Imaging the dopant: Chirality and local electronic disturbance

Chemical doping in materials is known to give rise to emergent phenomena. These phenomena are extremely difficult to predict *a priori*, because electron-electron interactions are entangled with local environment of assembled atoms. Is the effect of the chemical dopant global or local? Is the distribution of dopants random or is there clustering and phase separation. Scanning tunneling microscopy and low energy electron diffraction were combined to investigate how the local electronic structure is correlated with lattice distortion on the surface of $Sr_3(Ru_{1-x}Mn_x)_2O_7$, which has double-layer building blocks formed by $(Ru/Mn)O_6$ octahedra with rotational distortion. The figure on the left shows the structure at the surface when the material is cleaved. The presence of doping-dependent tilt distortion of $(Ru/Mn)O_6$ octahedra at the surface results in a C_{2v} broken symmetry in contrast with the bulk C_{4v} counterpart. It also enables us to observe two Mn sites associated with the octahedral rotation in the bulk through the "chirality" of local electronic density of states surrounding Mn, which are randomly distributed. The atomically resolved image of the Mn defects and their chirality is shown in the figure at the right below. ßThese results serve as fingerprint of chemical doping on the atomic scale.