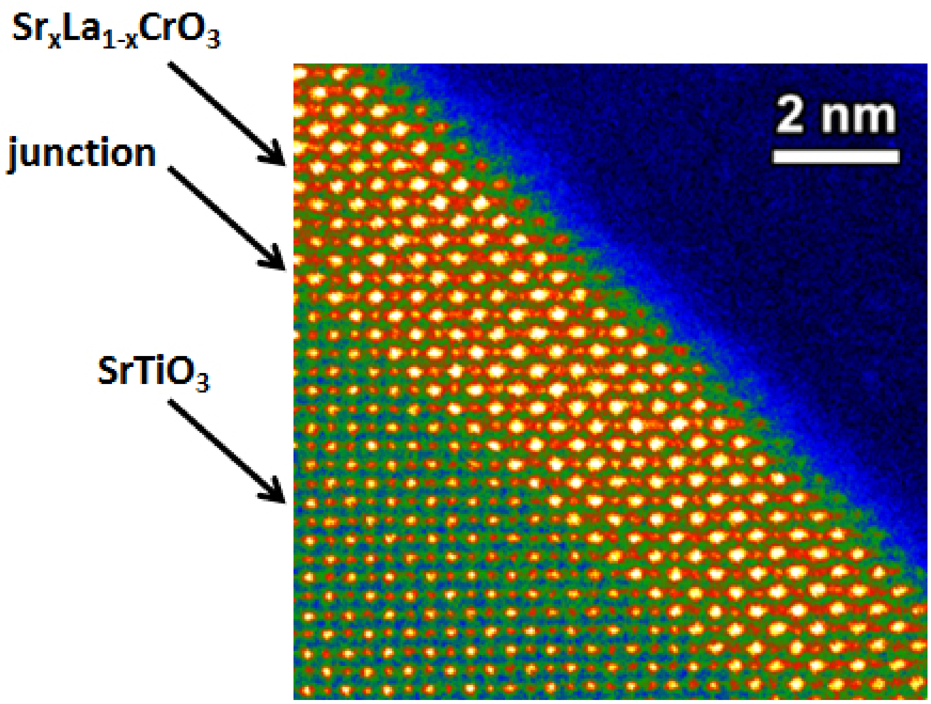
Specialized crystalline films revealed to be highly conductive and transparent

August 18 2015



$SrTiO_3$(001) heterojunction. The $Sr_{0.12}La_{0.88}CrO_3$ conducts holes and the SrTiO3 conducts electrons. When particles of sunlight (photons) are absorbed in the material, an electron and a hole are created, and they move to opposite sides of the junction: the electron to the $SrTiO_3$ and the hole to the $Sr_{0.12}La_{0.88}CrO_3$. If the junction is connected to an electrical circuit, the electricity created by the light can be used for electrical power (solar cell application), or to detect the incoming light (photodetector application).

The performance of solar cells, flat panel displays, and other electronics are limited by today's materials. A new material, created by modifying a transparent insulating oxide, replacing up to 25 percent of the lanthanum ions in the host material with strontium ions, offers considerable promise. The new perovskite film, with the formula $Sr_xLa_{1-x}CrO_3$, (x up to 0.25), conducts electricity more effectively than the unmodified oxide and yet retains much of the transparency to visible light exhibited by the pure material.

Materials that are both electrically conductive and optically transparent are needed for more efficient solar cells, light detectors, and several kinds of electronic devices that are by nature transparent to visible light. Of particular importance are new materials that conduct electricity by using missing electrons, otherwise known as "holes." The new perovskite film falls into this category.

The development of high-performance transparent conducting oxides (TCOs) is critical to many technologies ranging from flat panel displays to solar cells. Although electron conducting (n-type) TCOs are presently in use in many devices, their hole-conducting (p-type) counterparts have not been commercialized as candidate materials because they exhibit much lower conductivities. Scientists at Pacific Northwest National Laboratory along with collaborators at Binghamton University and the Paul Drude Institute in Berlin show that $La_{1-x}Sr_xCrO_3$ (LSCO) is a new p-type TCO with considerable potential. The researchers demonstrate that crystalline LSCO films deposited on $SrTiO_3$(001) by molecular beam epitaxy show figures of merit which are highly competitive with best p-type TCOs reported to date, and yet are more stable and structurally compatible with the workhorse materials of oxide electronics, as seen in the image. Being structurally and chemically compatible with other perovskite oxides, perovksite LSCO offers considerable promise in the design of all-perovskite oxide electronics.

More information: "Hole-Induced Insulator-to-Metal Transition in

$La_{1-x}Sr_xCrO_3$ Epitaxial Films." *Physical Review B* 91:155129. DOI: 10.1103/PhysRevB.91.155129

Provided by Pacific Northwest National Laboratory