New p-type, near-infrared transparent conducting thin films with better performance

January 19 2022, by Zhang Nannan

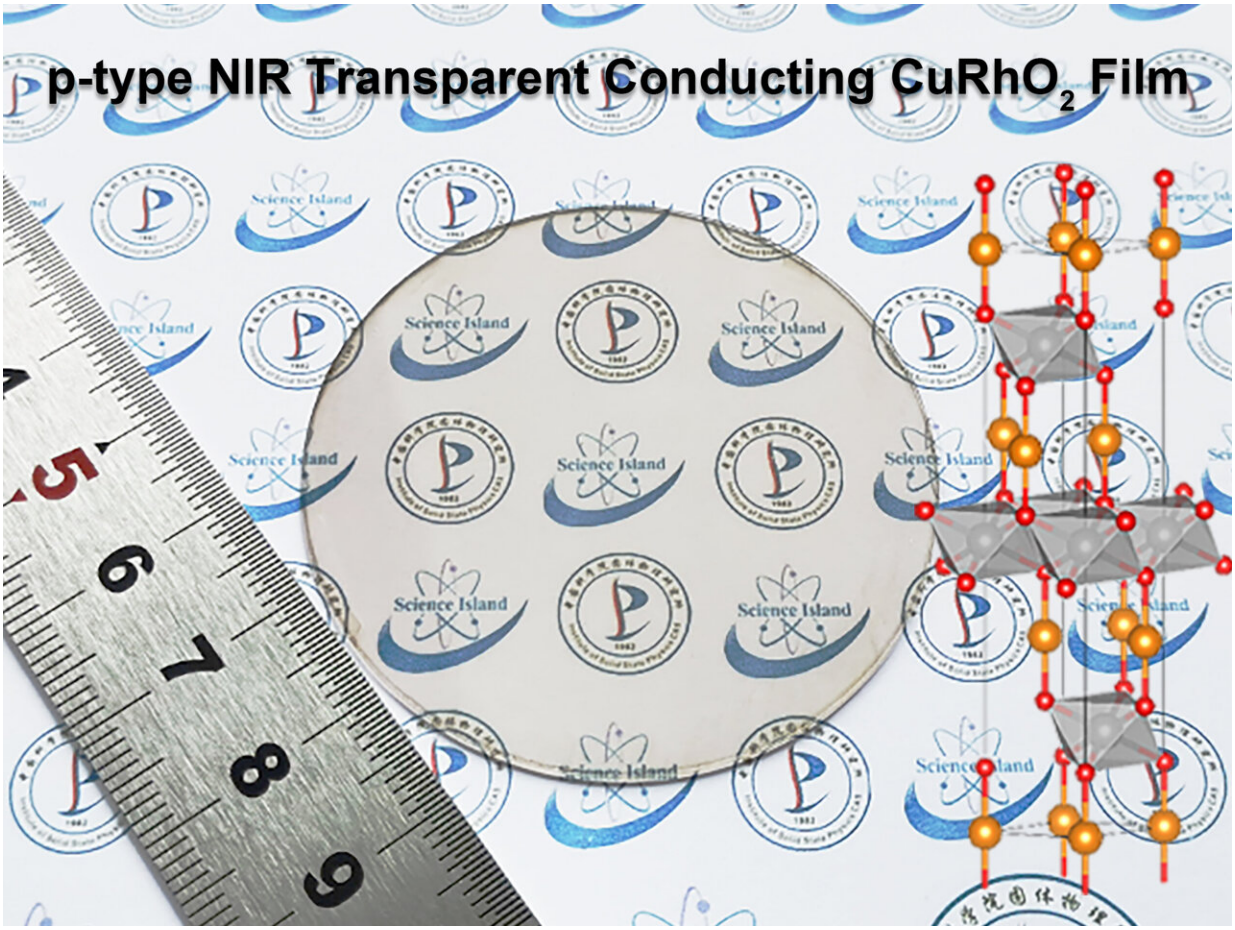

Fig. 1. Photo of p-type NIR TCCuRhO2 thin film with 2 inches size. Credit: Wei Renhuai

A group of scientists at the Hefei Institutes of Physical Sciences of the Chinese Academy of Sciences has developed new p-type (positive hole) near infrared (NIR) transparent conducting (TC) films with ultra-high conductivity, unveiling a new material of TC.

"They have extraordinary properties," Wei Renhuai, a physicist who led the team, "the NIR optical transmittance of the films can reach as high as 85~60%, while maintaining the film resistance at room temperature at a low level."

In recent years, p-type TC has attracted extensive attention. Although n-type (negative electron) TC is common in current market, the incorporation of p-type TC and n-type TC can achieve invisible active circuit heterostructure.

Compared with traditional delafossite-based P-type TC, the room-temperature conductivity of this novel TC is much higher. In addition, the films also exhibit high near-infrared transmittance with a low room-temperature sheet resistance.

In the experiment, based on the first-principles calculations, the scientists found that $CuRhO_2$ showed p-type conducting characteristics and processed a narrow indirect bandgap of 2.31 eV. Meanwhile, the optical absorption in the NIR and visible range is much low. The larger Rh^{3+} ionic radius makes the $CuRhO_2$ accept hole-type carriers with high concentration.

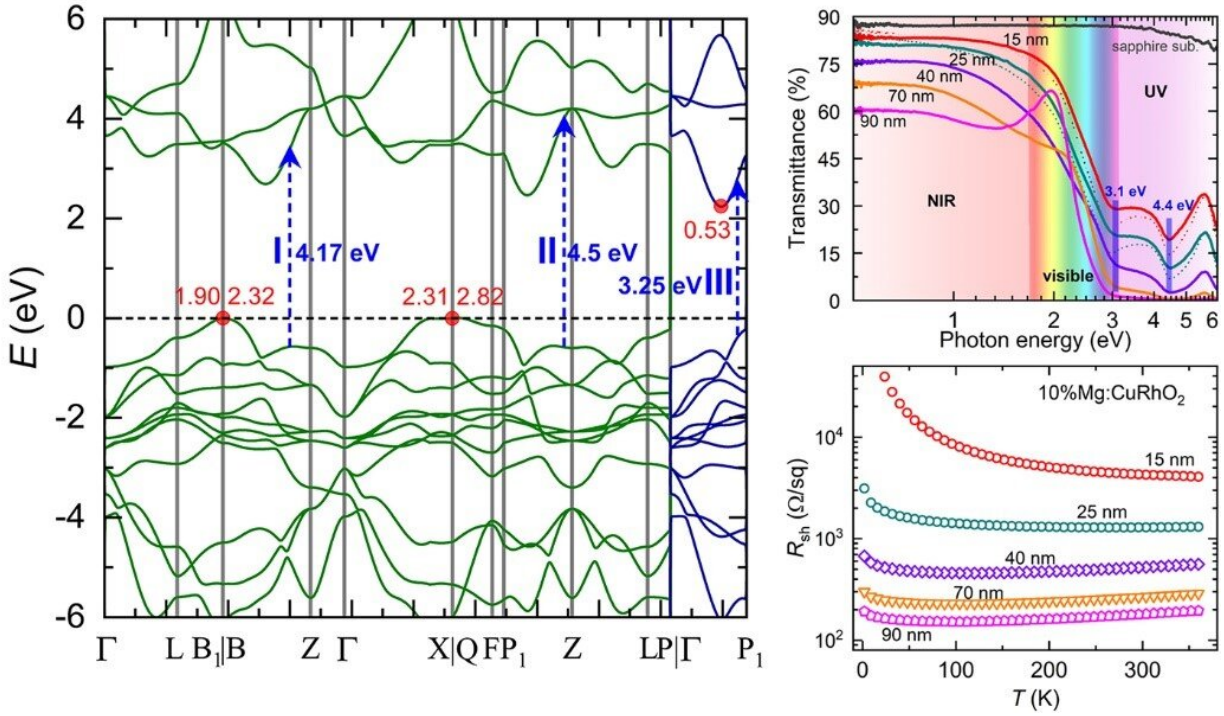

Fig. 2. Calculated electronic band structure for the $CuRhO_2$ (left).Optical transmittance and room-temperature sheet resistance for 10% Mg-doped $CuRhO_2$ thin films (right). Credit: Wei Renhuai

The great advance in p-type NIR TC $CuRhO_2$ thin films, based on both theoretical calculations and experimental results, will significantly improve the development of future multifunctional invisible optoelectronic devices.

More information: Chenhui Li et al, p-Type Near-Infrared Transparent Delafossite Thin Films with Ultrahigh Conductivity, *Advanced Optical Materials* (2022). DOI: 10.1002/adom.202102559

Provided by Chinese Academy of Sciences