Graduate Student Seminar

APS Practice Session

1) Josh Holt

Femtosecond transient studies of photoinduced charge transfer in polymers doped with strong acceptor molecules; applications for organic solar cells

JOSH HOLT, TOMER DRORI, SANJEEV SINGH, CHUANXIANG SHENG, Z. VALY VARDENY.
Current developments in organic solar cells (~5% efficiency nowadays) require understanding and control of photoinduced charge carrier transfer and electronic state dynamics of donor acceptor pairs. One current drawback to organic solar cell efficiency is negligible absorption in the near infrared region of the solar spectrum. We provide and compare evidence that poly(2-methoxy-5(2' ethyl)hexoxy-phenylenevinylene) (MEH-PPV) and regio-regular poly-3-hexyl thiophene (RR-P3HT) doped with 2,7-dinitrofluorenone (DNF) or 2,4,7- trinitrofluorenone (TNF) form below-gap charge transfer complex state that can extend absorption into the near infrared. Using fs transient and CW spectroscopies we found that the photoluminescence and mid-ir photoinduced absorption (PA) band of excitons are simultaneously quenched, when excited in the visible/uv or near ir. We compare our results to those of comparable systems using C60 as acceptor molecules.

2) Alex Ndobe

Below gap external quantum efficiency of organic solar cells.

ALEXANDRE NDOBE, VALY VARDENY, University of Utah. We fabricated a variety of organic bulk hetero-junction photovoltaic (PV) solar cells based on blends of regio-regular polythiophene (RR-P3HT) and MEHPPV with the fullerene molecules C60- and C70-PCBM. We found, surprisingly that the organic devices show a photo-voltaic effect even when excited with light having photon energy below the optical gap of the polymers. This implies that organic solar cells efficiencies can be improve by considering material other than PCBM that have higher infrared absorption but still can serve as good acceptors for the polymers. To complement this finding we measured the excitation dependence of various PV parameters such as the PV fill-factor, open-circuit voltage, and external quantum efficiency. The interesting excitation spectra reveal the device structure geometry as will be discussed in detail.

Thursday March 1, 2007
11:00 in JFB 206

Graduate Student Seminar

3) Tomer Drori

Photoinduced charge transfer from polymers to fullerene molecules revisited.

TOMER DRORI, Physics Department, University of Utah, CHUANXIANG SHENG, ALEX NDOBE, CUNGENG YANG, MINGHONG TONG, VALY VARDENY. We study the process of photoinduced charge transfer (PCT) between conjugated polymers and fullerene molecules as electron acceptors, using the technique of picosecond transient, and steady state photomodulation at various modulation frequencies and temperatures. The polymers studied were MEH-PPV and regio-regular P3HT [RR-P3HT], which are some of the common polymers that are used in organic photovoltaic, as well as polyfluorene [PFO] with optical gap in the blue spectral range; whereas the fullerene molecules where C_{60}, C_{70} and their PCBM variations. In all cases we found PCT as evident by the formation of strong photoinduced absorption (PA) polaron bands in the mid ir spectral range. Surprisingly we also found PCT with photon energy below the polymer optical gap. This below-gap PCT process will be discussed and compared with the more usual PCT process with above gap excitation.

4) Heather Seipel

Electrical spin measurements of diffused phosphorous donors in crystalline silicon

HEATHER SEIPEL, CHRISTOPH BOEHME, University of Utah. With recent experimental demonstration of the electrical detection of electron spins of phosphorous donors as well as their hyperfine coupling to the ^{31}P phosphorous nuclear spin [Stegner et al., Nature Physics, doi:10.1038/nphys465, (2006).], a potential mechanism for a ^{31}P in crystalline silicon (c-Si) nuclear spin readout based on spin-dependent ^{31}P - P_b recombination is available. To further investigate the properties of this mechanism, we present pulsed electrically detected magnetic resonance (pEDMR) measurements on diffusion doped silicon samples. For their preparation, c-Si (111) wafers are diffused with a profile whose concentration at the surface leads to a degenerately doped c-Si before it then drops off into the semiconducting region. Deep trenches are made with a plasma enhanced reactive ion etch where the choice of the trench depth determines the dopant concentration of the sample without changing any other sample preparation parameters. A study of the qualitative and quantitative nature of the observed pEDMR signals is presented for different etch depths.

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