Interplay of magnetic and transport properties in $Ge_{1-x-y}Pb_xCr_yTe$ Composite System

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GeTe-based semimagnetic semiconductors are a subject of intensive research in the recent years due to the presence of ferromagnetism induced by carrier mediated RKKY interaction. In particular, $Ge_{1-x}Cr_xTe$ crystals show relatively high Curie temperatures up to 150 K [1]. In the nanocomposite crystals with clusters of magnetic impurities a further increase of T_C might be observed.

The aim of this study was to investigate the structural, electrical and magnetic properties of bulk $Ge_{1-x-y}Pb_xCr_yTe$ crystals with average chemical content varying in the range of $0.181 < x < 0.220$ and $0.017 < y < 0.043$. XRD and SEM characterization showed all the samples are composite compounds consisting of GeTe-based matrix with PbTe and Cr-Te based clusters.

Two magnetic phase transitions were found in the studied system, the first between 130 and 150 K and the second around 40 K. The high temperature magnetic transition was identified as freezing of magnetic moments. Transition in lower temperatures changes from paramagnet-ferromagnet transition for crystals with 4.3 and 3.8 at.% into transition to spin-glass state for samples with lower average chromium contents.

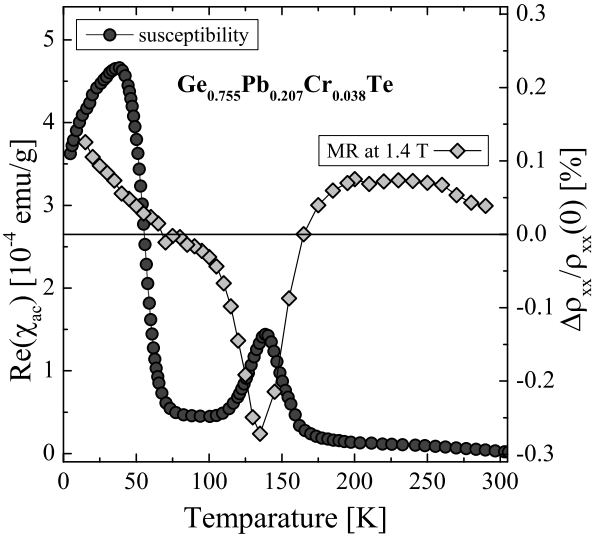

Figure 1: Temperature dependence of the real part of the ac magnetic susceptibility and magnetoresistance (MR) at $B = 1.4$ T for $Ge_{0.755}Pb_{0.207}Cr_{0.038}Te$ crystal.

All studied crystals are *p*-type semiconductors with high carrier concentrations, $n > 10^{20}$ cm^{-3}. The magnetotransport measurements showed negative magnetoresistance strongly correlated with the magnetic transition in the alloy. No signature of anomalous Hall effect was detected. Detailed analyzes were performed in order to explain the physical mechanisms responsible for the observed magnetotransport phenomena.

The research was supported by the Foundation for Polish Science - POMOST Programme co-financed by the European Union within European Regional Development Fund.

[1] Y. Fukuma et al. *Appl. Phys. Lett.* **89**, 152506 (2006).