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Delving into manganite conductivity

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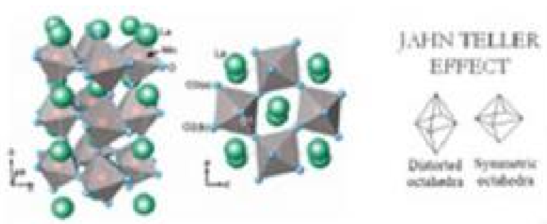

On the left, is a picture of the structure of LaMnO3. On the right, is a diagram of how the Jahn-Teller effect distorts the structure of LaMnO3.

(PhysOrg.com) -- Chemical compounds called manganites have been studied for many years since the discovery of colossal magnetoresistance, a property that promises important applications in the fields of magnetic sensors, magnetic random access memories and spintronic devices. However, understanding -- and ultimately controlling -- this effect remains a challenge, because much about manganite physics is still not known. A research team lead by Maria Baldini from Stanford University and Carnegie Geophysical Laboratory scientists Viktor Struzhkin and Alexander Goncharov has made an important breakthrough in our understanding of the mysterious ways manganites respond when subjected to intense pressure.

At ambient conditions, manganites have insulating properties, meaning they do not conduct electric charges. When pressure of about 340,000 atmospheres is applied, these compounds change from an insulating state to a metallic state, which easily conducts charges. Scientists have long debated about the trigger for this change in conductivity.

The research team's new evidence, to be published online by Physical Review Letters on Friday, shows that for the manganite $LaMnO_3$, this insulator-to-metal transition is strongly linked to a phenomenon called the Jahn-Teller effect. This effect actually causes a unique distortion of the compound's structure. The team's measurements were carried out at the Geophysical Laboratory.

Counter to expectations, the Jahn-Teller distortion is observed until LaMnO3 is in a non-conductive insulating state. Therefore, it is reasonable to believe that the switch from insulator to metal occurs when the distortion is suppressed, settling a longstanding debate about the nature of manganite insulating state. The formation of inhomogeneous domains—some with and some without distortion—was also observed. This evidence suggests that the manganite becomes metallic when the breakdown of undistorted to distorted molecules hits a critical threshold in favor of the undistorted.

"Separation into domains may be a ubiquitous phenomenon at high pressure and opens up the possibility of inducing colossal magnetoresistance by applying pressure" said Baldini, who was with Stanford at the time the research was conducted, but has now joined Carnegie as a research scientist.

Provided by Carnegie Institution

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