Researchers discover physical origin of electronic phase separation phenomena in complex oxides

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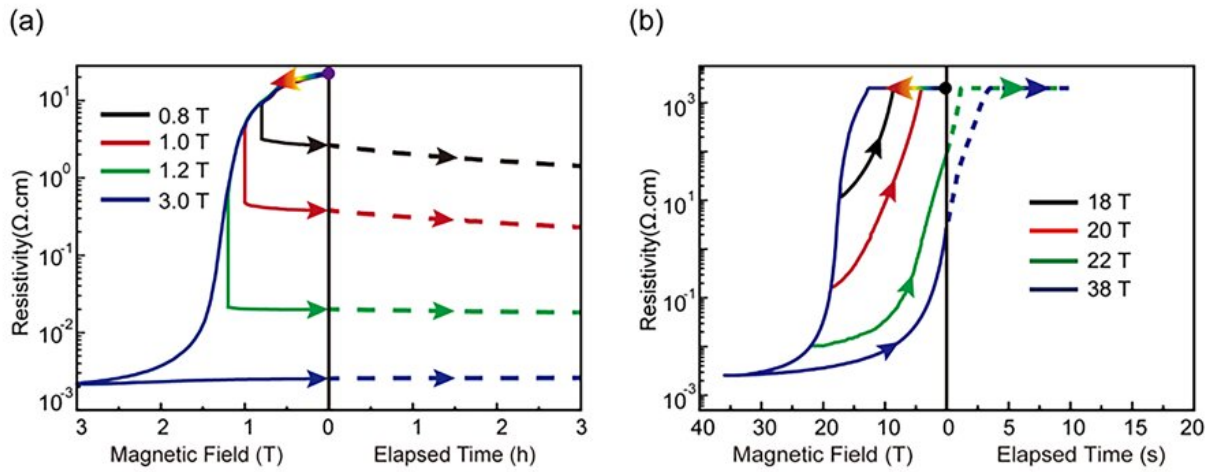

Low-temperature magnetoresistance after zero-field cooling. (a) Magnetoresistance of the alloy film at 10 K after zero-field cooling. (b) Same process as in A but for the ordered film at 0.38 K. Credit: MIAO Tian

A Chinese joint team has conducted a study and discovered the physical origin of electronic phase separation phenomena in complex oxides.

This work was done by SHen Jian from Fudan University in cooperation with Xi Chuanying and Tian Mingliang from the High Magnetic Field Laboratory, Hefei Institutes of Physical Science and was published in

Proceedings of the National Academy of Sciences.

Electronic phase separation (EPS) in manganite is the inhomogeneous spatial distribution of electronic phases, involving length scales much larger than those of structural defects or non-uniform distribution of chemical dopants.

Different theories have explained the origin of electron phase separation in manganese oxides in the early days. One theory suggests that the disorder caused by chemical doping is the origin of the electron phase separation in manganese oxides.

If perfectly "clean" samples could be grown, both phase separation and nonlinearities would be replaced by a bicritical-like phase diagram. However, it is very difficult to prepare fully ordered doped samples, and the study on the origin of electron phase separation in manganese oxides has been lacking in direct experimental verification, which is still controversial.

To tackle this problem, the team started their joint work on the Steady High Magnetic Field Facility (SHMFF) WM1 unit so they could collect experimental data under the extremely low temperature and strong magnetic field.

By using a layer-by-layer superlattice growth technique, they fabricated a fully chemically-ordered "tricolor" manganite superlattice, and compared their properties with those of isovalent alloyed manganite films.

They provided direct experimental evidence to show that the chemical-dopant induced disorder was the origin of electron phase separation in manganese oxides.

They reported a breakthrough in addressing a long-standing and challenging issue by revealing the physical origin of electronic phase separation phenomena in complex oxides.

More information: Tian Miao et al. Direct experimental evidence of physical origin of electronic phase separation in manganites, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1920502117

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