Surface Stabilized Antiferromagnetic Order: Superconductivity and Antiferromagnetism:

Low energy electron diffraction, scanning tunneling microscopy and spectroscopy, and first-principles spin-dependent density functional theory are utilized to investigate the geometric, electronic, and magnetic structures of the stripe-ordered (1×2) surface of $Ca(Fe_{1-x}Co_x)_2As_2$ (x = 0, 0.075). The figure below shows the bulk phase diagram (left) with the known spin ordering and the STM image of the stripped phase. The surface consists of half-Ca layer with a (1×2) structure. These surface Ca atoms move inward ~ 0.5 Å and the surface As-Fe_2-As layer is buckled. First-principles DFT calculations show that the (1×2) phase is stabilized by the bulk antiferromagnetic spin ordering through the spin-charge-lattice coupling. Furthermore, scanning tunneling spectroscopy measurements show the presence of a superconducting gap on the ordered (1×2) surface (x=0.075) at low temperature. But the spectra always have a finite zero-bias conductance indicating that the appearance of superconductivity coexisting with antiferromagnetic order is a result the proximity effect. The reconstructed surface, which tends to be an AFM ordered metal, is in close proximity to a superconducting bulk.