Improved efficiency of all-polymer solar cells
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The high FFs (~70%) of the all-polymer blend solar cells were achieved because of the longer charge-carrier lifetimes due to the lower bimolecular charge recombination coefficients. The preferred blend morphology for suppressing the bimolecular charge recombination is characterized by a well-ordered local structure due to chain aggregation by both the polymer donor (D) and acceptor (A). Credit: Hiroaki Benten

Polymer-based solar cells are a possible, less-wasteful solution. Such panels are thin and flexible, and thus are in principle quite versatile. Nevertheless, they have certain problems; e.g., a lower power conversion efficiency than silicon. "This efficiency is substantially limited by the fill factors: commonly less than 60%, even in advanced devices," says corresponding author Hiroaki Benten of Nara Institute of Science and Technology. "The science that underpins the limited efficiency of all-polymer blend solar cells remains insufficiently unexplored."

A ground-breaking result of this research is the high fill factor: 70%, which remained 60% even for polymer films several hundred nanometers thick. Competing polymer technology exhibits a 40% fill factor at this thickness. This is because bimolecular recombination of free electrons with free holes substantially inhibited the fill factor prior work, but was suppressed in the current study.

What suppressed bimolecular recombination within the polymer blends? "There was substantial charge delocalization in the donor and acceptor domains," explains Masakazu Nakamura, senior author. "Appropriate aggregation of the polymer donors and acceptors led to a substantially ordered local structure of the polymer, which helped keep the separation of the electrons from the holes."

Globally, approximately one-third of electricity currently comes from renewable sources. Silicon-based solar cells are the major contributor, but there's an increasing problem: what to do with the panels after their 30-year lifetime. A May 2022 article in Chemical & Engineering News lays out the problem: even when facilities recycle the frames and covers of the panels, the most valuable or even toxic elements are simply disposed. With a forecasted 80 million metric tons of solar panel waste to have been produced by 2050, this is a massive waste problem.

Provided by Nara Institute of Science and Technology


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