Engineering of antiferromagnetic materials for new concept spintronics devices

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The field of spintronics has evolved mainly with ferromagnetic materials, where antiferromagnetic materials have often played supporting roles. This trend has recently changed, and opportunities of antiferromagnetic materials have been revisited. Here I show our recent studies of the engineering of ferromagnetic and antiferromagnetic materials to realize new concept spintronics devices for ultralow-power integrated circuits and unconventional computing hardware. I will first present a current-induced analog-like control of magnetization in antiferromagnet/ ferromagnet or antiferromagnet/ nonmagnet bilayer systems that can function as artificial synapses and neurons for neuromorphic computing [1-5]. I will also show our latest results on a non-collinear antiferromagnetic Mn_3Sn thin films, which show unconventional response to electric current such as large anomalous Hall effect owing to the topology in momentum space [6].

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[1] S. Fukami *et al.*, Nat. Mater. **15**, 535 (2016).
[2] W. A. Borders *et al.*, Appl. Phys. Express **10**, 013007 (2017).
[3] A. Kurenkov *et al.*, Adv. Mater. **31**, 1900636 (2019).
[4] G. K. Krishnaswamy *et al.*, Phys. Rev. Appl. **14**, 044036 (2020).
[5] S. DuttaGupta *et al.*, Nat. Commun. **11**, 5715 (2020).
[5] J.-Y. Yoon *et al.*, Appl. Phys. Express **13**, 013001 (2019).