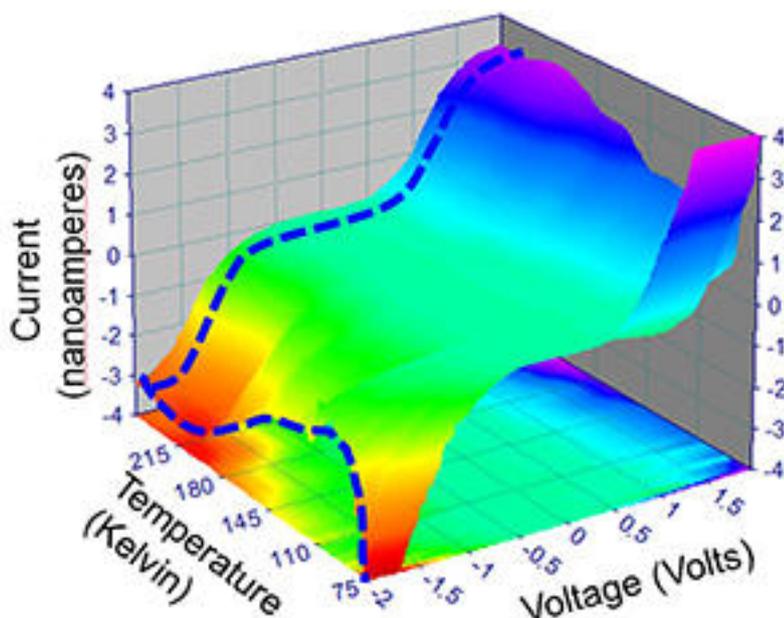


Unexpected Discovery goes beyond Surface of Oxide Films

Oak Ridge National Laboratory



OAK RIDGE, TN — Better batteries, electronic information storage, processing devices and catalysts are among potential benefits of an unexpected discovery made by Oak Ridge National Laboratory scientists using samples isolated from the atmosphere. Researchers at the Department of Energy lab learned that key surface properties of complex oxide films are unaffected by reduced levels of oxygen during fabrication — an unanticipated finding with possible implications for the design of functional complex oxides used in a variety of consumer products, said Zheng Gai, a member of DOE's Center for Nanoscale Materials Sciences at ORNL.

The findings are detailed in a paper published in *Nanoscale*.

While the properties of the manganite material below the surface change as expected with the removal of oxygen, becoming an insulator rather than a metal, or conductor, researchers found that the sample showed remarkably stable electronic properties at the surface. Gai emphasized that the robustness of a surface matters because it is precisely the surface properties that determine, influence and affect the functionality of complex oxides in catalysis and batteries.

"With these materials being a promising alternative to silicon or graphene in electronic devices, the ever-decreasing size of such components makes their surface properties increasingly important to understand and control," Gai said.

While this work provides a fundamental understanding of a material used and researched for catalysts, oxide electronics and batteries, Gai and lead author Paul Snijders noted that it's difficult to speculate about possible impacts.

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"I always say that, in basic science, we are discovering the alphabet," said Snijders, a member of ORNL's Materials Science and Technology Division. "How these letters will be designed into a useful technological book is hard to predict."

Making this discovery possible was the fact the authors did their experiment using scanning probe microscopy in a vacuum system with no exposure of the samples to the atmosphere. This contrasts with the conventional approach of growing a sample and then installing it in analysis equipment. During such a transfer, scientists expose the material to the water, nitrogen and carbon dioxide in the air.

By studying pristine samples, the ORNL team gained a surprising new understanding of the physics of the material surfaces — an understanding that is necessary to design new functional applications, Snijders said.

Other authors of the paper, titled "Persistent metal-insulator transition at the surface of an oxygen-deficient, epitaxial manganite film," are Min Gao, Hangwen Guo, Guixin Cao, Wolter Siemons and Thomas Ward of ORNL, Hongjun Gao of the Chinese Academy of Sciences and Jian Shen of Fudan University, China. Min Gao and Snijders contributed equally to this work, which was funded by DOE's Basic Energy Sciences. A portion of the research was conducted at the Center for Nanophase Materials Sciences. The paper is available at <http://pubs.rsc.org/en/content/articlelanding/2013/nr/c3nr02343e> [1].

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