

## Conversion Enhancement in Dye-Sensitized Solar Cells by Insitu Passivation of the Dyed Nanoporous Electrode with $\text{Li}_2\text{CO}_3$

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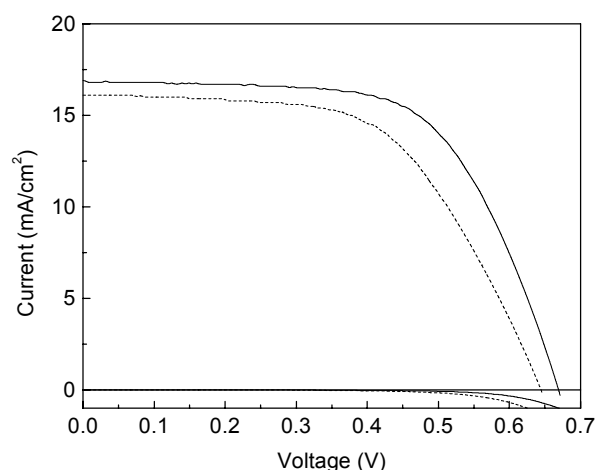
The high conversion efficiency in the dye-sensitized solar cells (DSSCs) may be attributed to the high surface area nanoporous electrodes that exhibit high light harvesting despite the monolayer coverage of dye molecules.<sup>1</sup> However, at the same time, the high surface area increases one of the principal factors that limit the performance of DSSCs, the recombination of the photogenerated electron with the holes transferred to the electrolyte. Several studies on the back reaction of injected electron were reported recently.<sup>2,3</sup> The recombination suppression effort is aimed at two regions of the nanoporous electrode, the high surface area nanoporous film and the uncovered area of the conductive substrate. Despite the previous achievements, it is important to develop new methods for recombination suppression with the emphasis on simplicity and a solution to both the semiconductor region and the conductive substrate.

Recent studies of lithium batteries show that the presence of  $\text{CO}_2$  in the electrolyte solutions increases the batteries performance. This improvement is attributed to efficient surface passivation by  $\text{Li}_2\text{CO}_3$  which is formed by an electrochemical reaction between the Li and the  $\text{CO}_2$ .<sup>4</sup>

We report here on the application of the lithium batteries methodologies regarding surface passivation by carbonate salts to DSSCs. Saturation of the standard DSSC electrolyte with  $\text{CO}_2$ , resulted in the increase of both the open circuit photovoltage and the short circuit photocurrent of the DSSCs (Figure 1). Consequently, more than 10% increase in the overall efficiency of the DSSC resulted from this simple treatment. Spectral and electrochemical results show that the effect should be attributed to the  $\text{Li}_2\text{CO}_3$  salt that is electrochemically deposited on the non dyed electrode surface, both at the nanocrystalline  $\text{TiO}_2$  and at the conducting substrate. The electronic isolating nature of the carbonate salt suppresses the reaction rate of the photoinjected electrons that diffuse in the porous  $\text{TiO}_2$  film. Moreover, being a good lithium ion conductor the carbonate layer allows accumulation of positive ions close to the  $\text{TiO}_2$  surface which improves the electron screening and thus the cell performance.

### References

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**Figure 1** Current-voltage characteristics of the DSSC differing by the electrolyte in the dark and under the illumination. Standard electrolyte: dashed line,  $\text{CO}_2$  containing electrolyte: solid line