Research Highlight

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Atomic-scale engineering of oxide interfaces yields a new family of synthetic magnetic structures

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A grand challenge in the field of magnetism is to find material systems that exhibit spin structures ranging from simple ferromagnets to exquisite non-collinear states. In bulk three-dimensional (3D) materials, however, the magnetic exchange interactions are built-in by the crystal symmetry and quantum chemistry, making it challenging to adjust the intrinsic magnetic structure. A major advance for the custom-design of spin structures was the discovery that the exchange interaction can be fine-tuned in nanoscale thin film multilayers to produce either ferromagnetic (FM) or antiferromagnetic (AF) interactions. This effect, known as interlayer exchange coupling (IEC), is adjustable using a thin nonmagnetic spacer layer interleaved between two magnetic layers. The first indisputable experimental evidence of this magnetic coupling was demonstrated in the 1980's using metallic Fe/Cr and rare-earth based multilayers[1]. The ability to engineer the exchange interaction introduced an unprecedented level of control to produce nanostructures known as synthetic antiferromagnets (Fig. 1). Ultimately, this led to the discovery of novel transport and spintronic phenomena culminating in the 2007 Nobel Prize (https://www.nobelprize.org/nobel_prizes/physics/laureates/2007).

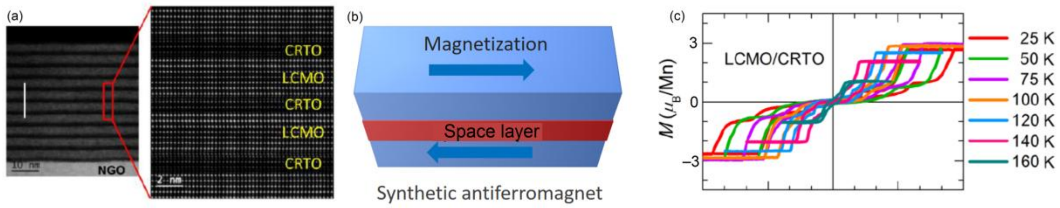

Fig 1. (Color online) **(a)** Cross-sectional transmission electron microscope image of a $La_{2/3}Ca_{1/3}MnO_3$ (LCMO)/$CaRu_{1/2}Ti_{1/2}O_3$ (CRTO) superlattice with 10 repeating units, with atomically matched interfaces. (b) Simplified schematic of a single unit of a synthetic antiferromagnet. (c) Magnetic hysteresis loop of a LCMO/CRTO superlattice showing antiferromagnetic exchange coupling. Reprinted with permission from Ref. [2], Copyright © 2017 AAAS