

# ENHANCEMENT MECHANISMS OF EXCITON FORMATION AND DISSOCIATION IN ORGANIC SOLAR CELLS

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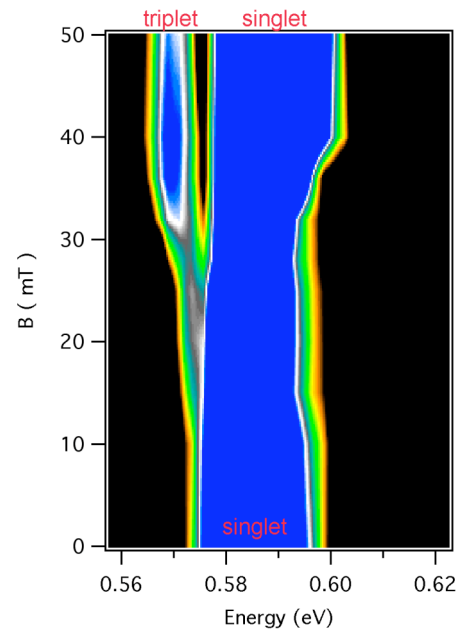
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In organic solar cells, photo-voltage is generated as excitons dissociate across the interface between a light absorbing polymer and a charge accepting contact. Efficient conversion of photons to electricity requires that the charge separation rate across the interface be substantially larger than the charge recombination rate. Here we describe the use of a capacitive photocurrent technique to study the exciton formation and dissociation across a single metal-polymer interface. This technique provides us with the ability to distinguish between excitonic and free carrier states, to determine excitonic binding energies and recombination times, and study the influence of interface materials and conditions on exciton formation and dissociation.

We have initially applied our technique to carbon nanotube / ITO junctions. Similar to polymers, carbon nanotubes have large excitonic binding energies, and exciton formation is the dominant light absorption mechanism. Our work on nanotubes has provided two possible strategies for enhancing charge generation in organic solar cells: 1) introduction of spin-orbit coupling to allow absorption into the triplet exciton state and 2) strain induced surface modifications to shift the excitonic peaks.

In the first set of experiments, nanotubes were coated with EuS, a ferromagnetic insulator with large spin orbit coupling. As shown in the figure to the right, the application of a small magnetic field to align the electron spins in the EuS results in the appearance of a low-energy photocurrent peak. The energy spacing of this peak from the main exciton peak suggests that it is due to the triplet exciton. The triplet exciton is normally not optically accessible, but the spin orbit coupling provided by the EuS allows for its observation. In a second set of experiments, nanotubes were grown on a piezoelectric quartz substrate, and the excitonic features tracked as a function of strain. The strain induced static charge in the quartz changed the dielectric environment, and shifted the position of the exciton peak, by up to 0.15 eV. A similar technique could be used to shift polymer absorption peaks, to increase near IR absorption, or to enhance exciton dissociation.



*Photocurrent magnitude as a function of excitation energy and magnetic field for a EuS coated single wall nanotube.*