Internal Photo Reference Electrode in Dye Sensitized Solar Cells for Three-Electrodes Electrochemical Characterizations

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The vast majority of dye sensitized solar cells (DSSCs) research is done using a two-electrodes configuration[1-3]. The sensitized nanoporous semiconductor electrode is pressed towards the counter electrode leaving an electrolyte layer of a few micrometers. In the absence of a reference electrode, any electrochemical characterization of the solar cell represents the whole system without the ability to differentiate the specific contribution of each electrode[4]. The interpretation of electrochemical measurements is further complicated by the fact that the potential of the counter electrode is determined by the electrolyte composition[2]. The latter may depend on the operating conditions of the cell including the bias potential and illumination intensities[5]. The standard way to incorporate a reference electrode in DSSCs involves a separation of the sensitized electrode from the counter and an increase of the cell volume. However, the volume increase alters the cell operation significantly.

We report here on the fabrication of DSSCs that contain an internal reference electrode thus enabling a three-electrodes measurement under operating conditions. We employ a standard DSSC in which the sensitized electrode (including the transparent conducting layer) is split by a narrow non-conducting gap (Figure 1). This enables one to perform two kinds of manipulations on the DSSC. First, using one half of the sensitized electrode and the counter electrode we determine the standard electrochemical performance of the cell. In addition, at the same stationary configuration, we use the second half of the sensitized electrode as a reference that maintains the open circuit potential. For the electrochemical measurements we employ a potentiostat, thus no current flows through the reference electrode during the measurement and the potential of the reference electrode is maintained constant[4].

A comparison of the iV curves of a DSSC measured in a two and three electrodes configurations shows a clear difference depending on the quality of the counter electrode. The influence of the latter is evident throughout the voltage scan with the exception of open circuit conditions. The counter electrode effect revealed by the three electrodes measurements is in part related to potential drops at the counter electrode. However, we find a significant influence of the counter electrode on the performance of the photoelectrochemical solar cell via internal recombination processes. The new photo-reference electrode and the resulting new insight on the photoelectrochemical DSSC will be presented.

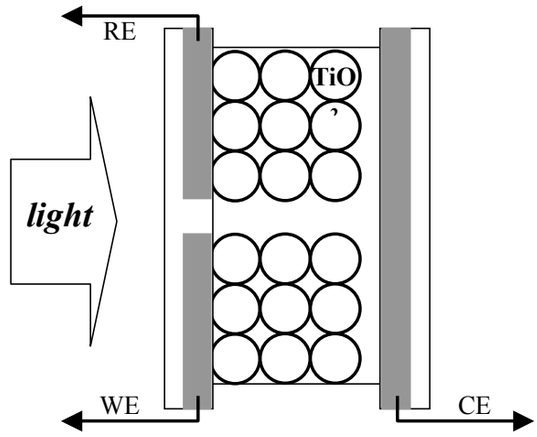

Fig. 1: A schematic presentation of the 3-electrodes DSSC. The standard 2-electrodes measurement is performed using the working (sensitized) and counter electrodes. For a 3-electrodes measurement of the same cell the reference electrode maintaining Voc is added.

References

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