Optical and magneto-optical study of Fe/Si multilayers

L. Uba[1], S. Uba[1], A. Polewko-Klim[1], T. Luciński[2], P. Wandziuk[2], A.N. Yaresko[3] and V.N. Antonov[4]

[1]*Institute of Physics, University of Białystok, Lipowa 41, 15-424 Białystok, Poland*
[2]*Institute of Molecular Physics, Polish Academy of Sciences*
M. Smoluchowskiego 17, 60-179 Poznań, Poland
[3]*Max-Planck-Institut for the Physics of Complex Systems, Dresden D-01187, Germany*
[4]*Institute of Metal Physics, National Academy of Sciences of Ukraine*
Vernadsky 36, 252142 Kiev, Ukraine

Experimental and theoretical investigations of the optical and magneto-optical (MO) properties of Fe/Si_xFe_{1-x} metal-semiconductor multilayers are presented. The Fe/Si_xFe_{1-x} multilayer films were prepared by magnetron-sputtering method with different spacer layer composition (x=100, 66, 50). The spacer layer thickness was varied within d=0.5-3.0 nm. The measured polar and longitudinal Kerr hysteresis loops for the films under study show behavior typical for the antiferromagnetically coupled sublayers. The interlayer coupling depends strongly on thickness and composition of the spacer layer and agrees well with the results obtained from magnetometry measurements [1]. The diagonal and off-diagonal components of the optical conductivity tensor of the multilayers have been determined in the photon energy range 0.8-5.8 eV from the measurements of the magneto-optical polar and longitudinal complex Kerr angles and the optical data measured by the spectroscopic ellipsometry. The experimental optical and MO response of the multilayers was compared with the theoretical ones calculated from first principles in density functional theory by LMTO method with the use of supercell approach. The calculations have been performed for different models of the multilayer structure. In particular, different spacer layer structures: metallic FeSi and semi-conducting $FeSi_2$ [2] iron-silicide phases, as well as pure Si and Fe doped Si structures, were investigated. Both experimental and theoretical results for the optical and MO spectra as well as the strength of antiferromagnetic interlayer coupling for the model structures of the Fe/Si_xFe_{1-x} multilayers are compared and discussed, giving important glance in the micro-scopic origin of interlayer coupling in the systems.

---

[1] P. Wandziuk, M. Kopcewicz, B. Szymański, and T. Lucinski, Molec. Phys. Rep. **40** (2004) 182.
[2] S.J. Clark, H.M. Al-Allak, S. Brand, and R.A. Abram, Phys. Rev. B **58** (1998) 103089.

Name of the presenting author (poster): Luba Uba
e-mail address: uba@alpha.uwb.edu.pl
url's: http://labfiz.uwb.edu.pl/ifd/