

Researchers pave the way for large-scale, efficient organic solar cells with water treatment

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Improving Organic Solar Cell Performance with Water Treatment

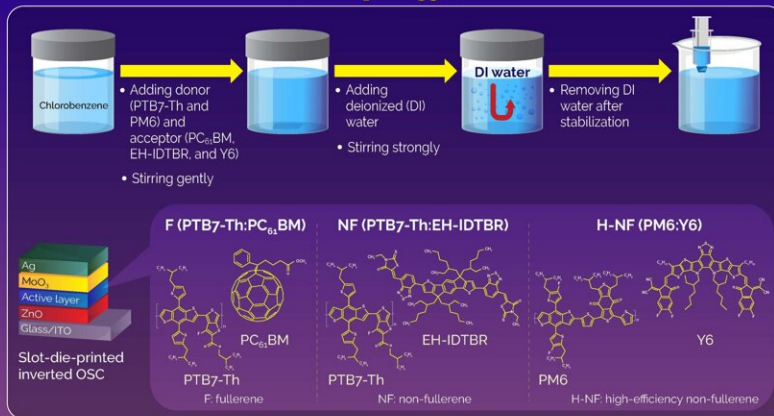
To improve the efficiency and stability of organic solar cells (OSCs), it is necessary to obtain high-quality bulk heterojunction (BHJ) thin films



But, controlling the BHJ morphology of the active layer for large-scale fabrication of OSCs is challenging

Can we improve the BHJ morphology irrespective of the materials used and device active area?

Fabricating high-quality BHJ thin films with water treatment (WT) for morphology control



BHJ films with WT show higher conversion efficiency than those without WT



11.92% conversion efficiency for an OSC module active area of 10 cm²

BHJ films with superior morphologies can be fabricated using WT, opening doors to large-scale, high-performance, stable OSCs

Introduction of Water Treatment in Slot-Die Coated Organic Solar Cells to Improve Device Performance and Stability
Han et al. (2022)
Advanced Functional Materials | 10.1002/adfm.202204871



Gwangju Institute of Science and Technology

Organic solar cells (OSCs) exhibit many desirable properties, including a high conversion efficiency and easy scalability. However, controlling the morphology of the active layer thin film during upscaling has proved challenging. In a new study, GIST researchers solve this problem with deionized water as a method for morphology control, enabling high efficiency OSC modules with large active areas. Credit: Dong-Yu Kim from Gwangju Institute of Science and Technology

Organic solar cells (OSCs), which use organic polymers to convert sunlight into electricity, have received considerable attention for their desirable properties as next-generation energy sources. These properties include its lightweight nature, flexibility, scalability, and a high power conversion efficiency (>19%). Currently, several strategies exist for enhancing the performance and stability of OSCs. However, a problem that remains is the difficulty of controlling the morphology of the active layer in OSCs when scaling up to large areas. This makes it challenging to obtain high-quality active layer thin films and, in turn, fine-tune the device efficiency.

In a recent study, a team of researchers from the Gwangju Institute of Science and Technology, Korea set out to address this issue. In their work, published in *Advanced Functional Materials*, they suggested a solution that appears rather counterintuitive at first glance: using [water treatment](#) to control the active layer morphology.

"Water is known to hinder the performance of organic electronic devices, since it remains in the 'trap states' of the [organic material](#), blocking the charge flow and degrading the device performance. However, we figured that using water rather than an organic solvent-based active solution as a medium of treatment method would enable necessary physical changes without causing chemical reactions," explains Professor Dong-Yu Kim, who headed the study.

The researchers chose the polymers PTB7-Th and PM6 as donor materials and PC₆₁BM and EH-IDTBR and Y6 as acceptor materials for the active layer. They noticed that inducing a vortex to mix the donor and acceptor materials in the active solution could lead to a well-mixed active solution, yet it was not enough on its own.

The active solution was hydrophobic and, accordingly, the researchers decided to use deionized (DI) water and vortices to stir the solution.

They let the donor and acceptor materials sit in chlorobenzene (host active solution) overnight, and then added DI water in the solution and stirred it, creating tiny vortices.

Due to the hydrophobic nature of the solution, the water pushed on the donor and acceptor molecules, causing them to dissolve more finely into the solution. They then let the solution rest, which caused the water to separate from the solution. This water was then removed and the water-treated active solution was used to prepare thin films of PTB7-Th: PC₆₁BM (F, fullerene), PTB7-Th: EH-IDTBR (NF, fullerene), and PM6: Y6 (H-NF, high-efficiency non-fullerene).

The researchers then examined the photovoltaic performance of these thin films in a slot-die-coated inverted OSC configuration and compared them with those for OSCs without water treatment.

"We observed that the water-treated active [solution](#) led to a more uniform active layer [thin films](#), which showed higher power conversion efficiencies compared to those not treated with water. Moreover, we fabricated large-area OSC modules with an active area of 10 cm², which showed a conversion efficiency as high as 11.92% for water-treated H-NF films," says Prof Kim.

More information: Nara Han et al, Introduction of Water Treatment in Slot-Die Coated Organic Solar Cells to Improve Device Performance and Stability, *Advanced Functional Materials* (2022). [DOI: 10.1002/adfm.202204871](https://doi.org/10.1002/adfm.202204871)

Provided by GIST (Gwangju Institute of Science and Technology)

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