Nanooptics and nanophotonics

Effect of donor – acceptor composition of organic dyes on productivity of solar cells based on nanopores TiO_2 films

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Förster energy transfer was studied between xanthene dye (donor of energy) and new polymethine dye (acceptor of energy) onto surface of TiO_2 films of dye sensitized solar cells. Energy donor and acceptor were chosen due to strong overlap of the absorption spectra of the donor and acceptor fluorescence, as well as an optimal arrangement of HOMO/LUMO orbitals of polymethine molecules relative to the conduction band of TiO_2. Measurements of fluorescence decay kinetics of donor onto TiO_2 shows that life time of xanthene dye was decreased at the presence of acceptor molecules. Energy efficiency, which was estimated with Förster-Dexter formula, reaches 22% at a concentration of acceptor molecules equal to 10^{-4} mol/l. Polymethine dye fluorescence intensity upon irradiation with white light increases almost in two times by the addition of donor molecules in the film.

Grätzel cells, sensitized by neat donor, neat acceptor and donor-acceptor compound, were assembled. Measurements of current-voltage characteristics of solar cells showed that the co-sensitization of semiconductor films by donor-acceptor compound leads to increasing of the light energy conversion efficiency in two times compared to the cell only on the basis of a polymethine dye. Measurements have shown that this is due to the expansion of the photosensitivity of the cells in the blue region of the spectrum. Thus, as the I-V measurements have shown, the main contribution gives the energy transfer process and not an event of co-sensitization of semiconductor films by heterogeneous dyes. Increase in total energy absorbed increases the number of charge carriers generated at the interface between the semiconductor layer and TiO_2 dye.