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Study of Exciton Binding Energy in Photovoltaic Polymers and Non-Fullerene Acceptors

Authors : Ho-Wa Li, Sai-Wing Tsang

Abstract : The excitonic effect in organic semiconductors plays a key role in determining the electronic devices performance. Strong exciton binding energy has been regarded as the detrimental factor limiting the further improvement in organic photovoltaic cells. To the best of our knowledge, only limited reported can be found in measuring the exciton binding energy in organic photovoltaic materials. Conventional sophisticated approach using photoemission spectroscopy (UPS and IPES) would limit the wide access of the investigation. Here, we demonstrate a facile approach to study the electrical and optical quantum efficiencies of a series of conjugated photovoltaic polymer, fullerene and non-fullerene materials. Quantitative values of the exciton binding energy in those prototypical materials were obtained with concise photovoltaic device structure. And the extracted binding energies have excellent agreement with those determined by the conventional photoemission technique. More importantly, our findings can provide valuable information on the excitonic dissociation in the first excited state. Particularly, we find that the high binding energy of some non-fullerene acceptors limits the combination of polymer acceptors for efficiency exciton dissociation. The results bring insight into the engineering of excitonic effect for the development of efficient organic photovoltaic cells.

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