RECENT DEVELOPMENTS OF THE PICOSECOND PULSED ELECTRON ACCELERATOR AND USING ULTRASHORT THZ PULSES TO STUDY EXCITON AND CHARGE CARRIER DYNAMICS [O-03]

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Currently, an electron accelerator-based pulsed radiolysis facility is under development to extend our time-resolved studies on charge dynamics in materials into the (sub)picosecond time regime. This accelerator is part of the ultrafast pulsed irradiation facility that also consists of a femtosecond Ti:Sapphire laser system, which is already operational for photolysis experiments. The materials under investigation are excited by either an ultrashort laser or relativistic electron pulse. The properties of generated excitons and charge carriers are detected by time-resolved THz conductivity and absorption or reflection spectroscopy. Eventually, the results will contribute to the improvement of the performance of, for instance, solar cells and light-emitting diodes, based on functional polymers, self-assembling molecular aggregates, inorganic nanoparticles or inorganic/organic composites.

Recently, we have studied exciton dynamics within PbSe nanocrystals using optical transient absorption[1]. Due to the fact that their bandgap scales with their size and that carrier multiplication occurs for photon energies well above the bandgap, semiconductor nanocrystals are promising materials to be applied in cheap and highly efficient solar cells.

For efficient solar cell operation, it is important to optimize the intrinsic photoabsorption properties (conversion from light energy to electronic excitations of the material), for instance by using carrier multiplication. Additionally, the stored energy has to be released into the form of free charges moving to the electrodes to drive the electron current of the solar cell. Time-domain THz spectroscopy is a useful contactless tool to study photoconductivity on a subpicosecond time scale[2]. We would like to study bilayers of photosensitive material (i.e. dye molecules or nanocrystals) and electron accepting material (i.e. TiO_2), which are called dye sensitized solar cells. From the time-domain THz spectroscopy information can be deduced on the diffusion length of excitons and charge separation efficiency, due to the high mobility of the electrons in the conduction band of TiO_2.

*[1] M.T. Trinh, A.J. Houtepen, J.M. Schins, T. Hanrath, J. Piris, W. Knulst, A.P.L.M. Goossens, L.D.A. Siebbeles, Nano Letters **2008**, in press, web release DOI: 10.1021/nl0807225.*

*[2] E. Hendry, M. Koeberg, J.M. Schins, L.D.A. Siebbeles, M. Bonn, Chemical Physics Letters **2006**, 432, 441.*