Magnetoresistance study of Fe doped TlInTe2 crystal

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In this study, the influence of spin dependent scattering effect on magnetoresistance (MR) in Fe doped $TlInTe_2$ magnetic semiconductor with chain structure has been investigated for normal (B⊥c) and parallel (B∥c) orientation of B vector relative to sample plane and c-axes. The single crystal of Fe doped $TlInTe_2$ which crystallizes in a tetragonal structure with I4/mcm space group was prepared by using the directed crystallization Bridgman method. Temperature dependence of resistance in cooling/heating regimes and magnetoresistance in heating regime have been measured in the range of 200 - 300 K and magnetic fields with induction B≤ 14T. For both orientations of magnetic field vector to the sample surface, the MR(B) curves shows remarkable hysteresis loops of different shape, exhibiting negative, positive and anisotropic magnetoresistive effect. We concluded that magnetotransport properties are determined by trivalent iron atoms which most probably substitute into In^{3+} ion sites located at the center of ($In^{3+}Te_4^{2-}$) structural units in the chain structure of $TlInTe_2$ crystal. The shape of hysteresis MR(B) loops is strongly different for configurations (B⊥c) and (B∥c) (current vector I is always parallel to b-axes). In particular, we observe sharp increase of initial (virgin) part of MR(B) curve up to maximal value of ∼1-1,2 % at B∼6 T for (B⊥c) orientation. At the same time for B∥c orientation, small negative MR effect of ∼2 % at B ∼ 14 T is observed for virgin curve. After first magnetization MR(B) loop for B⊥c orientation has double peak shape shifted on app. 2,5 T when B changes its sign. For B∥c configuration, MR(B) loop has only one peak shape where peaks are shifted on app. 1,5 – 1.7 T relative to each other. It is possible to explain such behavior of MR(B) loops by rotation of spins in Fe^{3+} ions, distributed in In-chains, if we make the following guess: spins in neighboring Fe ions, directed in In chains along c-axes, are antiparallel (AFM configuration) and are directed along a-axes. In such a case, for B⊥c configuration at B < 6 T spin rotates on 180° (through intermediate state at 90°) while for B∥c configuration spin rotates only on 90° at B ∼ 14 T. Such diffrent behavior of spins in magnetic field results in different character of electron scattering that fully determine MR(B) loops behavior.

Keywords: Magnetic semiconductors; magnetoresistance; spin-dependent scattering, antiferromagnetic structure.