NREL Highlights SCIENCE

Energetic Barrier Prevents Recombination in Organic Solar Photoconversion Systems

NREL researchers unravel the factors that affect charge generation and loss in high-performance conjugated polymer-fullerene blends used in organic solar cells.

Polymer:fullerene blends are popular light-harvesting materials in organic solar cells. Using time-resolved microwave conductivity—a highly sensitive spectroscopic technique—researchers at the National Renewable Energy Laboratory (NREL) revealed that charge carrier recombination is hindered by the presence of a previously unidentified energetic barrier in blends of the conjugated polymer P3HT and the fullerene PCBM, which is even present in the neat polymer. It was also discovered that in the neat polymer the large number of traps and dark carriers severely impact the carrier lifetime. The presence of the energetic barrier helps to explain the excellent charge-carrier generation observed in P3HT:PCBM blends. Understanding its origin can lead to design rules for more efficiently generating charges from sunlight. Ultimately, controlling the fate of charge carriers in binary mixtures of a conjugated polymer and fullerene derivative is critical to the development of more efficient solar photoconversion systems based on such low-cost materials.

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Reference: Ferguson, A.J.; Kopidakis, N.; Shaheen, S.E.; Rumbles, G. (2011). "Dark Carriers, Trapping, and Activation Control of Carrier Recombination in Neat P3HT and P3HT:PCBM Blends." *J. Phys. Chem. C*, 115, 23134–23148,. DOI: 10.1021/jp208014v.

Key Research Results

Achievement

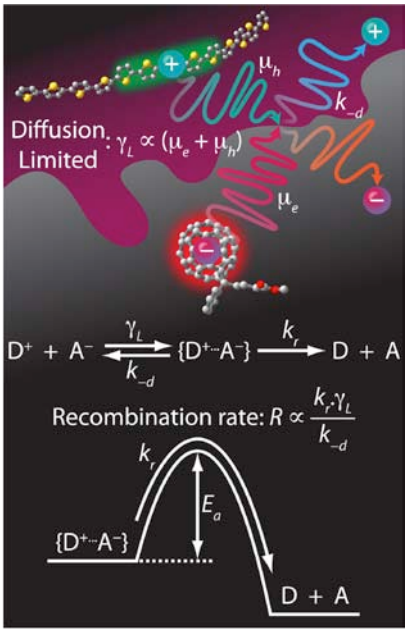
Researchers discovered that charge carrier recombination is hindered by the presence of an energetic barrier in a P3HT:PCBM blend, and even in the neat polymer.

Key Result

Identifying the existence of the energetic barrier helps explain the excellent charge carrier generation observed in P3HT:PCBM blends.

Potential Impact

Elucidating the origin of the energetic barrier will lead to design rules for more efficiently generating charges from sunlight, ultimately advancing the development of more efficient solar photoconversion systems.



While the carrier encounter probability is determined by the mobility, the presence of an energetic barrier means that only a tiny fraction of the encounters results in recombination and a reduced photocurrent.

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