Sensitiztion of TiO_2 by merocyanine dye in the prescence of plasmon nanoparticles

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Currently, an active search and study of non-metal organic luminophores for dye-sensitized solar cells is peformed. Merocyanine dyes are characterized by high bipolarity, narrow selective absorption bands, high absorption cross sections (extinctions) and high photochemical stability.

In present work we have studied the effect of Ag nanoparticles (NPs) on the sensitization of a TiO_2 film by merocyanine dye. For this purposes dye was adsorbed onto porous TiO_2 films with the addition of Ag/TiO_2 core-shell nanostructures at a concentration of 0, 0.5, 1, and 2 wt%. These nanostructures consist of a core – Ag nanoparticles (20 nm in diameter) and a TiO_2 shell with a thickness of 4 nm. These TiO_2 films were used both for spectral-luminescence measurements and for DSSC assembling according to a standard technique.

The absorption spectrum of merocyanine is located in the region of 500 – 650 nm with a maximum at 590 nm, the fluorescence band is centered at 630 nm. The measurements showed that the addition of Ag/TiO_2 NPs does not affect on the shape and position of the absorption and fluorescence bands of the dye. In the presence of plasmonic NPs, a 30% increase in the fluorescence intensity of the dye was recorded. The fluorescence lifetime of the dye practically does not change in the presence of Ag/TiO_2 NPs.

The current–voltage characteristics (CVC) of solar cells were measured under the illumination with a Xe lamp with a power of 100 mW/cm^2. The merocyanine dye has the following photovoltaic parameters: I_{sc}=0.18 mA/cm2, V_{oc}=355 mV, FF=0.33, η=0.21%. The addition of Ag/TiO_2 NPs doubles the efficiency of the DSSC sensitized with a merocyanine dye and I_{sc}=0.6 mA/cm^2, V_{oc}=373 mV, FF=0.20, η=0.43%. The data on the spectral sensitivity of DSSC show that the addition of Ag/TiO_2 NPs results in the growth in the spectral sensitivity of the solar cell in the absorption band of the dye. At the same time, absorption of plasmonic Ag NPs was recorded in the region of 420 nm. Thus, the combinatioin of the growth of fluorescence and spectral sensitivity of solar cells with Ag/TiO_2 NPs leads to an increase in the efficiency of the generation of charge carriers in a semiconductor sensitized by the investigated merocyanine.

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