Boosting the Power Conversion Efficiency of Organic Solar Cells Using Weakly Luminescent Gold(III) Corrole with Long-Lived Exciton State

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Transition metal complexes have been widely used as light-emitting and photon-absorbing materials in optoelectronic devices with diverse applications. While these complexes have been intensively studied in the field of organic light-emitting devices (OLEDs) due to their ***inherently high phosphorescence quantum yields*** (Φ), they are rarely employed in the fabrication of organic solar cells (OSCs) ***with reported examples showing poor photovoltaic responses*** with unexpectedly low power conversion efficiency (PCE) of ≤ 2.9% for most of the vacuum-deposited devices or ≤ 5.0% for solution-processed devices in the literature. Here, we successfully employed ***weakly luminescent gold(III) corrole***, namely **HKU-AuC**, as photon-absorber which can ***effectively boost up the PCE of OSCs to 6%*** under 1 sun AM1.5G simulated light illumination with high short-circuit current density of 14.2 mA cm^{-2} and fill factor of 0.57, which is the highest value among the reported PCE for OSCs incorporating metal-organic complexes. The superior device performance may be ascribed to the ***weakly emissive nature with low Φ of 0.04% and long excited state lifetime of 63 μs*** of **HKU-AuC**, which can minimize recombination loss and favor exciton-dissociation. A broad absorption covering the entire visible spectral region has also been observed, which is originated from mixing excited states of triplet ligand-to-metal charge-transfer and singlet ligand-centered $\pi\rightarrow\pi^*$ transitions. These distinct features of **HKU-AuC** may account for the significant increase in the photocurrent and PCE of OSCs. More importantly, the Φ is suggested to play an important role affecting the PCE and can be used to rationalize the inferior OSC performance based on other phosphorescent organometallic complexes. ***This work demonstrates for the first time to employ gold(III) complex as donor*** and opens up a new avenue to fully utilize transition metals for the fabrication of OSCs.

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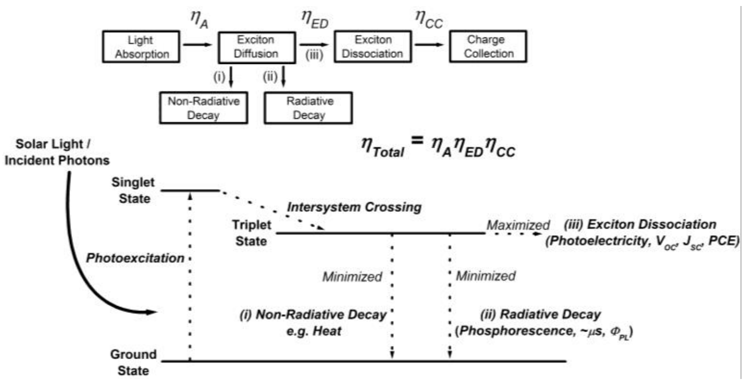

FIG 1. Mechanisms of the photoconversion in OSCs with triplet photoactive materials. η_{TOTAL}, η_A, η_{ED}, and η_{CC} are the total, light-absorption, exciton-dissociation and charge-collection efficiencies, respectively.

RELEVANT PUBLICATION

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