Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Webinar

Antiferromagnetic spintronics for low-power computing

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The demand for Artificial Intelligence and Big Data along with the increasing volume of digital information, has led to increasing demand for high-speed, low-power consuming multifunctional electronic devices at reduced dimensions. Spintronics offers a viable route to achieve these objectives through the concerted utilization of spin, charge, and orbital degrees of freedom, paving the way towards realizing non-volatile, power-efficient, and high-density architectures, complementing CMOS technology. In this regard, antiferromagnetic materials, exhibiting ultrafast spin dynamics, absence of parasitic stray magnetic fields, variety of current-induced magnetoresistive effects, robustness against external perturbation, and cost-effective material availability possess great potential as outstanding candidates for future spintronic devices and applications. Here, I will present our arduous yet rewarding progress on antiferromagnet (AFM)-based spintronics. First, we will briefly elucidate charge-to-spin conversion capabilities (or spin Hall effect) in metallic AFMs, a crucial ingredient for the realization of three-terminal low-power spintronic structures. Using this charge-to-spin conversion effect, we demonstrate magnetization switching of an adjacent FM in AFM/FM structure. Contrary to convention, magnetization switching occurs in an analogue manner, enabling us to demonstrate proof-of-concept nanoscale non-volatile spintronic memristors, promising for the development of neuromorphic architectures. Building from these results, we will then introduce a novel pathway where AFMs emerge as the sole active component of spintronic devices. We will demonstrate the key capabilities of electrical reading and writing of information in AFM/heavy-metal (HM) heterostructures, all in CMOS-friendly material systems. The present experimental results demonstrate the prospect of AFMs for ultra-fast and low-power spintronic hardware, beneficial for the realization of next-generation memories and neuromorphic computing architectures.

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