Modeling, simulation and design of dye sensitized solar cells

José Maçaira, Luísa Andrade* and Adélio Mendes*

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Abstract

It is well known that recombination and transport rule the performance of dye sensitized solar cells (DSC's); although, the influence that these two phenomena have in their performance, particularly on the open circuit-potential (V_{oc}) and on the short circuit current (J_{sc}), is not fully understood. In this paper a phenomenological model is used to describe the quantitative effect that transport and recombination have on the performance of the solar cell and their influence on its optimal design. The model is used to predict the influence of the recombination reaction rate constant (k_r) and diffusion coefficient (D_{eff}) on the V_{oc} and on the J_{sc}, whether a linear or non-linear recombination kinetic is considered. A methodology is provided for decoupling the conduction band shifts from recombination effects in charge extraction experiments. Results also suggest that the influence of recombination on the V_{oc} and on J_{sc} is highly dependent on the reaction order considered. This fact highlights the importance of considering the reaction order when modeling data obtained by experimental methods. The combined results are analyzed and discussed in terms of the collection efficiency and the optimization of the photoelectrode thickness. The model provides also a useful framework for exploring new concepts and designs for improving DSCs performance.