PRESS RELEASE

Gwangju Institute of Science and Technology Researchers Demonstrate Improved Performance of Transition Metal Oxide Based Organic Photovoltaics

They achieve this by removing residual organic metal-binding ligands from the transition metal oxide thin films, enhancing device stability and performance

Organic photovoltaics with a transition metal oxide (TMOs) interface layer are emerging as a promising alternative to conventional silicon-based photovoltaics. However, their electrical properties are often affected by unwanted organic metal-binding ligands left behind in the TMO synthesis process. Now, Gwangju Institute of Science and Technology (GIST) researchers have addressed this issue using a technique called anion-induced catalytic reaction, which removes the residual ligands, resulting in a 20-fold enhancement in electrical conductivity.

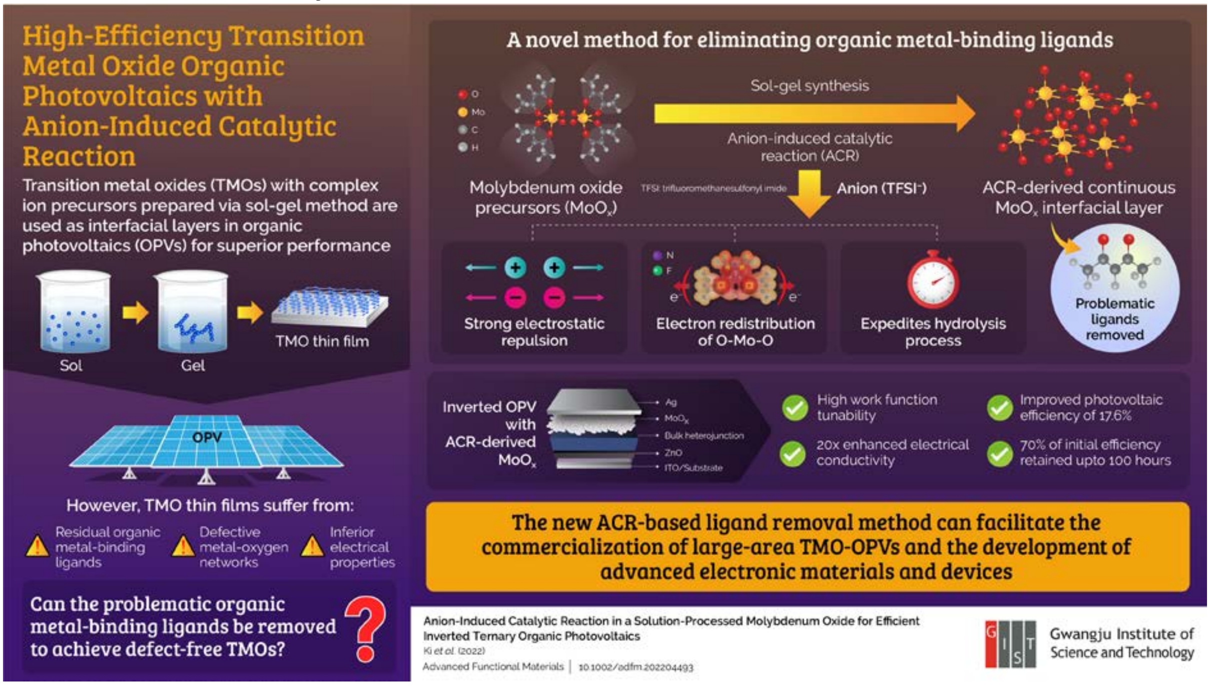

Image title: Removing residual organic metal-binding ligands with anion-induced catalytic reaction (ACR).

Image caption: Researchers from GIST report ACR as an effective way of removing unwanted ligands and improving the efficiency of organic photovoltaics (OPVs) with a transition metal oxide (TMO) interfacial layer.

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Harnessing the power of the sun and converting it into electricity using photovoltaic solar cells is one of the top contenders for combating the current energy crisis. To this end, researchers have developed organic photovoltaics (OPVs) with transition metal oxide (TMO) thin-film interfacial layers as a cost-effective alternative to commercial silicon solar cells. OPVs are known for their excellent photochemical properties and low-cost mass producibility.

However, the TMO layer often suffers from a degraded electrical conductivity due to the presence of lingering organic metal-binding ligands generated during their synthesis. This greatly limits the OPVs from reaching their full potential.

A team of researchers led by Prof. Kwanghee Lee from Gwangju Institute of Science and Technology in Korea found a way to overcome this challenge. The team demonstrated a simple and effective way of eliminating the residual organic metal-binding ligands from molybdenum oxide (MoO_x) precursor at room temperature by using a technique called "anion-induced catalytic reaction" (ACR). This breakthrough was made available online on 25 June 2022 was published in Volume 32, Issue 35 of the journal *Advanced Functional Materials* on 25 August 2022.

When asked about the rationale behind the study, Prof. Lee says, "*While OPVs with TMO thin films are headed towards power conversion efficiencies as high as 19%, the organic metal-binding ligands left behind the after sol-gel synthesis act like a double-edged sword, helping with the formation of the TMO thin films but deteriorating their properties as well. So, we aimed to find a way to eliminate the unwanted ligands after the synthesis process.*"

Accordingly, the team prepared a TMO thin film using an organic ligand-containing ionic compound and an MoO_x-based precursor by introducing ACR alongside the hydrolysis and condensation steps that take place during the sol-gel method. X-ray analysis and density functional theory calculations revealed that ACR induced a strong electrostatic repulsion via low-level anions, which expedited the hydrolysis process and resulted in the quick removal of the organic-metal binding ligands at room temperature.

The team then prepared an inverted OPV configuration using the ACR-derived MoO_x thin film to test its electrical properties. To their delight, they observed a 20-fold enhancement in the film's electrical conductivity along with an excellent work function tunability compared to pristine MoO_x. Further, the inverted OPV configuration showed 17.6% improved efficiency, with over 70% retention of the initial efficiency for up to 100 hours.

This novel strategy not only ensures a superior light-to-electricity conversion efficiency required for commercialization but also enables energy-efficient mass production of next-generation OPV solar cells. "*We strongly believe that the insights provided by our findings will open up new horizons in the production of large-area, wearable, flexible, and printable electronics*," concludes an optimistic Prof. Lee.

Reference

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About the Gwangju Institute of Science and Technology (GIST)
The Gwangju Institute of Science and Technology (GIST) is a research-oriented university situated in Gwangju, South Korea. Founded in 1993, GIST has become one of the most prestigious schools in South Korea. The university aims to create a strong research environment to spur advancements in science and technology and to promote collaboration between international and domestic research programs. With its motto of "A Proud Creator of Future Science and Technology," GIST has consistently received one of the highest university rankings in Korea.

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Kwanghee Lee is a Professor of Materials Science and Engineering at Gwangju Institute of Science and Technology (GIST) in Korea and is the director of the Research Institute for Solar and Sustainable Energies (RISE) at GIST. He received his Ph.D. in physics in 1995 and completed his postdoctoral training at the Institute for Polymers and Organic Solids from UC Santa Barbara in USA in 1997. Prof. Lee's group is currently working on printing electronics using metallic and semiconducting polymers. Additionally, his research focuses on the development of organic and perovskite solar cells with the highest efficiency. Prof. Lee was awarded the Order of Science and Technology Merit of the Republic of Korea in 2022 for his contributions to science.