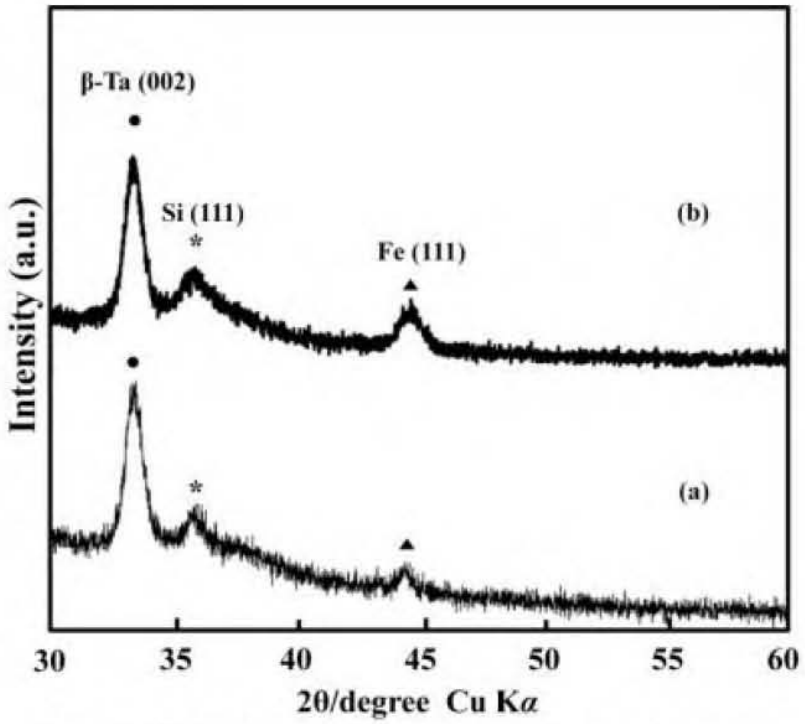

Figure 2. XRD patterns of (a) annealed and (b) unannealed samples .

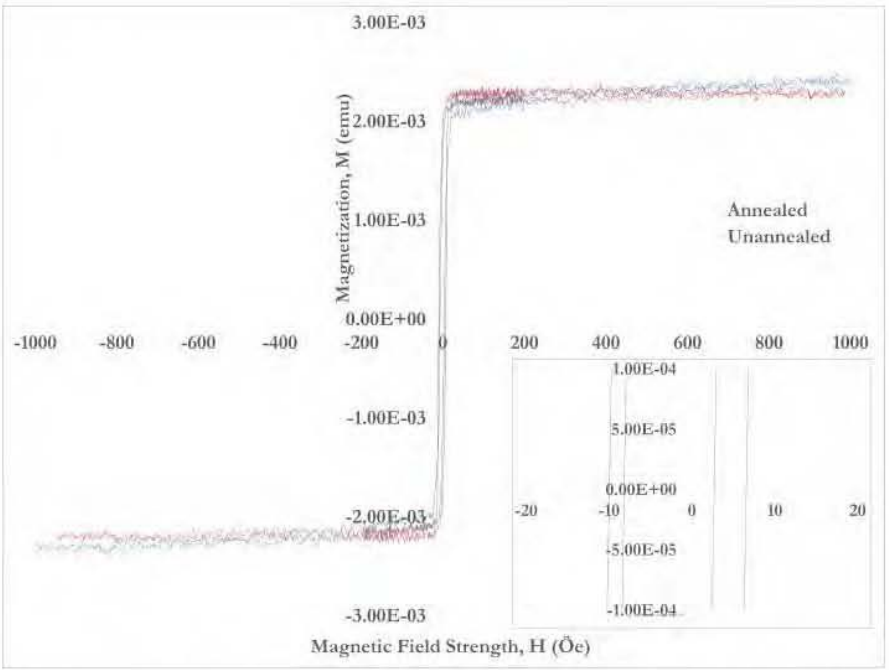

Figure 3. VSM Hysteresis loops for both annealed and unnealed samples. The inset shows a more detailed image of the hysteresis shift, indicative of an exchange bias effect.

Keywords: annealing, cobalt oxide/iron thin film systems, exchange bias effect.

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Reference

[1] J. Nogues and I.K. Schuller, "Exchange Bias", *Journal of Magnetism and Magnetic Materials*, Vol.192, pp. 203-232, 1999.