Magnetic properties of (Eu,Gd)Te semiconductor layers

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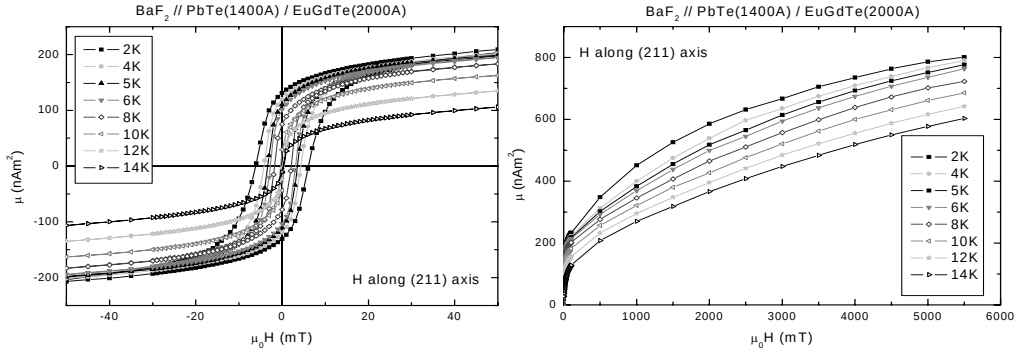
In (Eu,Gd)Te semiconductor alloys a well known antiferromagnetic semiconductor compound EuTe is transformed into n-type ferromagnetic alloy. This effect is driven by the RKKY interaction via conducting electrons created due to substitution of Gd^{3+} for Eu^{2+} ions. It is expected that the high degree of electron spin polarization in (Eu,Gd)Te can be exploited in new semiconductor spintronic heterostructures as a model injector of spin-polarized carriers. In this work we study experimentally magnetic properties of epitaxial layers of (Eu,Gd)Te in which both metallic and insulating electrical properties are observed depending on the Gd content and the crystal stoichiometry of the alloy.
(Eu,Gd)Te monocrystalline layers were grown by MBE on BaF_2 (111) substrates with either PbTe or EuTe buffer layers. Energy dispersive x-ray fluorescence analysis determined chemical composition of the layers with Gd content up to 5 at. %. The measurements of magnetic susceptibility, magnetization and ferromagnetic resonance revealed that the ferromagnetic transition is observed in (Eu,Gd)Te layers with the Curie temperature T_c=11-15 K. A more detailed analysis of the magnetization of (Eu,Gd)Te was carried out in a broad range of magnetic fields applied along various crystal directions both in- and out-of-layer plane (see an example of SQUID measurements presented in the Figure). It revealed, in particular, that a rapid low field ferromagnetic response of (Eu,Gd)Te layers is followed by a paramagnetic-like further increase towards the full saturation. Discussing this experimental finding we consider, in particular, the competition between ferromagnetic and antiferromagnetic exchange interactions as well as possible electronic separation effects.



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