RESCON 2025 PS 16

DEVELOPMENT OF LOW-COST, SUSTAINABLE COUNTER ELECTRODE FOR DYE-SENSITISED SOLAR CELLS USING ACTIVATED PALMYRA SHELL CHARCOAL/GRAPHENE COMPOSITE

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In recent years, significant research studies have focused on developing low-cost, alternative counter electrode (CE) materials for dye-sensitised solar cells (DSCs), due to the high-cost of conventional platinum counter electrodes. This study aimed to develop an alternative, low-cost CE material for DSCs by fabricating a composite based on activated palmyra shell charcoal (APSC) and graphene. In this project, APSC powder was produced in a carbonisation process under steam activation with reduced O_2 level, followed by grinding into a fine powder. Then, the counter electrodes were prepared using 0.5 g of APSC powder and 1-ethenylpyrrolidin-2-one (PVP) binder in a propan-2-ol solution. The resulting suspension was sprayed onto pre-heated FTO plates and sintered at 300 °C for 30 min. Composite counter electrodes were prepared according to the above method by incorporating trace amounts of graphene while maintaining a constant APSC amount. The mass ratio of graphene-to-APSC was subsequently optimised to obtain the maximum power conversion efficiency by enhancing the conductivity and catalytic activity of the composite counter electrodes. To assemble the DSCs, a N719 dye-coated photoanode with a 0.20 cm^2 mask and counter electrode was gently clipped, and the space between the photoanode and CE was filled with the liquid electrolyte I^-/I_3^- . Then, the solar cell performance was evaluated using SPD SS-25 LED solar simulator (simulated sunlight source), under AM 1.5 illumination of 100 mW cm^{-2}. The DSC fabricated with the APSC CE exhibited a power conversion efficiency of 5.16%, while a 14% graphene-incorporated composite CE exhibited a power conversion efficiency of 6.56%, significantly higher than APSC CE and slightly lower than the 7.65% power conversion efficiency of platinum-based DSCs. The resulting composite-based DSCs provide a sustainable, low-cost, eco-friendly alternative to platinum counter electrodes for dye-sensitised solar cells, thereby supporting the development of cost-effective solar energy technologies.

Keywords: Activated palmyra shell charcoal, Composite counter electrode, Dye-sensitised solar cell, Graphene