Anomalous Hall effect in Ge_{1-x-y} Mn_x $(Eu,Yb)_y$ Te semimagnetic semiconductors

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Interesting possibilities of new future spintronic application gives co-occurrence of ferroelectric and ferromagnetic properties. Materials which possess such unique properties are semimagnetic semiconductors, inter alia, $Ge_{1-x}Mn_xTe$. It is well known from early 70's that even a small admixture of MnTe in GeTe leads to a ferromagnetic behavior [1]. The source of the ferromagnetism is the RKKY interaction. The magnetic Curie temperature depends on both the Mn content and carrier concentration and its highest reported value (for x_{Mn}=0.6) does not exceed 160 K.

In the present paper, the results of electron transport and magnetic studies of $Ge_{1-x}Mn_xTe$, $Ge_{1-x-y}Mn_xEu_yTe$ and $Ge_{1-x-y}Mn_xYb_yTe$ are presented. We investigated Bridgman bulk crystals with Mn content up to 0.1 and Eu/Yb content up to 0.04. X-ray investigation revealed that the samples are single phase and showed that in the investigated composition range the crystals are rhombohedrally distorted. The Hall effect and electric conductivity measurements (up to 13 T in the temperature range 1.5-170 K) were performed using standard DC technique. Magnetic properties (magnetization vs. magnetic field and magnetic susceptibility vs. temperature) were studied using Lake Shore 7229 Magnetometer/ Susceptometer. Magnetization of studied samples was measured at magnetic fields up to 9 T at the very same temperatures as the transport measurements were done. The Curie temperature obtained for investigated materials containing Eu or Yb ions substantially exceeds the values of T_C reported in $Ge_{1-x}Mn_xTe$ crystals and layers with similar composition and carrier concentration, and reaches 150 K. The origin of that Curie temperature enlargement is not fully explained yet and is discusses elsewhere [2].

The simultaneous analysis of the total Hall coefficient and magnetization measurements data enabled us to determine the anomalous Hall coefficient RS value and its dependence on carrier concentration, crystal composition, and temperature. The results are discussed and compared with those obtained previously for analogous materials $Sn_{1-x-y}Mn_x(Er,Eu)_yTe$ [3].

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