

Title: Photoinduced electron transfer in polymer sensitized solar cells

Name: Hadiya.V.M

Advisor: Dr. Jyotishman Dasgupta, TIFR Mumbai

Quest for clean and renewable source of energy has led to the development of artificial photovoltaic devices which makes use of solar energy for generating electricity. In recent years, Dye Sensitized Solar Cells (DSSC) is gaining more attention as an alternative to conventional Si based solar cells because of its cheap fabrication technology. But, to date the power conversion efficiency attained for DSSC are very low when compared to the Si based technology. Our work aims to improve the efficiency of DSSC by fundamentally characterizing the different chemical processes and optimizing the associated reaction kinetics. Currently we are focussing on structurally identifying the dye binding moiety to the TiO₂ surface and measuring the electron injection/recombination rates. Since we need to have dyes that have wider absorption and large spatial separation of charges for larger efficiency, we focus our attention on conjugated oligomers/polymers. Currently we have focussed our attention to diketopyrrolopyrrole based conjugated polymer TDPP-BBT (thiophene-diketopyrrolopyrrole-2,6-bis(tributyltin)-4,8-dihexyloxybenzo[1,2-b;3,4b]dithiophene) provided to us by Prof. Satish Patil and co-workers (IISc Bangalore). Our steady state absorption and fluorescence measurements indicated that the dye weakly binds to the TiO₂ substrate but fluorescence quenching is observed upon TiO₂ binding. In order to temporally follow the electron injection, we have carried out time-correlated single photon counting and fluorescence upconversion measurements which showed the injection rates to be faster than ~30 ps. Resonance Raman studies on the polymer will provide the binding information to TiO₂ and is currently under investigation.

Concurrently we are in the process of setting up a time-resolved stimulated Raman spectrometer which is based on using femtosecond and picosecond pulses. In brief, a femtosecond actinic pulse is used to initiate the photochemistry while a combination of picosecond Raman pulse and a broadband femtosecond probe pulse is used for stimulating the Raman transition. We make use of a commercial Ti:sapphire oscillator with an amplifier system which has got an output of 4 W with 1 KHz repetition rate and less than 30 fs pulse width as the source from which we generate all the three pulses. Also we are using a commercial optical parametric amplifier for getting tunable output for the actinic pulse. Additionally we will construct noncollinear optical parametric amplifier with two amplification stages for generating tunable Raman pulse. All the three pulses will be spatially and temporally overlapped in the sample to get the stimulated Raman signal in the probe direction which will be detected by a spectrograph-CCD arrangement. I have been actively participating in setting this system up in TIFR.