500cm² large-area organic solar cell film developed

— A team led by Dr. Hongkyu Kang and Professor Kwanghee Lee solves the thin film non-uniformity problem by forming a hydrophilic oxide layer

— Published in Advanced Energy Materials... "Expected results of industry-university cooperation, commercialization of film modules"

▲ Researchers are presenting large-area flexible transparent electrodes, opaque organic solar cell modules, and transparent organic solar cell module films. (From left in the front row) Senior Researcher Hongkyu Kang, Director Kwanghee Lee, Postdoctoral researcher Hyeok-Chan Kwon (From left in the back row) Researcher Yang-Soo Lee, Researcher Hyeon-Seok Jeong, Researcher Won Jeong, Postdoctoral researcher Jun-Ho Jang, Researcher Aeri Park, Researcher Seungchan Kim

A high-efficiency, large-area module film has been developed that will contribute to the commercialization of the 'organic solar cell,'* a next-generation solar cell that will replace the existing silicon solar cell.

It is evaluated as a research achievement that can overcome the existing limitation of decreasing efficiency as the film size increases and accelerate the commercialization of large-area flexible organic solar cells.

* **organic solar cell:** A next-generation solar cell that uses an eco-friendly organic material for the photoactive layer that absorbs light and generates electric charge. It can be mass-produced in the form of a roll at an ultra-low cost and high speed, and it can be manufactured in the form of a flexible, transparent, and light film compared to conventional silicon solar cells, so it can be attached and used on glass, walls, etc. Recently, energy conversion efficiency of about 20% has been reported in small-area organic solar cells, and interest in large-area module manufacturing technology for commercialization at home and abroad is increasing.

Existing organic solar cell research has mostly been conducted at the level of small cells fabricated on an expensive and hard indium tin oxide (ITO) transparent electrode glass substrate (about 1 cm^2).

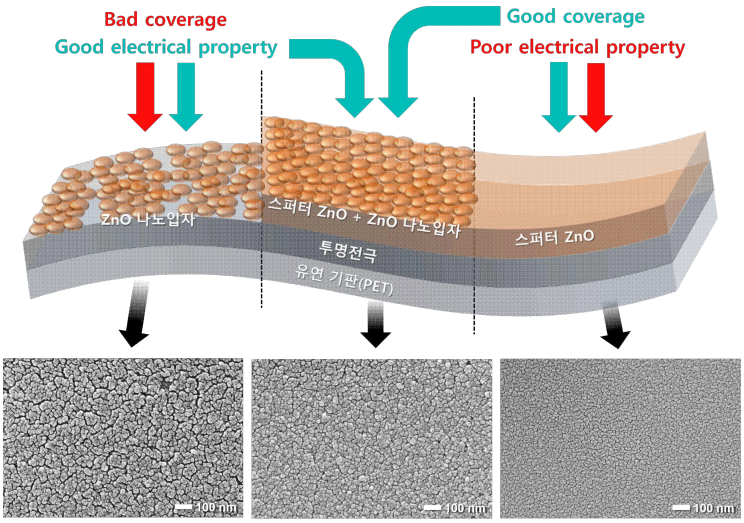
There have been some studies on large-area and flexible modules, but as the module size increases and becomes more flexible, it shows very low module efficiency*, making it difficult to commercialize.

* **efficiency of organic solar cell modules:** the efficiency of a module configured by electrically connecting several striped cells, the smallest unit in a solar cell generation system, in series

A joint research team led by Dr. Hongkyu Kang (Senior Researcher) at the GIST Center for Research Innovation and Research Institute for Solar and Sustainable Energies Director Kwang-Hee Lee (School of Materials Science and Engineering Professor) developed a high-efficiency organic solar cell module film production technology with a large area of 500 cm^2 or more on a flexible transparent electrode substrate.

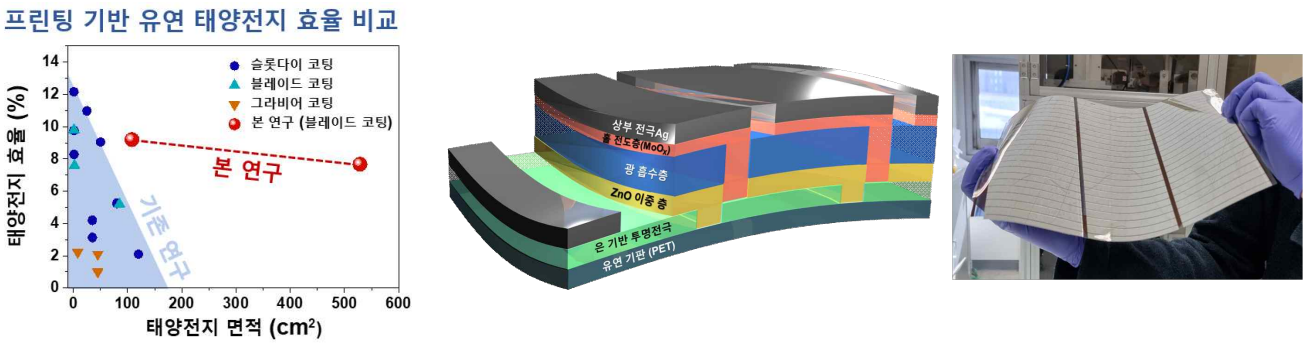
The research team found that in flexible transparent electrode films that do not contain rare earth indium*, the hydrophobic surface properties that do not spread well cause nano-thin film nonuniformity of solar cell materials. To solve this problem, a hydrophilic oxide layer was introduced to significantly improve surface wettability, thereby forming a uniform large-area nano thin film.

* **rare earth indium:** A rare metal widely used in the electronics industry, such as semiconductor manufacturing, display coating, electroplating, and solar cells. As reserves are concentrated in China (70%), there is an urgent need to develop alternatives.



▲ Schematic diagram and electron micrograph showing the difference in the surface state of the zinc oxide (ZnO) nanoparticle layer according to the presence or absence of the oxide layer

The module film produced by the research team showed an efficiency of 7.67% at a size of 528cm^2, and this study is the first time a large-area film of 500cm^2 or more has been reported to the academic community as a print-based flexible organic solar cell module film.

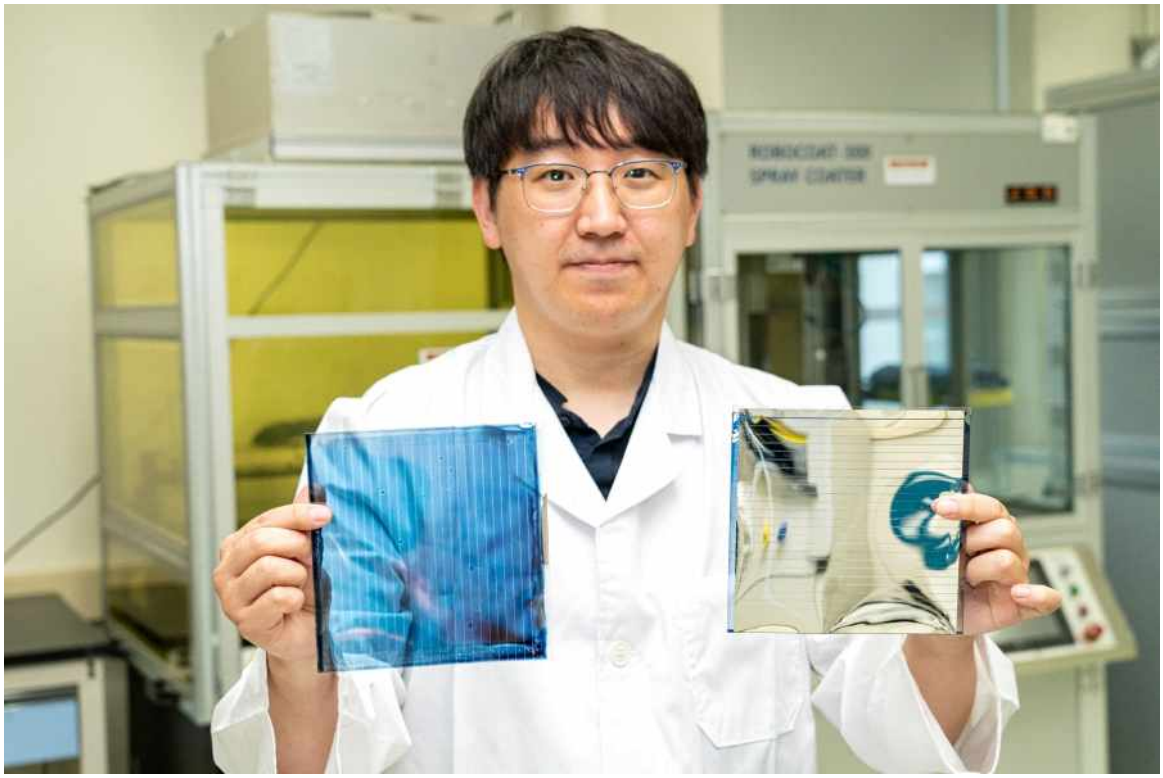


▲ Schematic diagram of the structure of a large-area flexible organic solar cell module (left) and actual photo (right)

In particular, this study is the result of industry-academic cooperation in which GIST developed the original technology for the first time in Korea and applied the "flexible transparent electrode manufacturing technology" delivered by MS Way Co., Ltd. Based on this research, it is expected that it will be possible to commercialize it by establishing a value chain for commercialization of organic solar cells with materials, parts, equipment, and construction companies along with MS Way Co., and strengthening industry-academic joint research.

MSway Co., Ltd. received the technology to replace indium-based transparent electrodes, which had been entirely dependent on foreign imports because domestic production was impossible, from GIST and localized and mass-produced large-area flexible transparent electrode films for the first time in the industry.

Dr. Hongkyu Kang said, "This study is meaningful in that it solved the nano-thin film non-uniformity of the solar cell material, the biggest obstacle to the commercialization of organic solar cells, and realized a flexible large-area module with high energy conversion efficiency. The government plans to advance the commercialization of organic solar cells that can be applied in film form to various applications without a separate site so that residents-friendly solar cells can spread."



▲ GIST Center for Research Innovation Senior Researcher Hongkyu Kang is demonstrating transparent (left) and opaque (right) flexible solar cell films.

Recently, GIST, together with local governments in Gwangju, Jeollanam-do, and Jeju, and related regional organizations such as the Green Energy Research Institute, is promoting a super-wide cooperative planning project that includes next-generation organic solar cells as one of the new and renewable energy sources for distributed energy.

Organic solar cells are highly cost-competitive and have transparency, lightness, flexibility, and aesthetics, so they can be attached as films to building windows (urban type), automobile windows (mobility type), glass greenhouses (farming type), etc., so industry-academic cooperation with R&D is steadily progressing.

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