Uncovering the secret of ternary polymer solar cell success

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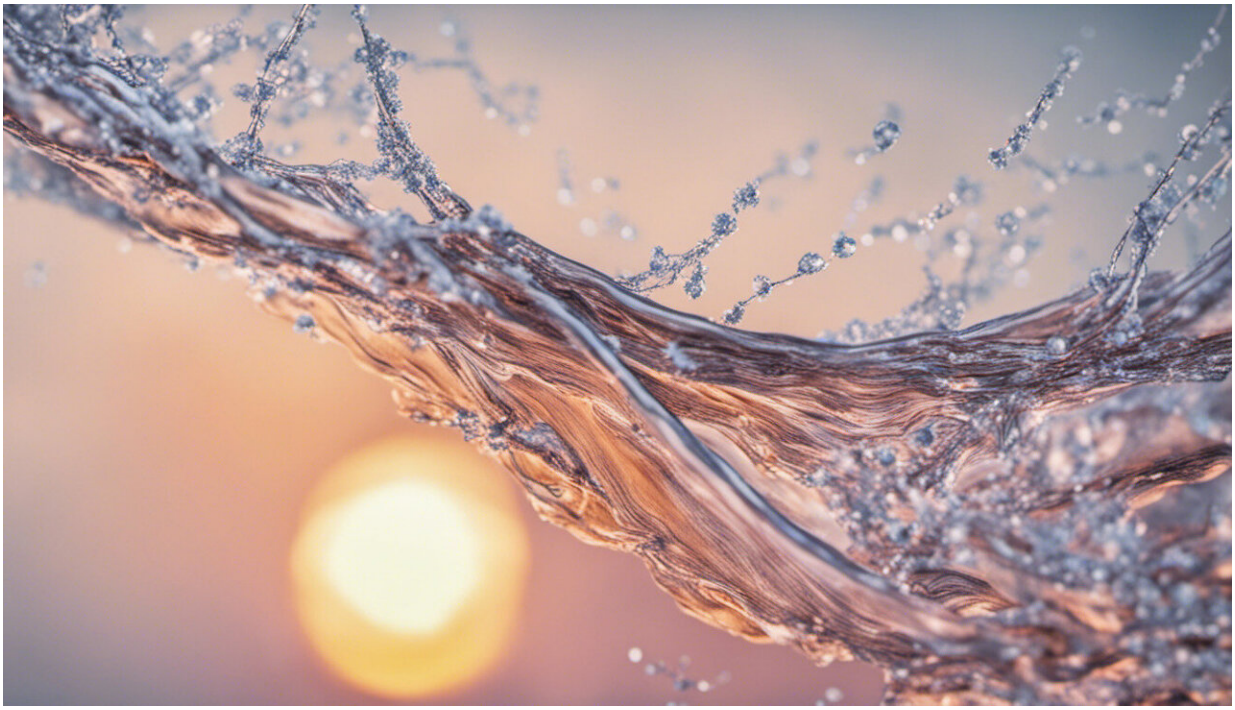

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Solar cells will doubtless play a significant part in a sustainable energy future. Polymer solar cells (PSCs) specifically provide an excellent option because they are cheap to produce and can be both flexible and semitransparent. Ternary polymer solar cells are showing encouraging power conversion efficiencies, but it isn't always clear why. Now,

researchers from the University of Tsukuba and Hiroshima University have taken a closer look at PSCs in operation. Their findings are published in *npj Flexible Electronics*.

PSCs generally contain a material that is the p-type semiconductor mixed with one that is the n-type semiconductor. This blend gives the right combination of charge carriers—holes and electrons—for a current to flow when sunlight shines on the cell.

Blends with these two components are known as binary PSCs. However, it has recently been found that adding an extra ingredient to the mix—giving what is known as a ternary PSC—can improve the power conversion efficiency (PCE) and stability of the solar cell. The trouble is that up until now nobody has thoroughly investigated why.

The researchers therefore conducted electron spin resonance (ESR) spectroscopy while the PSC was operating. This gave them the chance to observe the behavior of the electrons and holes when the cell was irradiated with sunlight and to get answers on a molecular level.

"It has been reported that the accumulation of charge over time contributes to the performance of cells deteriorating," explain study author Professor Itaru Osaka and study corresponding author Professor Kazuhiro Marumoto. "We therefore used ESR to look at a system made up of the polymer PTzBT and large molecule PC61BM. It has been found that adding an acceptor molecule, known as ITIC, to this system improves the PCE and the stability of the cell, so we looked closely at cells with and without ITIC to determine why."

The ESR spectroscopy experiment showed that the short-circuit current decreased as a result of the accumulation of electrons in the PC61BM and holes in PTzBT. Adding ITIC was found to reduce this accumulation by enhancing the orientation of the chainlike PTzBT polymer molecules

in the active layer.

"Being able to understand why something works is important for ensuring that effects are optimized to their full potential," says study corresponding author Professor Kazuhiro Marumoto. "By getting a molecular level picture of the effects of ITIC on a very promising PSC system, we believe we have taken a step closer to the commercial reality of polymer solar cells as part of a greener future."

More information: Dong Xue et al, Stability improvement mechanism due to less charge accumulation in ternary polymer solar cells, *npj Flexible Electronics* (2022). DOI: 10.1038/s41528-022-00153-z

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