Proximity enhanced room temperature ferromagnetism in $Fe_5GeTe_2/PtSe_2$ van der Waals heterostructure

Roselle Ngaloy
Bing Zhao
Saroj P. Dash
Department of Microtechnology and Nanoscience, Chalmers University of Technology, SE-41296, Göteborg, Sweden
ngaloy@chalmers.se

The van der Waals (vdW) ferromagnets and their heterostructure with complementary quantum materials are emerging systems for spintronics and quantum technologies. However, it has been highly challenging to achieve above room-temperature ferromagnetism and their heterogeneous integration with other vdW materials. The family of Fe_5GeTe_2 is among the first room-temperature metallic vdW material to be synthesized. In our previous work, we have demonstrated room temperature spin-valve devices with Fe_5GeTe_2 (FGT)[1] – characterized with a canted magnetic moment, and Co-doped Fe_5GeTe_2 (CFGT) – with in-plane anisotropy, in graphene transport channels. Anomalous Hall effect measurements of FGT flakes in these devices show soft ferromagnetic behaviour, which poses a problem for device stability in memory and logic applications. Here, we report the proximity enhanced above room temperature ferromagnetism in FGT in van der Waals heterostructure with a semimetal $PtSe_2$. Using anomalous Hall effect (AHE) measurements, we observe a substantial increase in remanence and coercivity of FGT with a perpendicular magnetic anisotropy in a hybrid structure with $PtSe_2$ at room temperature, indicating a proximity-induced effect. We suspect that the interfacial proximity exchange coupling could significantly enhance the intralayer spin interaction in FGT, hence giving rise to enhanced magnetic moments and anisotropies. Our findings provide the potential for the vdW heterostructure interface engineering and its implementation towards an all-vdW high-performance spin-orbit torque memory and logic devices.

References

[1] Bing Zhao, Roselle Ngaloy, Sukanya Ghosh, Soheil Ershadrad, Rahul Gupta, Khadiza Ali, Anamul Md. Hoque, Bogdan Karpiak, Dmitrii Khokhriakov, Craig Polley, B. Thiagarajan, Alexei Kalaboukhov, Peter Svedlindh, Biplab Sanyal, Saroj P. Dash, Advanced Materials, 2209113 (2023)

Figures

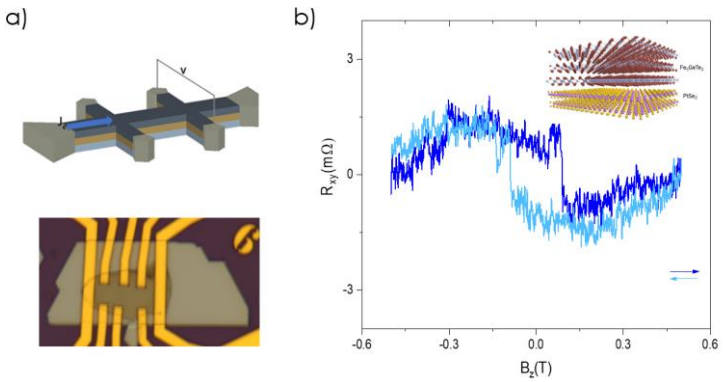

Figure 1: AHE effect of $FGT/PtSe_2$ at room temperature. (a) Microscopic picture of the devices with AHE measurement geometry. (b) Rxy vs. magnetic field at room temperatures for Fe_5GeTe_2 on $PtSe_2$ at room temperature (293 K). The ordinary Hall contribution with a linear background is subtracted from the measured data.