Transport properties of Fe/Si multilayers with various iron thickness

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Antiferromagnetically coupled Fe/Si multilayers attract a lot of attention due to their potential application in spintronics. In order to characterize the Fe/Si interfaces and their influence on interlayer exchange coupling we follow the evolution of transport and magnetic properties, which are related to formation of interfacial Fe-Si phases in particular stages of the multilayer growth. In this work $[Fe(d_{Fe})/Si(1.1\ nm)]_{15}$ multilayers, for iron thickness $0.25 < d_{Fe} < 4$ nm, deposited by magnetron sputtering, have been studied. Silicon layer thickness is chosen to correspond to maximum of antiferromagnetic coupling between Fe layers, as reported previously [1]. Transport properties are investigated by Hall effect, resistance, and magnetoresistance measurements. A transition from semiconducting to metallic behavior occurs for Fe thickness between 0.7 and 1 nm. Both magnetic moment measurements and the $4\pi M_S$ data extracted from anomalous Hall effect show that samples lose their magnetic moment for $d_{Fe} < 0.5$ nm. Temperature coefficient of resistance (TCR) and $4\pi M_S$ dependence on Fe thickness, taken at 250 K, is shown in Figure 1. In the range $0.5 < d_{Fe} < 1$ nm the investigated multilayers possess both semiconducting and magnetic properties. Based on the resistivity data of whole stack and individual components we make efforts to estimate the interfacial Fe-Si mixture contribution to resistivity of investigated multilayers.

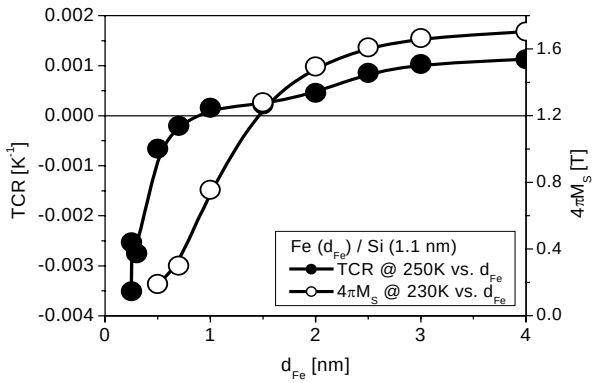

Fig. 1. Temperature coefficient of resistance (TCR) of Fe/Si multilayers, and $4\pi M_S$ data as a function of Fe thickness (d_{Fe}).

[1] T. Luciński, P. Wandziuk, J. Baszyński, B. Szymański, F. Stobiecki, J. Zweck, phys. stat. sol. (c) **3** (2006) 93.

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