Magnetic properties of Fe/Au multilayers

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The Fe/Au multilayered (MLS) structures can exhibit many interesting physical properties depending on Fe, Au sublayer thicknesses, crystal structure and level of structure imperfections. We report studies on the temperature dependence of magnetic and magneto-optical properties for the series of Fe/Au MLS with the small Fe sublayer thicknesses prepared by dc-sputtering on GaAs(001) substrates. The x-ray diffraction analysis shows that the Fe/Au films studied exhibit layered structure with (111) fcc texture. The magnetization processes M(H) were measured by magneto-optical technique in polar and longitudinal geometry in the temperature range 8-300 K The temperature dependence of the magnetization and initial AC susceptibility was measured at the same temperature range. For the very small Fe layer thickness of the order of 0.2 nm we observed, at room temperature, the field dependence of magnetization that varies from paramagnetic through typically superparamagnetic to ferromagnetic with decreasing of Au spacer layer thickness. All MLS structures studied exhibit ferromagnetic phase at low temperature and the Curie temperature depends strongly on Au spacer layer thickness. The temperature evolution of experimental M(H) data shows coexistence of the superparamagnetic and ferromagnetic phases in Fe/Au (111) MLS. We separate the magnetic phases on the base of the M(H) data in the fitting procedure. To interpret the experimental data we adopt the model developed by P. Allia [1] for the granular systems. We show the coexistence of two magnetic phases, ferromagnetic and superparamagnetic, in Fe/Au MLS for the thickness layers ratio $t_{Fe}/t_{Au} < 0.3$. In conclusion, we can state that the interacting nanoparticles have been one of main sources of magnetism in the MLS system studied when the Fe layer thickness is in the range 0.2-0.5 nm.

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[1] P. Allia, F. Celegato, M. Coisson, A. Da Re, F. Ronconi, F. Spizzo, P. Tiberto, and F. Vinai, J. Magn. Magn. Mater. **290-291** (2005) 580

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