Magnetic and structural studies of GeMnSnTe epitaxial layers

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Multiferroic (MF) materials which are simultaneously ferroelectric (FE) and ferromagnetic (FM) are interesting due to their potential applications, yet very rare. $Ge_{1-x}Mn_xTe$ is a semiconductor MF, with FE and FM orders coupled to each other, which leads to FE domain switching under applied magnetic field. However, ferroelectric (rhombohedral)/paraelectric (cubic) phase transition in GeMnTe cannot be investigated with the ferromagnetic resonance (FMR) technique due to FE Curie temperature,T_C^{FE}, significantly higher than T_C^{FM}. To lower T_C^{FE} GeMnTe layers co-doped with tin were grown.

We present results of XRD, SEM, SQUID and FMR studies of MBE grown GeMnSnTe layers. All were found to be both ferromagnetic and rhombohedral, with the distortion axis perpendicular to the layer surface. Only in the case of the highest Sn and Mn content the rhombohedral axis was found to be tilted from the substrate normal. Addition of Sn changes considerably the magnetocrystalline anisotropy, from purely uniaxial in GeMnTe to distorted cubic in GeMnSnTe. Moreover, domain switching is supressed.