

MAR05-2004-000266

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Fundamental electronic processes in organic photovoltaic cells

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In most organic photovoltaic (PV) cells, excitons must diffuse to a donor-acceptor interface where they dissociate by electron transfer. It is therefore critically important to understand exciton diffusion in detail in order to optimize device architectures. We have measured the exciton diffusion length of various organic materials using steady-state photoluminescence quenching in well-defined polymer/titania bilayer heterostructures. We address how processing conditions can affect the exciton diffusion length in the investigated systems and suggest ways to engineer new materials with larger exciton diffusion lengths. To study charge transport of polymers confined in nanometer channels, we have formed films of anodic alumina with arrays of straight nanopores on indium tin oxide electrodes. We filled the pores with conjugated polymers by spin casting them over the pores and then melting the film. Measurements of the transmission and reflectance of polarized light as a function of angle show that the polymer in the nanopores is partially aligned in the direction perpendicular to the substrate as compared to a neat film. Fitting the current-voltage curves of the diodes to a space charge limited current model shows that the mobility can be increased by a factor of 20. By replacing the insulating alumina with a semiconductor, such as titania, we should be able to make efficient ordered bulk heterojunction solar cells.