Giant spin dependent transport phenomena in topological insulator – ferromagnet multilayers

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Novel spin related phenomena originating from topological surface states in topological insulator (TIs) have become a very exciting topic in spintronics. Exploring those phenomena in TI/ ferromagnet heterostructures not only provides new insights into the spin physics in TIs but also opens the pathway to novel spintronic devices. In this talk, we report various giant spin-related transport phenomena in BiSb topological insulator – ferromagnet multilayers, with focus on the giant spin Hall effect generated by the topological surface states in BiSb for ultralow power SOT-MRAM and racetrack memory applications. Here, BiSb is a narrow-gap topological insulator with multi surface states and high carrier mobility, thus it has high electrical conductivity which is necessary for spintronic applications [1]. We found that BiSb can generate a large spin current for ultralow power spin-orbit-torque switching in both epitaxial [2] and non-epitaxial BiSb/ferromagnet heterostructures [3-5]. We also found a large interfacial Dzyaloshinskii–Moriya interaction and ground-state skyrmions in BiSb/MnGa bilayers even at room temperature [6]. Furthermore, we observed a giant unidirectional spin Hall magnetoresistance effect up to 1.1% in a BiSb/GaMnAs bilayer [7]. Those giant phenomena can be utilized to significantly improve the performance of SOT-MRAM [8,9] and racetrack memories.

REFERENCES

[1] Y. Ueda, N. H. D. Khang, K. Yao, and P. N. Hai, *Appl. Phys. Lett.* 110, 062401 (2017).
[2] N. H. D. Khang, Y. Ueda, P. N. Hai, *Nature Mat.* 17, 808 (2018).
[3] N. H. D. Khang, S. Nakano, T. Shirokura, Y. Miyamoto, P. N. Hai, *Sci. Rep.* 10, 12185 (2020).
[4] T. Fan, N. H. D. Khang, T. Shirokura, H. H. Huy, P. N. Hai, *Appl. Phys. Lett.* 119, 082403 (2021).
[5] T. Fan, N. H. D. Khang, S. Nakano, P. N. Hai, *Sci. Rep.* 12, 2998 (2022).
[6] N. H. D. Khang, T. Fan, and P. N. Hai, AIP Adv. 9, 125309 (2019).
[7] N. H. D. Khang and P. N. Hai, *J. Appl. Phys.* 126, 233903 (2019).
[8] H. Wu *et al*., *Nature Commun.* 12, 6251 (2021).
[9] N. H. D. Khang *et al*., *Appl. Phys. Lett.* 120, 152401 (2022).