Understanding Charge Carrier Dynamics for polymer:non-fullerene blend

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In organic semiconductors, the optical absorption is essential for the performance of organic photovoltaics. For the energy conversion, the absorption by the semiconductors generates excitons which generates free charge carriers. Although, high performance is reported for the non-fullerene acceptors, the understanding about charge generation is limited. Keeping this in view, here we employed optical spectroscopic techniques to study the charge generation mechanism for FLR (1,6,7,10-tetramethylfluoranthene) as non-fullerene electron acceptor and P3HT (Poly(3-hexylthiophene)) as electron donor blended in different polarity solvents. A basic understanding of the charge transport by enlightening the influence of solvents on the aggregation behavior through steady state UV-Visible and photoluminescence spectroscopy. By employing ultrafast Vis-NIR transient absorption spectroscopy for the first time, we try to understand the ultrafast generation and charge separation mechanism with systematic variation in solvents by incorporating the time evolution of the transient species under various pump-probe wavelengths. The lifetime kinetics for the different excitation wavelengths has been depicted showing the fast decay term at lifetime of few picoseconds (ps) (~1-5 ps) and slow decay lifetime of ~500 ps. The good intermixing of the components can be observed by the charge generation in the blend on a ps time scale. It can be observed that the non-halogenated solvents contributes for higher charge generation as compared to the halogenated solvents in terms of aggregation, conjugation length and photoluminescence quenching. With the addition of FLR in P3HT with appropriate solvent, there is enhanced polaron population indicating good solvent-material combination which is important for improved charge generation. This study shows the role of FLR as emerging non-fullerene acceptors for improving the performance of future devices.

References

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