Tailoring Carbon Aerogel as the Counter Electrode for Dye-sensitized Solar Cells

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Carbon aerogel (CA) has attracted considerable attention mainly because of its unique properties, including high specific surface area, good chemical and thermal stabilities, high mechanical strength, and low cost. To qualify for an good electrocatalyst, the following three requirements need to be satisfied. Firstly, the material should possess a high intrisic electrocatalytic property, as judged by its standard heterogeneous rate constant. Secondly, the structural material should offer a sufficient specific surface area for the application. Lastly, it should have a resonable conductivity.

In this study, CA is acted as both electrocatalytic layer and conducting substrate and served as the counter electrode (CE) in dye-sensitized solar cells (DSSCs). Its sheet resistance (R_{sh}, 0.01 Ω sq^{-1}) is smaller than that of the FTO substrate (1.48 Ω sq^{-1}). The precursor of CA was carefully controlled to provide different specific surface areas, namely, CA-O, CA-F, and CA-C. The specific surface areas of CA-O, CA-F, and CA-C were measured to be 592, 643, 724 m^2/g, respectively. Among these, the mechanical strengthes for both CA-F and CA-C (5.56 and 3.01 GPa) approach that of the FTO (5.25 GPa). These physical properties show the potential of CA to replace the conducting FTO substrate. As shown in **Fig. 1**, a DSSC with CA-C on its CE reached a power conversion efficiency (η) of 9.08% with an open-circuit voltage (V_{OC}) of 0.77 V, a fill factor (*FF*) of 0.71, and a short-circuit current density (J_{SC}) of 16.59 mA cm^{-2}. This CA-C-based DSSC performs better than the cell with a Pt-based DSSC (η: 7.92%, V_{OC}: 0.74 V, *FF*: 0.67, J_{SC}: 15.98 mA cm^{-2}). To investigate the CA-C-based DSSC performance under dim light, the *J-V* curves of the best DSSC with CA-C were measured at 0.5 sun (50 mW cm^{-2}), as shown in **Fig. 2**. The DSSC with CA-C exhibits an η of 9.08% at 100 mW cm^{-2} and the best η of 9.16% at 0.5 sun. The results suggest the possibility of CA-C to replace Pt and FTO substrate in DSSCs.

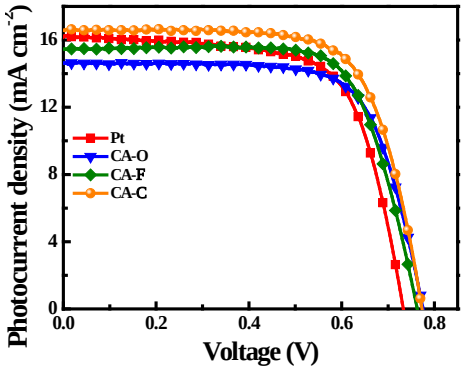

Fig. 1 Photocurrent density-voltage curves of the DSSCs with the Pt and various CAs on their CEs, measured under 100 mW cm^{-2} (0.1 sun).

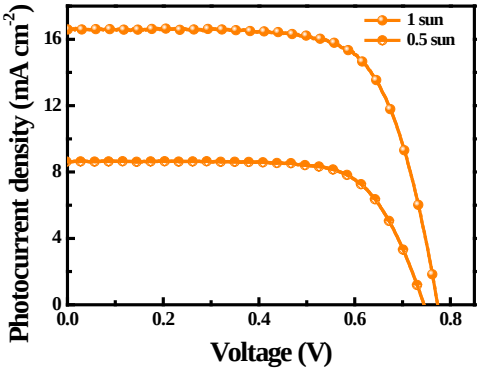

Fig. 2 Photocurrent density-voltage curves of the DSSC with the CA-C, measured under 1.0 sun (100 mW cm^{-2}) and 0.5 sun (50 mW cm^{-2}).

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