Improved performance and stability in quasi-solid dye-sensitized solar cell based on dendron-modified talc electrolyte.

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Abstract

Dendron-modified talcs were used to gel a liquid electrolyte used in dye-sensitized solar cells improving their performance and stability.

Introduction

Recently, the use of clays as additives in electrolytes of dye sensitized solar cells (DSSCs), has been investigated. These materials act as gelling agents of liquid electrolytes and are a potential alternative to solve technical problems presented by conventional DSSCs (based on liquid electrolytes) such as electrolyte leakage and solvent vaporization[1], which limit both their stability and practical use[1]. In the literature, clays used as gelling agents in the electrolytes of DSSCs have mainly been phyllosilicates, such as a dioctahedral mica, and the smectites: laponite, bentonite, montmorillonite and saponite[2]. Here, the effects of generation 5 PAMAM-modified talc (G5 PAMAM-talc), and the polyiodide modified solid (PAMAM/I_2-talc), as additives in composite gel electrolytes for DSSCs were investigated. The purpose is to evaluate the advantages of using a gel electrolyte and the effect of the intercalation of polyiodides into clays interlamelar space on the stability of the devices.

Results and Discussions

The characteristics of DSSC with gel electrolytes were compared to those of reference DSSCs with the liquid electrolyte. The solar cells were illuminated under 1 Sun for approximately 1000 h. Whilst the solar cells with PAMAM/I_2-talc and reference electrolyte remained quite stable in regards to all photovoltaic parameters (Figure 1), the cells with PAMAM-talc clearly degraded in this period. In the PAMAM-talc cells, especially, the photocurrent decreases, which results in a corresponding degradation of the efficiency as well. In addition, the solar cells with PAMAM-talc have decreased FF after 600 h. PAMAM-talc removes free active redox species from the electrolyte solution. The iodide species interact with available basic sites in PAMAM dendron by Lewis acid-base interactions. After that, free iodide species from electrolyte could react with the adsorbed iodide in the dendron to form long chain polyiodides as confirmed by Raman and UV-vis spectroscopy. Therefore, the previous intercalation of polyiodides into the organotalc present a positive effect in the gelation of the electrolytes, diminishing the removal of free species present in the electrolyte and increasing the stability of the DSSCs compared to the devices where the previous iodide intercalation was not made.

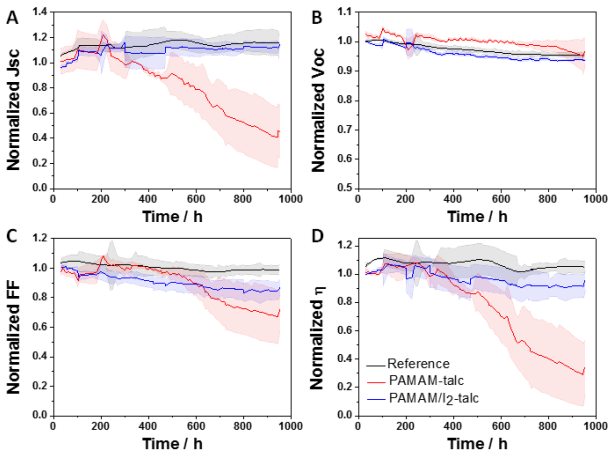

Figure 1. Normalized aging data of the cells with electrolyte gelled by PAMAM-talc and PAMAM/I_2-talc under 1 Sun for approximately 1000h.

Conclusions

The cells with PAMAM-talc degraded during aging while the cells with PAMAM/I_2-talc presented as good a stability as the reference cells within the studied period. The intercalation of polyiodides positively affects the stability of the quasi-solid DSSCs presenting approximately equal performance to the reference solar cells with liquid electrolyte.

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