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Interfacial Properties of Antiferromagnetically-coupled Fe/Si Multilayered Films

K. W. Kim,[1] Y. V. Kudryavtsev,[1] J. Y. Rhee,[2] J. Dubowik[3] and Y. P. Lee[1]
[1]Department of Physics, Sunmoon University, Asan 336-840, Korea
[2]Department of Physics, Hoseo University, Asan 336-795, Korea
[3]Institute of Molecular Physics, Poznan 60-179, Poland

Recently, Fe/Si multilayered films (MLF) have been a focus of interest due to the strong antiferromagnetic (AF) coupling observed in such kind of MLF. Much consideration has been given to whether the coupling in the Fe/Si MLF originates from the same nature as in the metal/metal MLF. In particular, a question of whether the spacer layer in the Fe/Si MLF is metallic or semiconducting is of interest. Inspite of various experimental techniques envolved in the study, the chemical composition and the properties of the interfacial regions in the MLF exhibiting the AF coupling is still questionable.(1) (3) The nature of the AF coupling and the interfacial properties of Fe/Si MLF are investigated in this study.

A series of Fe/Si MLF with a fixed nominal thickness of Fe (3 nm) and a variable thickness of Si (1.0 - 2.2 nm) were deposited by RF-sputtering onto glass substrates at room temperature. The atomic structures and the actual sublayer thicknesses of the Fe/Si MLF are investigated by using x-ray diffraction. The magnetic-field dependence of the equatorial Kerr effect clearly shows an appearance of the AF coupling between Fe sublayers at t_{Si} = 1.5 - 1.8 nm. The drastic discrepancies between the experimental magnetooptical (MO) and optical properties, and the computer-simulated ones based on the assumption of sharp interfaces between Fe and Si sublayers leads to a conclusion that pure Si is absent in the AF-coupled Fe/Si MLF. Introducing in the model nonmagnetic semiconducting FeSi alloy layers between Fe and Si sublayers or as spacer between pure Fe sublayers only slightly improves the agreement between model and experiment. A reasonable agreement between experimental and simulated MO spectra was reached with using the fitted optical properties for the spacer with a typical metallic type of behavior. The results of the magnetic properties measured by vibrating sample magnetometer and magnetic circular dichroism are also analyzed in connection with the MO and optical properties.

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