2nd Spintronics Research Network Seminar

Field-free spin-orbit torque switching and its applications

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2025 12/18 (Thu) 10:30-12:00

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Spin-orbit torque (SOT), arising from spin-orbit coupling-induced spin currents, has gained much attention because it promises efficient magnetization switching in spintronic devices, in particular magnetic random-access memory (MRAM) [1]. However, the switching is not purely electrical in laterally homogeneous structures. An extra in-plane magnetic field is required to achieve deterministic switching, and this is detrimental for device applications. Therefore, it is of crucial importance to find a way of field-free SOT switching of perpendicular magnetization along with reducing the switching current density for the widespread application of SOT technology.
In this talk, I will present various material engineering strategies for achieving field-free SOT switching with reduced switching current through the generation of out-of-plane spin currents and the associated torques. These include magnetic and antiferromagnetic trilayers as well as side-gated structures [2-4]. Furthermore, I will introduce novel SOT-based spintronic applications, such as spin logic devices, physically unclonable functions (PUFs) [5], and probabilistic bits [6].

[1] J. Ryu, et al., Adv. Mater. 32, 1907148 (2020)
[2] S-h C. Baek, et al., Nat. Mater. 17, 509 (2018)
[3] J. Ryu, et al., Nat. Electron. 5, 217 (2022)
[4] M-G. Kang et al., Nat. Commun. 12, 7111 (2021)
[5] S. Lee, et al., Adv. Mater. 34, 2203558 (2022) & J. Kang et al., ACS Nano, 18, 20, 12853 (2024)
[6] Under review

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