Femtosecond transient absorption and electrochemical impedance in the studies of solar cells sensitized by ADEKA-1 and MK-2 dyes: post-assembly molecular and atomic passivation of titania surface

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Unwanted electron recombination at the interfaces: titania-dye and titania-electrolyte are among the main limitations in further development of dye-sensitized solar cells (DSSC). Recently, the best DSSC efficiency of over 14% was reported for a novel organic dye, ADEKA-1, having silyl-anchor unit,[1] and we have shown that the back electron transfer process is directly related to the performance in this system.[2] In our current studies we determine the interfacial electron transfer dynamics in DSSC after innovative post-assembly treatments of titania surface by atomic layer deposition of Al_2O_3 and hierarchical multi-capping (Fig. 1). Electron injection, titania-dye and titania-electrolyte recombination were measured from femtoseconds to seconds in solar cells with cobalt-based electrolyte, champion ADEKA-1 dye and its popular carboxyl-anchor analogue, MK-2 dye. Both molecular capping and alumina blocking layers slow down electron injection process (from average rate constant 1.1 ps^{-1} to 0.4 ps^{-1}) and partial sub-ns back electron transfer from titania to the dye (from ca. 10 ns^{-1} to 5 ns^{-1}). Single alumina layers (of 0.1 nm thickness) have the highest impact on reducing the rate constants of these electron transfer processes, and for the thicknesses greater than 0.3 nm the rates hardly change.

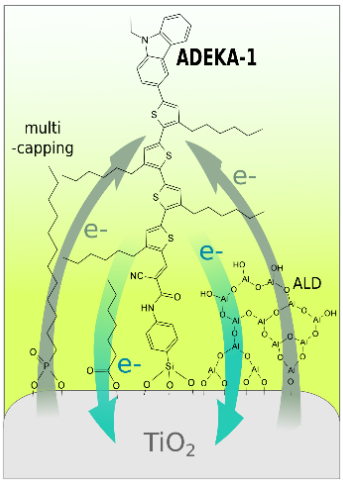

Figure 1. The structure of ADEKA-1, scheme of multi-capping and ALD techniques.

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