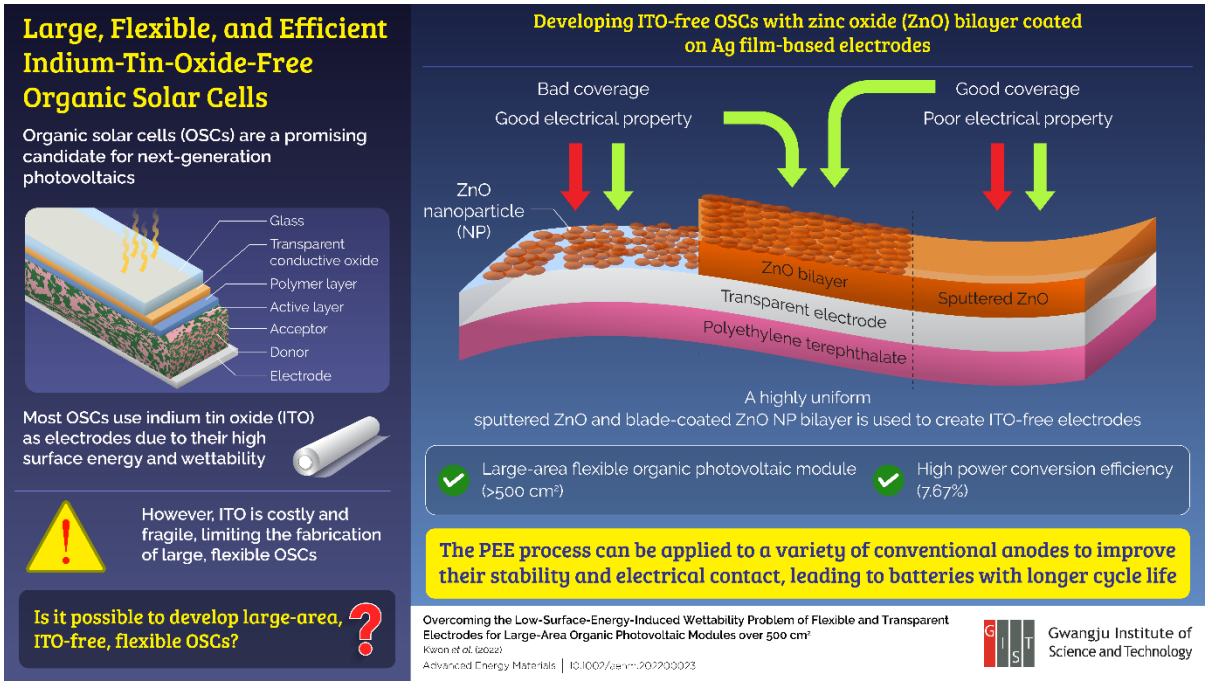
Gwangju Institute of Science and Technology Scientists Realize Large-Area Organic Solar Cells that are Low-cost, Flexible, and Efficient

The breakthrough is achieved by replacing the electrode material with a cheaper and non-fragile alternative that resulted in high conversion efficiencies

Organic solar cells (OSCs) are considered the future of photovoltaics due to their beneficial features like light weight, flexibility, and high conversion efficiency. But, most OSC electrodes use indium tin oxide (ITO), which is too costly and fragile to enable large-area, flexible OSCs. Now, researchers from the Gwangju Institute of Science and Technology have developed non-ITO based OSC electrodes using zinc oxide as a replacement that can help realize low-cost, large-area, efficient OSCs for commercial applications.



Organic solar cells (OSCs), which make use of organic materials to convert sunlight into electricity, are an attractive candidate for future photovoltaics. This is due to several of their desirable features, such as their light weight, flexibility, malleability, and, most importantly, high power conversion efficiency (PCE). Such qualities make them ideal for a wide range of applications.

Despite their massive commercialization potential, however, there is a catch. Most OSCs are produced using a technique called "spin coating", which allows for high PCEs but makes for poor scalability. Additionally, OSCs with flexible electrodes use indium tin oxide (ITO), which makes them expensive and too fragile for realizing large-area modules. Thus, if the commercial promise of OSCs is to be realized, they must overcome their dependence on ITO.

This is where Dr. Hongkyu Kang and Prof. Kwanghee Lee from the Gwangju Institute of Science and Technology (GIST) in Korea come in. In their paper made available online on 16 April 2022 and published in Volume 12, Issue 21 of *Advanced Energy Materials* on 2 June,

2022, they put forth a new method to create OSCs using zinc oxide (ZnO) that overcame the issues of cost and scalability without comprising the PCE.

In particular, this research was the result of an industry-university collaboration, in which GIST developed the original technology for the first time in Korea and transferred it to MSWAY Co., Ltd., which had been entirely dependent on foreign imports as the domestic production of ITO-based electrodes was impracticable. With the new technology, it is expected that a value chain will be established for the commercialization of OSCs with construction and equipment companies, strengthening the value of industry-university joint research.

The team used sputtered ZnO and a ZnO nanoparticle layer obtained through a "blade coating" technique to create a uniform bilayer on an ultrathin silver film electrode. "*The ultrathin silver film electrode with ZnO bilayer has the flexibility, wettability, and high surface energy of ITO but is not brittle or expensive. This makes it easier to use ZnO for manufacturing organic solar cells and developing a printing technology for large-area solar cell technology",* says Dr. Kang.

The new ZnO bilayer-based OSCs demonstrated an efficiency of 7.67% for a module area of 528 cm^2, which makes it the most efficient large-area OSC when compared to previous research. This was due to the reduction of "recombination" of charge carriers in OSCs by the crystalline ZnO nanoparticles that, in turn, improved their open-circuit voltage, i.e., PCE.

The creation of these ITO-free OSCs with a large area and the same flexibility and efficiency as that of ITO-based OSCs can be a game changer for the future of solar cell technology. "*Our method opens doors to the commercial use of these OSCs, such as their integration into building walls and windows to realize self-sustaining buildings",* says Prof. Lee. Indeed, the superiority of large-area OSCs in terms of commercial potential and efficiency can usher in a new age of power generation and help us in the fight against climate change.

That is a future we surely look forward to!

Reference

Authors:	Hongkyu Kang [1], Kwanghee Lee [2]
Title of original paper:	Overcoming the Low-Surface-Energy-Induced Wettability Problem of Flexible and Transparent Electrodes for Large-Area Organic Photovoltaic Modules over 500 cm2
Journal:	*Advanced Energy Materials*
DOI:	10.1002/aenm.202200023
Affiliations:	[1]Center for Research Innovation, Gwangju Institute of Science & Technology [2]Research Institute for Solar and Sustainable Energies, Gwangju Institute of Science & Technology

*Corresponding author's email: klee@gist.ac.kr (Prof. Kwanghee Lee), gemk@gist.ac.kr (Dr. Hongkyu Kang)

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.

Website: http://www.gist.ac.kr/

About the authors

Hongkyu Kang is a Senior Researcher at the Center for Research Innovation at the Gwangju Institute of Science & Technology (GIST). He is researching large area organic and perovskite photovoltaics on flexible substrates. Dr. Kang received his PhD in material science and engineering at GIST and completed his stint as a visiting researcher at the Centre for Plastic Electronics at Imperial College London in 2018. He joined the Research Institute for Solar and Sustainable Energies (RISE) at GIST as a research professor for the 2015-2020 period.

Kwanghee Lee is a Professor of Materials Science and Engineering at the Gwangju Institute of Science & Technology (GIST). He is also a director of the Research Institute for Solar and Sustainable Energies (RISE). His group is developing printing electronics using metallic and semiconducting polymers. Additionally, his research focuses on developing organic and perovskite solar cell with highest efficiency. Prof. Lee received his PhD in physics in 1995, and completed his postdoctoral training at the Institute for Polymers and Organic Solids from UC, Santa Barbara in 1997.