Comparative Contributions of Singlet and Triplet Excitons in the Performance of Organic Devices

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Absorption of light of energy at least equal to the bandgap of an organic solid results in exciting electron and hole pairs which instantly form singlet or triplet Frenkel excitons. In this study, the properties of singlet and triplet excitons are compared with a view of determining their suitability in organic device applications. These properties include exciton absorption, diffusion, recombination (both radiative and non-radiative) and dissociation [1]. Excitation of singlet excitons occurs through the exciton-photon interaction and that of triplet excitation occurs due to exciton-spin-orbit-photon interaction [2]. The spin-orbit coupling determines the intersystem crossing, which converts singlet into triplet excitons [3]. Diffusion of singlet and triplet excitons via Förster and Dexter energy transfer mechanisms are also compared [4] and the probability of charge carrier recombination into the excitonic state is discussed. Dissociation of singlet and triplet excitons at the donor-acceptor interface in organic solar cells (OSCs) due to exciton-phonon interaction operator is compared [5]. The roles of singlet and triplet exciton binding energies and Bohr radii on the excitation and dissociation mechanisms are also compared and analyzed [4]. In organic light emitting devices (OLEDs) the emission may be more efficient with singlet excitons however if doped with heavy metal atoms then triplet excitons can also contribute to the light emission. In OSCs, singlet excitons diffuse faster and dissociate easily due to the lower binding energy, which enhances conversion efficiency but their relatively faster recombination acts against it. As triplet excitons do not recombine easily their generation may be more useful in OSCs. Such comparative studies will be presented in detail.

Keywords: Frenkel singlet and triplet excitons, organic solar cells, exciton-spin-orbit-photon interaction, spin-orbit coupling, Förster and Dexter energy transfer, exciton dissociation.

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