Manipulation of oxygen vacancies by local electric fields in 3d oxides

Oxygen vacancies play a central role in the physics and chemistry of transition metal oxides. For the case of 3d-oxoperovskites, the possibility of the metal to adopt different valence states, together with the stability of the structure in the presence of a large number of vacancies in the anion sublattice, offers a vast range of possibilities to control the magnetic, optical and transport properties of these materials. However, achieving a precise control over the amount of vacancies and their spatial distribution is still far from possible.

In the first part of this talk I will discuss the effect of epitaxial strain on the enthalpy of formation of oxygen vacancies in thin films of SrTiO3. I will describe the possibility of using the local electric field generated by an AFM-tip to create accumulation/depletion regions of oxygen vacancies in SrTiO3 with sub-micron resolution. Relaxation experiments were used to obtain the room temperature diffusion coefficient of the vacancies, under different degrees of epitaxial strain.

In the second part of the talk I will discuss how in some cases the electric field generated by the AFM-tip can be used to induce a local crystallographic transition between two states with different functionalities. In this case, oxygen vacancies accumulated by the electric field reorganize spontaneously to form a different crystal structure through a topotactic transformation, defining a new functional state with extra stability against diffusion. I will discuss the cases of SrFeO3-d and LaSrMnO3-d.