Visualizing short-range charge transfer at interfaces

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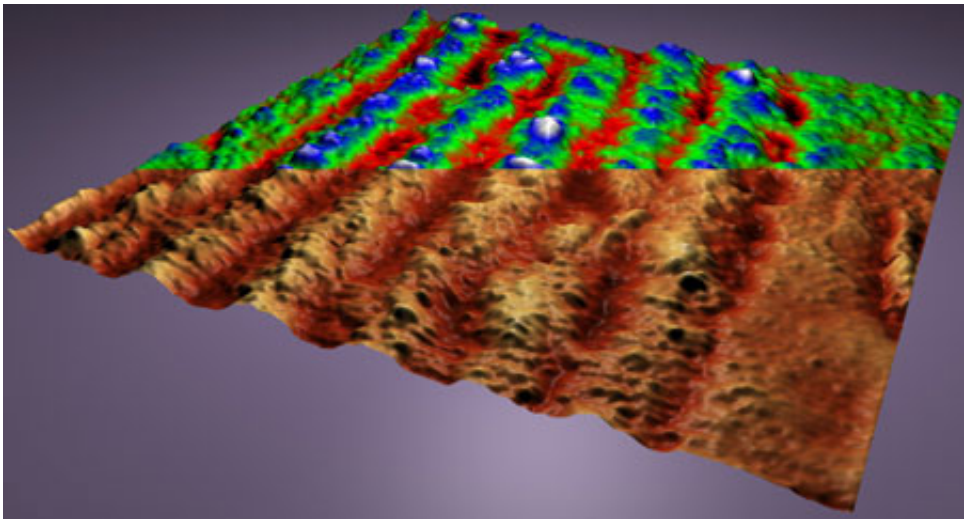

STM image that provides insight into topography as well as electronic properties; cross-sections of an oxide superlattice where peaks correspond to layers of cuprate superconductor and valleys to metallic manganites (bottom region).

The precise mechanisms governing the relationships between superconductivity and magnetism were examined by using advanced scanning tunneling microscopy (STM) at the Center for Nanoscale Materials by users from Argonne's Advanced Photon Source working with CNM's Electronic & Magnetic Materials & Devices Group. Using cross-sectional STM and spectroscopy together with atomic-resolution electron microscopy, the team developed a clearer picture of the physical and chemical behavior of interfaces between cuprate and

manganite layers within a complex-oxide-based superconducting/ferromagnetic material. The results show that the fundamental length sale of the electronic evolution between YBCO and LCMO is confined to the subnanometer range.

Previous measurements of magnetic and electronic properties in superconducting oxide materials relied on aggregate or "bulk" measurements of a large area. Because these materials do not have natural cleavage planes that provide scientists an easy way of looking directly at the interfaces between two dissimilar oxides, the Argonne team developed a way to precisely probe nanoscale features along the edges of the materials. The properties of electrons at such interfaces are not well-understood. When one layer is superconducting and the other is magnetic, the researchers needed to ascertain how these two dissimilar phases meet at their boundary. This required sampling the behavior of electrons in the region using especially sensitive STM techniques.

The findings provide a complete and direct microscopic picture of the electronic transition across a YBa2Cu3O7-d (YBCO) and La2/3Ca1/3MnO3 (LCMO) interface, which is an important step towards understanding the competition between ferromagnetism and superconductivity in complex-oxide heterostructures.

More information: Chien et al.,Visualizing short-range charge transfer at the interfaces between ferromagnetic and superconducting oxides, *Nature Communications*, 4, 2336 (2013). (DOI: 10.1038/ncomms3336)

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