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P186 Predicting Activation Energies for the Recombination Reaction in Dye-Sensitized Solar Cells

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From the 1.7×10^5 TW of solar energy that strikes continuously the earth, a practical terrestrial solar energy conversion potential value is estimated to be about 600 TW [1]. The way of taking advantage of all this energy is, undoubtedly, using solar cells. The photovoltaic cells made from silicon, although showing efficiencies of 15-25%, present high-manufacturing costs and toxic chemicals in their fabrication process. On the other hand, dye sensitized solar cells (DSCs) are environmentally friendly and have a low-cost production. The current and voltage outputs determining the DSC's efficiency are recombination limited and result from a balance betweencharge generation and recombination fluxes.

In this work the recombination reaction kinetics is studied, making use of a previously developed phenomenological model [2]. Our unique laser assisted sealing technique allows to study the effect of temperature between -10 ºC up to 100 ºC without electrolyte leakage or external contaminants penetration [3]. A complementary analysis of the experimental results and the simulated ones allows determining the activation energies, E_a, for the recombination reaction for better understanding the uncertainty that surrounds the recombination reaction order coefficient, β.

*I-V*and EIS analyses were conducted in four batches samples of DSCs, in a temperature range from -10 to 100 ºC. To experimentally change the recombination reaction constant, k_r, theglass frit sealing perimeter was varied, while maintaining all others solar cell design parameters; this way it is possible to change the fraction of free TCO area exposed to electrolyte.

The influence of temperature is mainly seen at the V_{oc} and so it is possible to plot k_r for each temperature as a function of V_{oc}. Then, for a constant value of V_{oc} at 25 ºC, the independent influence of temperature on k_r can be determined; theE_a is determined as a function of the V_{oc} of the cell at 25 ºC – Figure 1. As V_{oc}increases, the Fermi level of the TiO_2 moves toward conduction band edge and E_a for recombination decreases. For low potentials $E_a$is highly dependent on the recombination order coefficient considered, reinforcing it is very important to obtain experimental data on recombination kinetic studies.

These results are very interesting for a correct comparison between solar technologies. If efficiency is compared at operating temperatures instead of standard values, then the efficiency gap between DSCs and other PV technologies could be lower than previously anticipated.

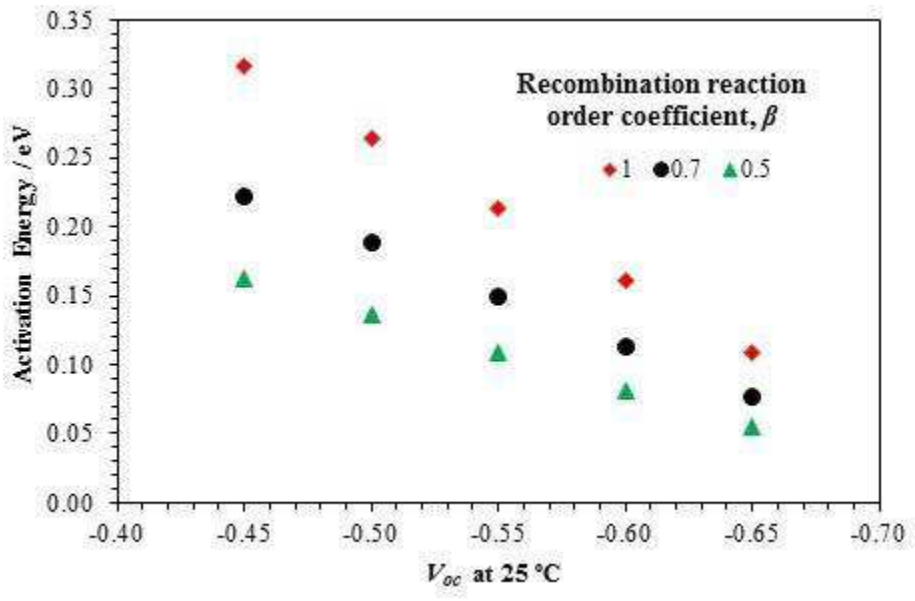

Figure 1 Figure 1: Predicted activation energies for the recombination vs Voc at 25 ºC, considering several recombination reaction order coefficient values, β.

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