Time-Resolved Spectroscopy for Third Generation Photovoltaics

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Traditional single threshold solar energy devices are limited to about 30% conversion efficiency, mostly due to two major losses: 1. an inability to harvest sub-threshold photons and 2. conversion photon energies in excess of the threshold into heat. The next generation of photovoltaic devices will circumvent these losses by clever control of energy flow. In this seminar, I address two strategies to overcome the single threshold limit: photon upconversion and the hot carrier cell.

Using multiple organic chromophores, we are able to harvest red light and through a triplet-triplet annihilation process upconvert this into the visible region of the spectrum. Our kinetic investigations have enabled the development of a model which matches our observed efficiencies which exceed those previously obtained by severalfold, and importantly break through the false 11% ceiling that some expect due to spin statistical arguments.

The Hot Carrier Cell is a device under development by a consortium lead by the School of Photovoltaic and Renewable Energy Engineering at UNSW. Crucial to the project is the measurement of the ultrafast kinetics of electron cooling in semiconductors. We achieve this by using sophisticated femtosecond lasers to map out the electron cooling in real time.