Spin pumping and probe in permalloy dots-topological insulator bilayers

H. C. Han[1], Y. S. Chen[2], M. D. Davydova[3], P. N. Petrov[3], P. N. Skirdkov[3, 4, 5], P.A. Stremoukhov[3], J.G. Lin[2], J.C. Wu[1], J.C.A. Huang[6], K. A. Zvezdin[3, 4, 5] and A. K. Zvezdin[3, 4, 5]

[1]Department of Physics, National Changhua University of Education, Changhua 500, Taiwan

[2]Center for Condensed Matter Sciences, National Taiwan University, Taipei 106, Taiwan

[3]Moscow Institute of Physics and Technology, 141700, Dolgoprudny, Russia

[4]Russian Quantum Center, Skolkovo, Moscow Region 143025, Russia

[5]Prokhorov General Physics Institute, RAS, 119991, Moscow, Russia

[6]Department of Physics, National Cheng Kung University, Tainan 701, Taiwan

Spin-orbitronics is considered as one of the most promising directions of spintronics due to the high excitation eciency of magnetization dynamics using of spin-orbit coupling (SOC) effects. Among many SOC materials the topological insulators stand out due to their high spin-to-charge conversion factors as well as the potential of utilization of the surface states. In the recent experimental works [1,2,3,4]]the 3D topological insulator Bi2Se3 was shown to possess the outstanding level of the spin-charge conversion, which leads to ample opportunities of magnetization control.

We present the ferromagnetic resonance (FMR) spin pumping experiment along with the theoretical study of spin-to-charge conversion in the periodic arrays of permalloy nanodots deposited onto 3D topological insulator Bi2Se3. Two resonance peaks are observed and related to the Kittel and the inhomogeneous edge modes respectively. The features of the magnetization dynamics under FMR excitation in a nanodot are successfully simulated with micromagnetic modelling. A numerical approach for calculating the spin-pumping voltage is proposed; the corresponding voltages are simulated using micromagnetic modeling data. The efficiency of spin-to-charge conversion is estimated for two nanostructured systems with di erent dot-size. In the report the results of the following experiments with Bi_3Se_3- based topological insulator will be presented:

Our data suggest that topological insulators could enable very efficient electrical manipulation of magnetic materials at room temperature in memory and logic applications, supersensitive spin diodes, neuromorphic structures and other advanced spintronic applications.

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1. A. Mellnik, J. Lee, A. Richardella, J. Grab, P. Mintun, M. H.Fischer, A. Vaezi, A. Manchon, E.-A. Kim, N. Samarth, et al.,Nature 511, 449 (2014).
2. A. Figueroa, A. Baker, L. Collins-McIntyre, T. Hesjedal, and G. van der Laan, Journal of Magnetism and Magnetic Materials 400, 178 (2016), proceedings of the 20th International Conference on Magnetism (Barcelona) 5-10 July 2015.

3. F. B. Abdulahad, J.-H. Lin, Y. Liou, W.-K. Chiu, L.-J. Chang, M.-Y. Kao, J.-Z. Liang, D.-S. Hung, and S.-F. Lee, Phys. Rev. B 92, 241304 (2015).
4. H. C. Han, Y. S. Chen, M. D. Davydova, P. N. Petrov, P. N. Skirdkov, J.G. Lin, J.C. Wu, J.C.A. Huang, K. A. Zvezdin, and A. K. Zvezdin, App.Phys.Lett (2017) – accepted.