TR Photo- Luminescence

Time-resolved photoluminescence

TR-PL is a powerful technique for probing the dynamics of excitonic transitions within semiconductor materials such as those used in thin-film based photovoltaics.

Dr Enrico De Como and co-workers at the Ludwig-Maximilians-University Munich, Germany, are using the technique to investigate the efficiency of organic solar cells. Organic solar cells may offer key benefits such as high efficiencies, low costs and ease of production. Such cells typically consist of thin films of conjugated polymer with a fullerene layer. They rely upon photo-induced charge transfer occurring between the light harvesting conjugated polymer and the strong acceptor fullerene layer. The charge transfer excitons (CTEs) formed in this process have a limited lifetime. Photoluminescence from de-excitation of excitons is one of the most important recombination mechanisms that occurs; recombination impacts directly on the efficiency of such structures.

The decay dynamics of the CTE of the cells were investigated by analysing the photoluminescence with an iStar ICCD camera coupled to a Shamrock 500i spectrometer. A pulsed laser (Ti-Sapphire at 540 nm, rep rate 90 kHz) was used to excite the sample and trigger the iStar. Figure 2 shows a kinetic series captured by the DH340T-18U-03 camera of the photoluminescence spectra in the visible region. Each photoluminescence spectrum was acquired with a 5 ns gatewidth and a linear step delay of 5 ns. Signal for each delay was accumulated at the frequency of the laser i.e. 90 kHz. By considering a time slice of integrated intensity through the profiles, the decay characteristics can be plotted and lifetimes determined from power-law models. Decay time between 20 ns and 40 ns were measured during this experiment.

Figure 1: Kinetic series of PL spectra taken with New iStar model DH340T-18U-03 mounted on a Shamrock 500i. Laser excitation was from a pulsed laser.