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Structure and Physical Properties of Fe/Si Multilayered Films with Very Thin Sublayers

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Multilayered films (MLF) consisting of transition metals and semiconductors have drawn a great deal of interest because of their unique properties and potential technological applications. Fe/Si MLF are a particular topic of research due to their interesting antiferromagnetic coupling behavior. Although a number of experimental works have been done to understand the mechanism of the interlayer coupling in this system, the results are controversial and it is not yet well understood how the formation of an iron silicide in the spacer layers affects the coupling. The interpretation of the coupling data has been hampered by the lack of knowledge about the intermixed iron silicide layer which has been variously hypothesized to be a metallic compound in the B2 structure or a semiconductor in the more complex B20 structure. It is well known that both magneto-optical (MO) and optical properties of a metal depend strongly on their electronic structure that is also correlated with the atomic and chemical ordering. In order to understand the structure and physical properties of the interfacial regions, Fe/Si multilayers with very thin sublayers were investigated by the MO and optical spectroscopies.

The Fe/Si MLF were prepared by rf-sputtering onto glass substrates at room temperature with a total thickness of about 100 nm. The thicknesses of Fe and Si sublayers were varied from 0.3 to 0.8 nm. In order to understand the fully intermixed state, the MLF were also annealed at various temperatures. The structure and magnetic properties of Fe/Si MLF were investigated by x-ray diffraction and vibrating sample magnetometer, respectively. The MO and optical properties were measured at room temperature in the 1.0 - 4.7 eV energy range. The results were analyzed in connection with the MO and optical properties of bulk and thin-film silicides with various structures and stoichiometries.