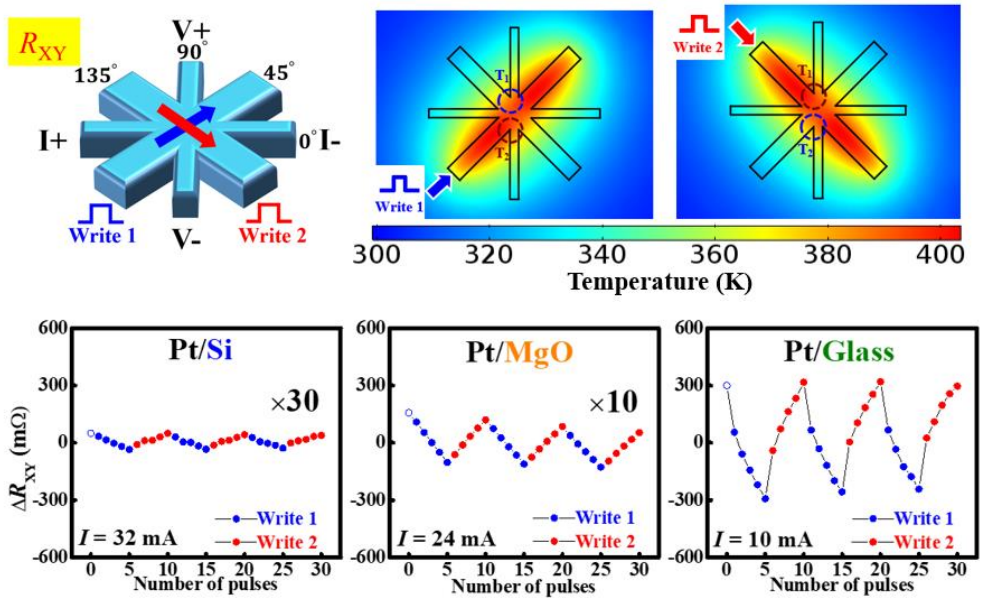
Absence of Evidence of Electrical Switching of the Antiferromagnetic Néel Vector

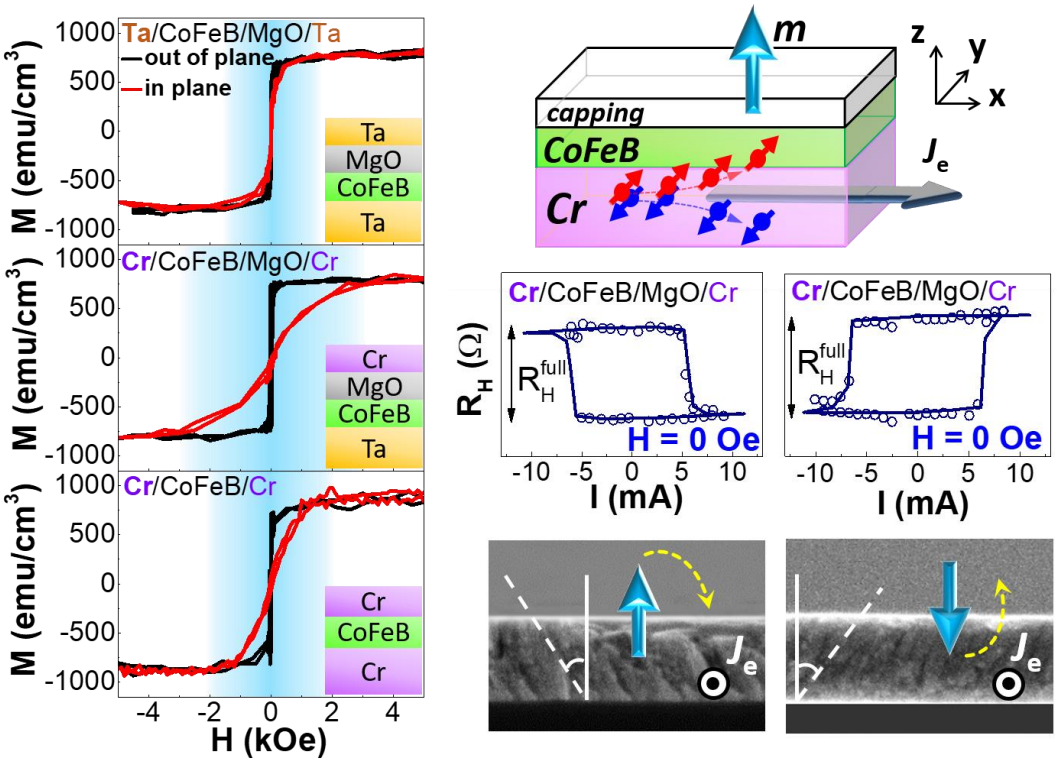
Antiferromagnet with zero net magnetization has several unique advantages, including ultrafast dynamics in the terahertz frequencies, robust against field perturbation, and generating no stray field. Recently, there have been numerous reports of electrical switching of antiferromagnetic (AFM) Néel vector via spin-orbit torque (SOT) attracting worldwide attention. By applying a write current in the AFM layer or the normal metal (NM)/AFM bilayer, in a patterned multiterminal structure, the measured resistance shows recurring signals due to supposedly electrical switching of the AFM Néel vector. However, the researchers including those at the Department of Physics (Professor Ssu-Yen Huang, Chih-Chieh Chiang) of the National Taiwan University and the Institute of Physics, Academia Sinica (Dr. Danru Qu) demonstrate that similar signals can be observed in such patterned structures, with and *without* the AFM layer. This widely held switching signal may not be conclusive evidence of SOT switching of AFM but the thermal artifacts of patterned metal structure on substrate. We show that under a large writing current density beyond the Ohmic regime, the multiterminal devices can generate unintended anisotropic thermal gradients and voltages. As a consequence, the strength of the signal is greatly affected by the thermal conductivity of the substrates. Our results seriously question the validity, and indeed the prospect, of SOT switching of AFM Néel vector. We indicate AFM switching requires unequivocal detection of the AFM Néel vector before and after the SOT switching. This work is published in **Physical Review Letter** (**123**, 227203 (2019)) and is highlighted as an ***Editor's suggestion and Featured in Physics***.



C. C. Chiang, S. Y. Huang*, D. Qu, P. H. Wu and C. L. Chien, Phys. Rev. Lett. **123**, 227203 (2019), ***Editors' Suggestion & Featured in Physics***.
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.123.227203

Cr-induced Perpendicular Magnetic Anisotropy and Field-Free Spin-Orbit-Torque Switching

Current-induced spin-orbit torque (SOT) switching in a heterostructure with perpendicular magnetic anisotropy (PMA) has attracted great attention as a new writing method for spintronic devices. However, this highly attractive switching scheme is often accompanied by an unfavorable external magnetic field. In this work, we demonstrate polarity-controlled *field-free* SOT switching in 3d Cr. Moreover, we find that Cr metal can induce strong interfacial PMA, without either heavy metal or MgO layer. Most importantly, field-free SOT switching could be achieved without introducing asymmetrical geometrical pattern, heavy metal, additional ferromagnetic or antiferromagnetic layers. We show that the underlying cause for the deterministic field-free switching lies in the slanted columnar microstructure, whose tilting angle is only around 5°, for the otherwise uniform thin films. The direction of oblique columnar structure dictates the up and down orientations of the PMA layer. Our results uncover the significant role of 3d materials and shed light on field-free SOT magnetization switching. This work is published in **Physical Review Applied** (**11**, 061005 (2019)) as a ***letter***.



T. C. Chuang, C. F. Pai, and S.Y. Huang*, Phys. Rev. Appl. **11**, 061005 (2019), ***Letter***
https://journals.aps.org/prapplied/abstract/10.1103/PhysRevApplied.11.061005