Interface Magnetization Transition via Minority Spin Injection at Multiferroic Oxide Interface

G. Lüpke,[a] F. Fang,[a] Y. W. Yin,[b] Qi Li[b]

[a] *Department of Applied Science, College of William & Mary, Williamsburg, Virginia 23187, USA*

[b] *Department of Physics, Pennsylvania State University, University Park, Pennsylvania 16802, USA*

Electric-field control of magnetism is a key issue for future development of low-power spintronics and magnetic random access memories. In multiferroic tunnel junctions the magnetoelectric (ME) coupling enables an electric field to manipulate the interfacial magnetization through switching of the ferroelectric (FE) polarization resulting in a four-state resistance and large tunneling electroresistance effect. Here we selectively probe the interface magnetization of the n-type $BaTiO_3/La_{0.7}Sr_{0.3}MnO_3$ (BTO/LSMO) heterojunction and discover a new interface ME effect [1]. The injection of minority spins at the interface causes a sudden, reversible transition of the spin alignment of interfacial Mn ions from ferromagnetic (FM) to antiferromagnetic (AFM) exchange coupled (Fig. 1), while the bulk magnetization remains unchanged. We attribute the emergent interfacial AFM interactions to weakening of the double-exchange mechanism caused by the strong Hund's rule coupling between injected minority spins and local magnetic moments. The effect is robust and may serve as a viable route for electronic and spintronic applications.

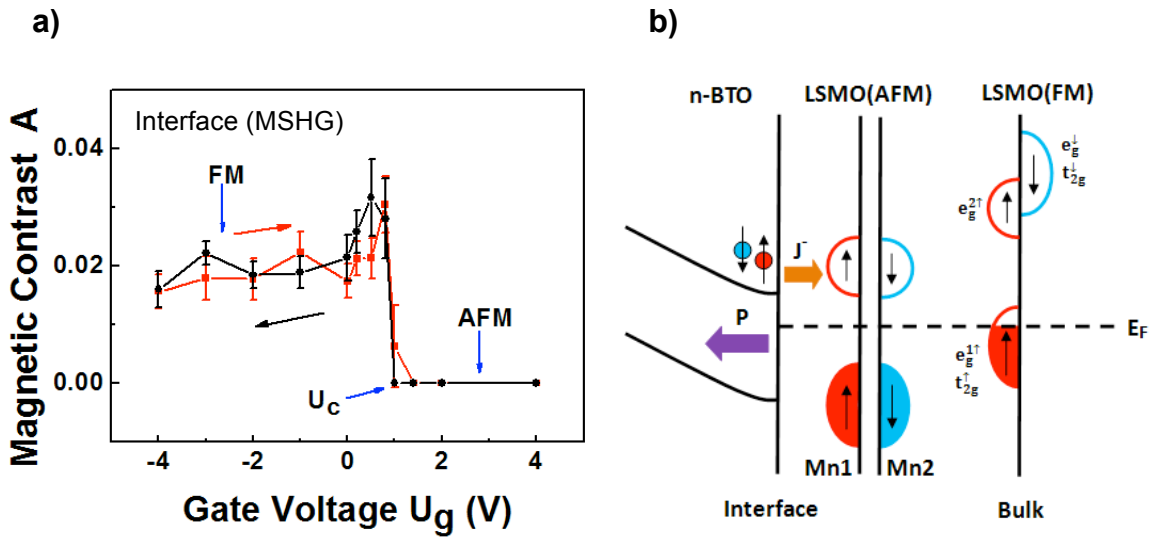

Figure 1: (a) Magnetic contrast A determined from MSHG hysteresis-loop measurements as a function of gate voltage U_g. The BTO/LSMO interface exhibits a FM-to-AFM phase transition at U_c, while the bulk LSMO maintains the FM state. (b) Schematic band diagram of the n-type BTO/LSMO Schottky junction for $U_g > U_c$, depicting the electron current J^-, ferroelectric polarization P, and considering an AFM-ordered LSMO interface layer and a half-metallic LSMO electrode with only spin-up states at the Fermi level E_F.

[+] Author for correspondence: Luepke@wm.edu

[1] F. Fang et al, Appl. Phys. Lett. 109, 232903 (2016).