Anomalous Hall Effect in Antiferromagnetic MnTe: the Role of Domain Structure

K. P. Kluczyk[1], P. Skupiński[2], M. J. Grzybowski[1], M. A. Borysiewicz[3], E. Łusakowska[2], W. Wołkanowicz[2], J. Z. Domagała[2], K. Grasza[2], A. Mycielski[2], K. H. Ahn[4], K. Výborný[4], K. Gas[2], M. Sawicki[2] and M. Gryglas-Borysiewicz[1]

[1]*Faculty of Physics, University of Warsaw, Pasteura 5, Warsaw, Poland,*
[2]*Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, Warsaw, Poland,*
[3]*Łukasiewicz Research Network - Institute of Microelectronics and Photonics, Al. Lotników 32/46, Warsaw, Poland,*
[4]*Institute of Physics, Academy of Sciences of the Czech Republic, Cukrovarnická 10, Praha, Czech Republic,*

Antiferromagnets get increasing attention as their magnetic state has a significant influence on resistivity state opening way to applications in data transfer and storage [1, 2]. One of the most interesting effects is the anomalous Hall effect (AHE): non-zero transverse voltage, present in spite of magnetic compensation. Here hexagonal MnTe is a model platform: it is a room temperature antiferromagnetic semiconductor with colinearly arranged Mn magnetic moments in antiferromagnetically coupled planes, perpendicular to $\langle 0001 \rangle$, for which hysteresis in the AHE has just been demonstrated [4, 5]. It has been predicted that the existence of the AHE in MnTe depends on the orientation of the Néel vector ($\vec{n}$) relative to the crystal axis [5]. In particular, for $\vec{n}$ oriented along $\langle 10\bar{1}0 \rangle$ the Berry curvature has a non-zero integral and giving rise to the AHE, while for the perpendicular directions ($\langle 11\bar{2}0 \rangle$, $\langle 0001 \rangle$) the AHE is forbidden by symmetry. In this paper, we adress the dependence of the AHE on crystalline directions in MnTe.

Bulk samples were prepared to measure the resistivity tensor $\hat{\rho}$ along different crystal directions in the hexagonal lattice. We show that regardless of the direction in the (0001) plane, the AHE hysteresis is present. This observation suggests the contribution to the AHE from other domains rotated by 60° from $\langle 10\bar{1}0 \rangle$. There is no AHE hysteresis when $\vec{B}$ is applied in (0001) plane. In this configuration we see a resistance decrease when magnetic field is appied, corresponding to reorientation of the in-plane domains.

The impact of both, local domain structure and crystal symmetry on the anomalous Hall effect will be discussed.

[1] P. Wadley et al., *Science* **351**, 587–590 (2016).
[2] L. Baldrati et al., *Phys. Rev. Lett.* **123**, 177201 (2019)
[3] L. Šmejkal et al., *Phys. Rev. X* **12**, 040501 (2022)
[4] R. D. G. Betancourt et al., *Phys. Rev. Lett.* **130**, 036702 (2023)
[5] K. P. Kluczyk et al., arXiv: 2310.09134 (2023)