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Light-induced processes in the new generation solar cells

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ABSTRACT

The dye-sensitized solar cell is an interesting system, where light absorption occurs by a molecular dye adsorbed to a nanostructured, mesoporous metal oxide film, with subsequent electron injection into the conduction band of the metal oxide. The electron injection efficiency needs to be high in order to have a high-efficiency solar cell. After electron injection, the dye needs to be regenerated by an electron donor in the solution, and this process needs to be faster than electron back transfer from the metal oxide to the oxidized dye. The balance of the kinetics of the various processes determines the overall performance of the solar cell. The kinetics of charge carrier transport and recombination processes can be modeled in a variety of ways, and can be compared to other solar cell systems such as organic photovoltaics and the very recently reported perovskite-based solar cells.
In this presentation, a variety of systems will be analyzed with a focus on determining the influence of the kinetics of the many processes taking place on the cell performance. TiO2-based and ZnO-based dye-sensitized solar cells will be compared using both experimental and more theoretical approaches. A theoretical analysis of transport and recombination kinetics in bulk heterojunction solar cells will be discussed, and recent, initial results on perovskite solar cells will be presented.