Methods for the Characterization and Enhancement of Exciton Harvesting in Organic Photovoltaic Cells

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In order to generate photocurrent from an organic photovoltaic cell (OPV), the optically generated exciton must be dissociated into its constituent charge carriers. This process is carried out at the interface between electron donating and accepting materials. Consequently, photocurrent is generated only at the donor-acceptor (D-A) interface, and exciton diffusion to the interface is a critical step in the photoconversion process. The focus of this work is on the development of methods that permit the accurate measurement of the exciton diffusion length, and the realization of architectures that demonstrate enhanced exciton harvesting. In measuring the exciton diffusion length, emphasis is placed on quantifying the role of excitonic energy transfer in the dissociation process by explicitly measuring the Förster radius between donor and acceptor materials [1]. These effects are often incorrectly ignored, potentially leading to overestimates of the exciton diffusion length. In this work, efforts to overcome the short diffusion length are focused on small molecule OPVs that contain a continuously graded D-A film composition as a means to simultaneously optimize both exciton diffusion and charge collection. In a properly optimized graded heterojunction OPV, power conversion efficiencies >4% can be realized, exceeding the performance of corresponding planar and uniformly mixed structures [2].

[1] W.A. Luhman and R.J. Holmes, *Adv. Func. Mater.* 21, 764 (2011).
[2] R. Pandey and R.J. Holmes, *Adv. Mater*. 22, 5301 (2010).