Frustrated magnetic ordering in $Ge_{1-x-y}(Sn_xMn_y)Te$ multiferroics

Abdul Khaliq*,[1] Monika Arciszewska,[1] Andrei Avdonin,[1] Beata Brodowska,[1] Abbas Khan,[1] Witold Dobrowol-ski,[1] Vasya E. Slynko,[2] Evgen I. Slynko,[2] and Lukasz Kilanski[1]

[1]*Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL- 02668 Warsaw, Poland*
[2]*Institute of Materials Science Problems, Ukrainian Academy of Sciences, Chernovtsy, Ukraine*

Diluted magnetic semiconductor (DMSs) multiferroics offer intriguing possibilities and potential for spintronic applications due to the incorporation of magnetic ions in semiconducting lattice [1]. Ferroelectric GeTe based multiferroics propose striking properties to explore entanglement of magnetic and spin-orbit coupling in one system [2]. Further studies of these materials establish the basis for Rashba spin splitting, magnetoresistance, spin-torque manipulation of magnetic domains and novel quantum phases like topological insulators. In this work, we present systematic studies of ferroelectric GeTe based $Ge_{1-x-y}(Sn_xMn_y)Te$ crystals grown in the range $0.18 \leq x \leq 0.79$ and $0.020 \leq y \leq 0.086$, focused over their magnetic, magnetotransport and ferroelectric properties. We examined the ferroelectric phase transition temperature changes with the chemical composition of the samples. Temperature dependent ac susceptibility measurements were performed to explore the behavior of magnetic ordering of the chosen compositions. In extensively studied group IV-VI narrow band gap semiconductors, the Ruderrnan-Kittel-Kasuya-Yosida indirect-exchange in-teraction is known to mediate ferromagnetism via free carriers, here we report $Ge_{1-x-y}(Sn_xMn_y)Te$ multiferroic and its magnetic exchange interactions. Furthermore, multiferroic structures such as $Ge_{1-x-y}(Sn_xMn_y)Te$ present the possibility to understand the dynamics at the ferroic domain walls which could lead to atomic scale electronics [3].

Keywords: Diluted magnetic semiconductors, multiferroics, magnetoresistance, frustrated magnetic ordering.

References:

[1] T. Dietl et al. Rev. Mod. Phys. **86**, 187 (2014)
[2] J. Krempasky et al. Nature Communications **61**, 291 (2000)
[3] P. Schoenherr et al. Nano Lett. **19** 1659 (2019)

Acknowledgements *The research was financed by the National Science Centre, Poland under the project number 2018/30/E/ST3/00309.*