Magnetic anisotropy of (Ge,Mn)Te layers

W. Knoff,[1] A. Łusakowski,[1] A. Wołoś,[1,2] and T. Story[1]

[1] *Institute of Physics, Polish Academy of Sciences, Warsaw, Poland*

[2] *Institute of Experimental Physics, University of Warsaw, Poland*

Magnetic anisotropy of (Ge,Mn)Te semiconductor layers exhibiting carrier-induced ferromagnetism was experimentally studied by ferromagnetic resonance (FMR) method. The one micron-thick monocrystalline (Ge,Mn)Te layers were grown on diamagnetic BaF_2 (111) substrate by molecular beam epitaxy technique. The analysis of the angular dependence of the FMR resonant field carried out for the external magnetic field direction varying in the (1-10) and (11-2) crystal planes revealed the usual in-plane location of the magnetization easy axis for the $Ge_{0.8}Mn_{0.2}Te$ layer with the cubic structure whereas the normal to the layer plane easy axis was found for the rhombohedral $Ge_{0.9}Mn_{0.1}Te$ layer. These experimental findings are theoretically discused employing group-theoretical methods for various crystal structures as well as density functional theory (DFT) calculations of magnetization dependent contribution to the total electronic energy of (Ge,Mn)Te supercell composed of 64 atoms with Mn substituting Ge at fcc cation sublattice sites. The DFT calculations of (Ge,Mn)Te show an order of magnitude increase of uniaxial magnetic anisotropy in the rhombohedrally distorted layer as compared to the cubic one.

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