Dynamical electrical/optical addressing of solid-state tunneling

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Future electronics aims to deploy the intrinsic properties (eg ferroelectricity) of exotic inorganic or organic materials to achieve memory or computing devices. This field traditionally overlooks the impact of structural defects within the dielectric on device properties. Our team's research philosophy is to utilize the electronic properties of these nanoscale objects to predict and control the ensuing device properties. We've recently reported on how the ground (F+) and excited (F+*) states of oxygen vacancies within MgO alter spin- and symmetry-polarized solid-state tunneling (SST; see Figure) across the canonical MgO tunnel barrier [SCH14]. We thus resolved a glaring contradiction between 10+ year-old tunneling spintronics theory and experiment.

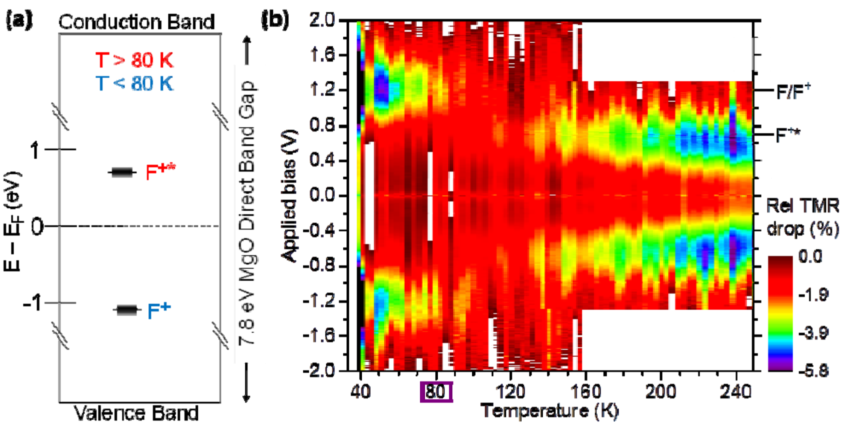

Figure: Impact of (a) the temperature-dependent, electronic symmetry-polarized potential landscape of the ground and excited (*) state of an oxygen vacancy F+ in MgO on b) the thermal decrease in tunneling magnetoresistance TMR(V,T) between FeCoB electrodes [SCH14].

This opens an exciting playground of solid-state physics revolving around the fundamental effect of SST. We propose to explore the electrical and optical dynamics (10^{-10}-10^{-3}s) of this playground. Our aim is to demonstrate a new paradigm for artificial synapses [ADV12,MIY12,KRZ12], and to offer insight into future information processing and quantum computing solutions. We've recently performed experiments on addressing SST using both laser light and synchrotron radiation, are also studying light emitted from these devices, and benefit from ab-initio theoretical support. The experimental PhD will consist in undertaking the first-ever dynamic multifunctional (T,V,H,light [in,out,polarization]) measurements within this playground. Interest in clean-room techniques and programming is a plus.

Starting References (* from the team):

[ADV12] *Advances in Neuromorphic Memristor Science and Applications*, Springer Series in Cognitive and Neural Systems 4, 9 (2012)
[KRZ12] *The Memristive Magnetic Tunnel Junction as a Nanoscopic Synapse-Neuron System*,P. Krzysteczko et al, Adv. Mater. 24, 762 (2012)
*[MIY12] *Robust spin crossover and memristance across a single molecule*, T. Miyamachi, et al. Nature Commun. 3, 938 (2012).
*[SCH14] *Localized states in advanced dielectrics from the vantage of spin- and symmetry-polarized tunneling across MgO*, F. Schleicher et al, Nature Comm. 5, 4547 (2014).