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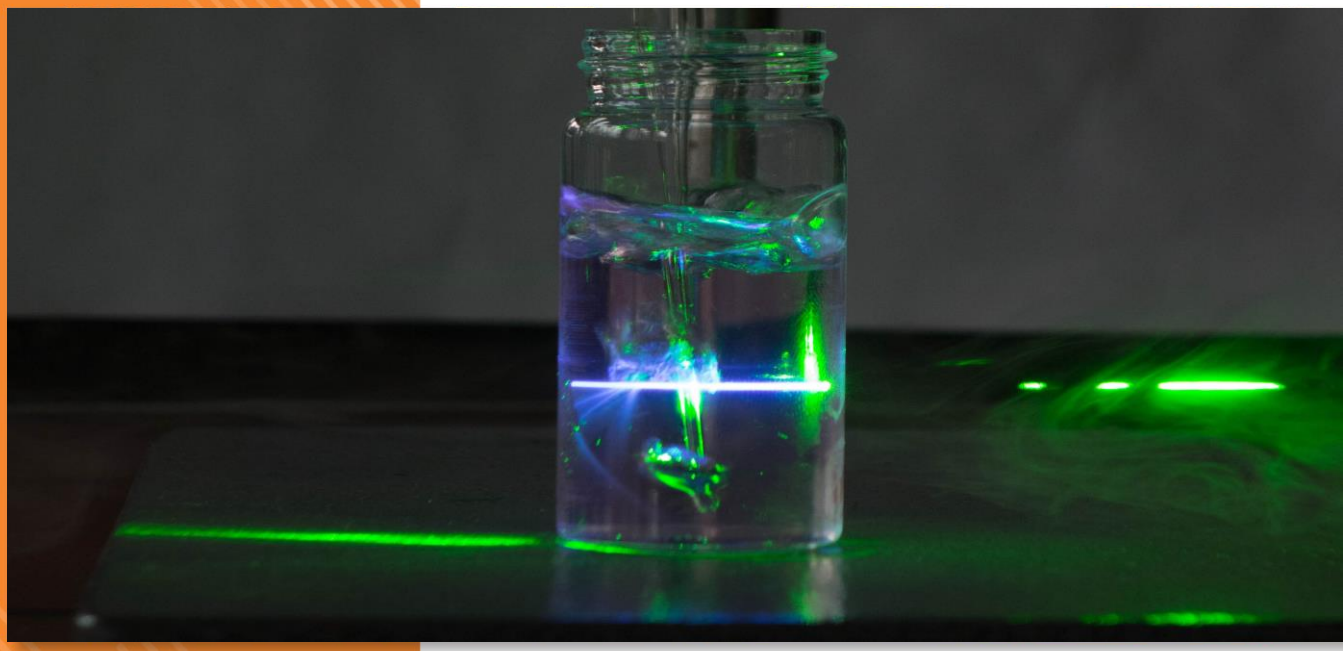

Charges on the move: the physics and perspective of state-of-the-art organic solar cells

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Organic solar cells (OSCs) are currently experiencing a second golden age thanks to the development of novel non-fullerene acceptors (NFAs). The blend of the donor polymer PM6 with the NFA acceptor Y6 has become the fruit fly of research on NFA-based solar cells. This is because of the high efficiency (>15 %) of single junction PM6:Y6 solar cells, which has now been reproducibly achieved in many labs around the world. In blends with PM6 and other donor polymers, high efficiency (>19 %) have been recently achieved in single junction devices, with the perspective to approach the commercially relevant 20 %.

Here, we summarizes our recent understanding of the processes governing the performance of OSCs based on Y6 and related compounds. For PM6:Y6, we find that free charge generation is essentially barrierless and that the fill factor of the device is essentially limited by the diffusion length of the charges, which is smaller than the active layer thickness. This puts the understanding of the recombination processes at the focus of our investigations. Most recently, we addressed the role of energetic disorder and energetic offset in the competition between charge extraction and recombination. By performing temperature dependent charge transport and recombination studies, we come to a consistent picture of the density of state distributions for free charges, which allows us to analytically describe the dependence of the open-circuit voltage on temperature and illumination intensity. We conclude that energetic disorder of charge transfer manifold has to be considered in the analysis of the photovoltaic properties. Intriguingly, our observations also reveal a significant enhancement in recombination of free carriers when decreasing the energy offset. At first glance, one might interpret this as an increased recombination via reformation and decay of the exciton decay. However, our in-depth analysis reveals that this pathway accounts for no more than 10% of the total recombination. This hints at an additional recombination channel which opens up for small offset systems.

Neuer Termin!

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