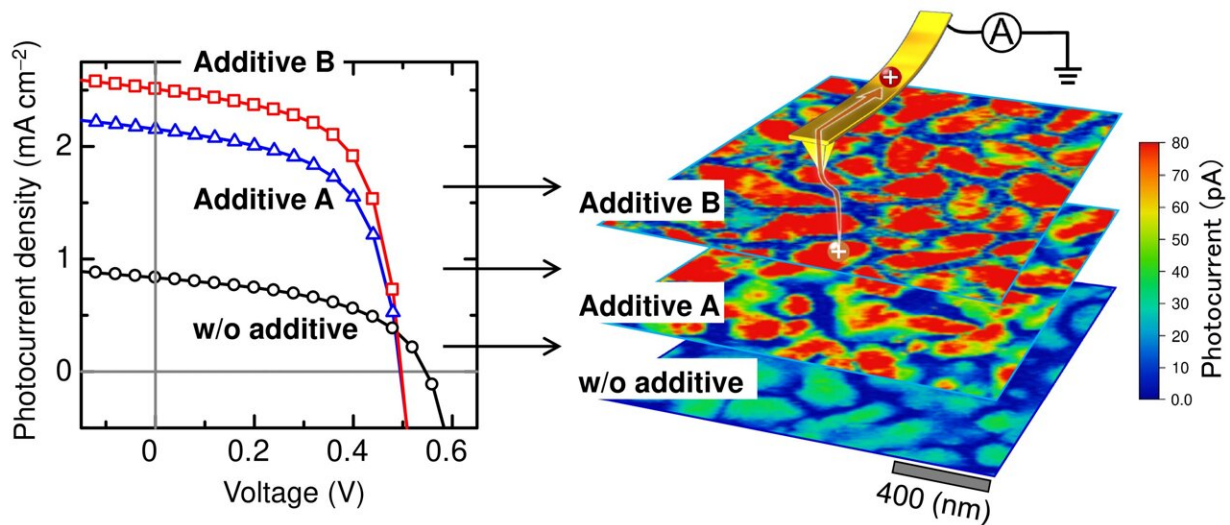


Illuminating how solvent additives improve efficiency in polymer solar cells

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Improvements in the device performance by addition of a solvent additive A and B (left). Photocurrent flowing in the polymer solar cells, which is visualized at nanometer scale by PC-AFM (right). Credit: Nara Institute of Science and Technology

All-polymer blend solar cells are expected to play an important role in the transition to clean energy technologies because they can be easily produced in large-scale flexible sheets. However, their performance has lagged behind that of more traditional silicon alternatives, as well as other organic solar cells.

All-polymer blend [solar cells](#) are formed by combining two polymer solutions that solidify into a film on an electrode with in the form of interpenetrating networks, a kind of "phase-separation." The introduction of solvent additives to the polymer solution has been shown to increase the efficiency of all-polymer blend solar [cells](#). However, the exact process underlying this improvement has not been fully understood. Now, in a study recently published in *ACS Applied Polymer Materials*, researchers from Nara Institute of Science and Technology have investigated the performance enhancement mechanism using photoconductive atomic force microscopy (PC-AFM). Their findings are expected to help accelerate the widespread application of polymer-based solar cells.

"The empirical nature of solvent additive-mediated efficiency enhancement has hindered the optimization of all-polymer blend solar cell performance, so there has been an urgent need for a greater understanding of the process," explains senior author Hiroaki Benten. "To that end, we used PC-AFM to interrogate the nanoarchitecture that underpins the performance enhancement."

PC-AFM is an advanced microscopy technique that allows photocurrents to be visualized with nanometer-scale resolution. The researchers found that trace solvent additives improved the power conversion and photocurrent density of an all-polymer blend solar cell by a factor of up to ~3 by enhancing the ordering and crystallization of the polymer microstructure in the solar cell without damaging the phase-separated structure.

Absorption spectroscopy measurements further confirmed that the trace additives improved the ordering in the polymer microstructures. By forming a network that efficiently transports the photogenerated charges to the external electrode, the flow of photocurrent is increased.

"We found that local photocurrents were enhanced, somewhat like forming a new charge current highway, while the scale of phase separation that is critical to device functionality was retained," says coauthor Masakazu Nakamura. "We believe that this insight will be broadly applicable to all-polymer blend solar cells, not just those based on our choice of polymers."

The results of the study are expected to be important for optimizing the performance of all-polymer [blend](#) solar cells. By using the findings to minimize laboratory trial-and-error, it is hoped researchers can speed up ongoing bench-to-market efforts, taking us a step closer to high-performance solar cells that are environmentally sustainable and easy to produce on a large scale.

More information: Yuji Yamagata et al, Nanoscale Observation of the Influence of Solvent Additives on All-Polymer Blend Solar Cells by Photoconductive Atomic Force Microscopy, *ACS Applied Polymer Materials* (2021). [DOI: 10.1021/acsapm.1c01173](https://doi.org/10.1021/acsapm.1c01173)

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