Non-linear Hall Effect at the Interface of Pt and MnSe

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Anomalous Hall effect (AHE) is present in diverse material systems. In ferromagnets, it depends directly on the magnetization of the material and therefore may provide important information about magnetic properties. It can be also present in Pt interfaced with magnetic insulating materials (such as yttrium iron garnet or antiferromagnetic oxides) likely due to the magnetic proximity effect. However, even Pt on its own exhibits AHE under the influence of strong external electric field [1]. Research on AHE in heterostructures containing Pt layer has mainly focused on ferromagnetic metals or insulating antiferromagnets, leaving antiferromagnetic semiconductors unexplored. In our study, we investigate wurtzite MnSe - a novel phase predicted to exhibit altermagnetic band spin-splitting [2] - to explore its magnetic structure experimentally by interfacing it with Pt.

We conduct magnetotransport measurements on molecular beam epitaxy (MBE) grown structures containing wurtzite MnSe (20 nm) and thin Pt (5 nm) as a top layer in a wide temperature range. We observe non-linear Hall resistivity resembling the AHE that changes its sign upon reducing the temperature below 25 K (Fig. 1), which is not expected to occur for Pt itself [1]. Hence, we conclude that MnSe interface is responsible for the observed behavior of the Hall resistance.

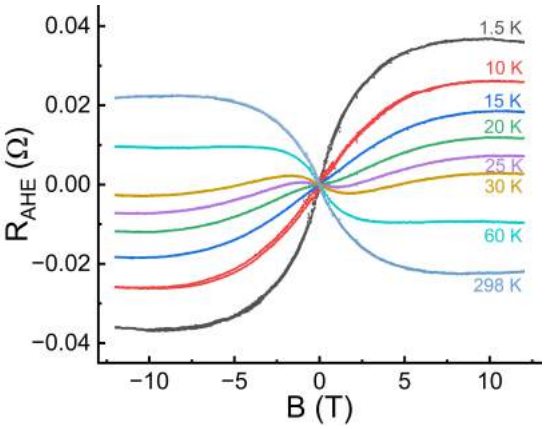

Figure 1: Non-linear Hall effect measured at different temperatures.

Moreover, we explore temperature dependence of resistivity to look for magnetic phase transitions in wurtzite MnSe. We also aim to identify spin Hall magnetoresistance (SMR) through slight variations in magnetoresistance resulting from interactions at the MnSe/Pt interface.

In summary, we identify non-linear Hall effect in heterostructures of MnSe and Pt and confirm that such systems can be interesting for spintronics and fundamental research of solid state interface physics.

[1] Shimizu, S. et al. "Electrically Tunable Anomalous Hall Effect in Pt Thin Films", Phys. Rev. Lett. 111, 216803 (2013), DOI:10.1103/PhysRevLett.111.216803

[2] Grzybowski, M. J. et al. "Wurtzite vs rock-salt MnSe epitaxy: electronic and altermagnetic properties", Nanoscale (2024), DOI:10.1039/D3NR04798A

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