The Influence of Fe Layer Thickness on Electronic and Magnetic Properties of Antiferromagnetically Coupled Fe/Si Multilayers

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9.7 cm

The main goal of our study was to examine whether the existence of the antiferromagnetic (AF) exchange coupling in Fe/Si multilayers Mls is related to the appearance of the interfacial Fe silicide phases and how it is influenced by Fe layer thickness. The $[Fe(d_{Fe})/Si(1.1nm)]_{15}$ Mls were deposited in UHV by magnetron sputtering onto oxidized Si wafers for different Fe layer thicknesses $0.3<d_{Fe}<4$nm. The crystalline structure of our Mls and their multilayer periodicity were examined using the high- and small-angle X-ray diffraction, respectively. The transmission electron microscopy of the cross-section was used to examine the morphologies of selected samples. The temperature dependences of the Hall effect and the resistance supplemented with magnetic moment measurements showed that both magnetic and electronic properties of the AF coupled Fe/Si Mls are influenced by interfacial mixing between Fe and Si layers. The current-voltage characteristics measured perpendicularly to the Ml planes allowed us to show the semiconducting character of nominally pure Si spacer layers. The associated minimal tunneling barrier height evaluated for Fe(3nm)/Si(1.1nm) by the Simmons fit was found to be 1eV. We showed that the application of interfacial Co (or Au) thin layers prevent the mutual interlayer diffusion terminating the existing AF interlayer coupling.

13.4 cm

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