Departamento de Física de Materiales

SEMINARIO

DISENTANGLING RESISTIVE SWITCHING MECHANISMS IN COMPLEX OXIDE-FERROELECTRIC JUNCTIONS

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Ferroelectric tunnel junctions hold much technological potential, for instance as random access memories, or as memristors in the nascent field of neuromorphic computing. The key for that is the large, remnant, reversible resistance switching observed upon application of voltage pulses across the junction (tunnel electro-resistance). Furthermore, for judiciously selected materials, that can be accompanied by a change in the electrode's physical properties (for example magnetism), which greatly enlarges the functionalities and the associated physics. Those effects are most often explained by electrostatics, namely by an asymmetric accumulation of screening charges in the electrodes, which makes electron tunneling depend on the ferroelectric polarization direction. Here we univocally demonstrate that a different microscopic mechanism plays a main role: changes in the oxidation state of the electrode due to oxygen electro-migration across the junction interfaces. This is shown using superconducting cuprate electrodes, whose ground-state is extremely sensitive to the oxygen content and can be determined via spectroscopic conductance measurements. Besides providing crucial understanding on resistive switching across complex-oxide/ferroelectric junctions, that mechanism could be exploited to realize Josephson junctions tunable by electric field pulses, thereby opening new avenue in the field of superconducting electronics.

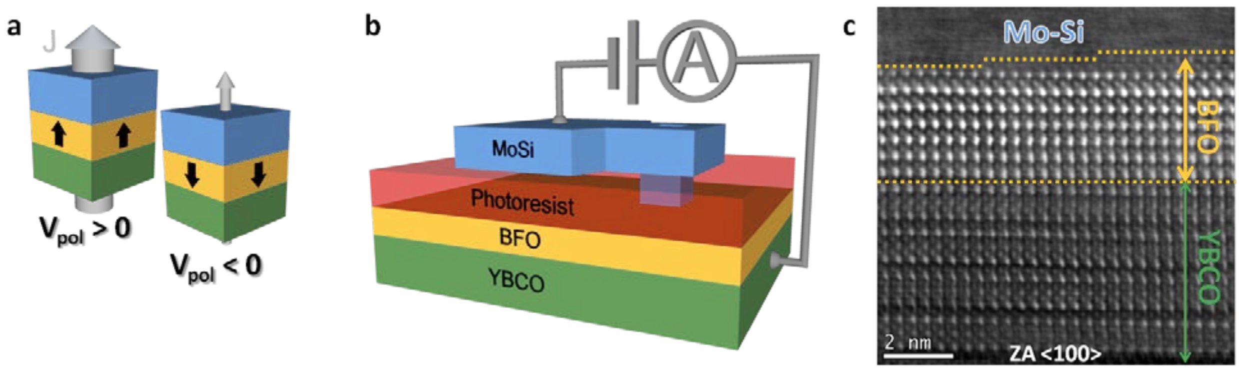

Figure 1: Ferroelectric tunnel junctions. (a) A tunnel junction whose barrier is ferroelectric can be reversibly switched between a high and low conductance states by the application a voltage pulse of amplitude V_{pol}, which sets the remnant ferroelectric polarization direction towards one electrode or the opposite. **(b)** Scheme of a superconductor/ferroelectric/superconductor tunnel junction based on a $YBa_2Cu_3O_{7-\delta}$/$BiFeO_3$ heterostructures on which a micrometric $Mo_{80}Si_{20}$ contact is made through an aperture across an insulating photo-resist overlayer. **(c)** Typical cross-sectional high angle annular dark field (ADF) micrograph of the MoSi (amorphous)/BFO/YBCO interface along the <100> zone axis. BFO grows epitaxially on top of the YBCO layer and the BFO/YBCO interface is abrupt and mostly defect free, other than occasional interface steps. Stacking faults consisting in double CuO_x chain layers can be observed YBCO layer, which not affecting the layer integrity nor the sharpness of the BFO/YBCO interface.