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# Enhancing the Efficiency of Dye-Sensitized Solar Cells through the Integration of Reduced Graphene Oxide (RGO) into $TiO_2$ Multi-Layered Photoanode

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In Dye-Sensitized Solar Cells (DSSCs), an efficient photoanode is crucial for improving light harvesting and electron transport. In a typical photoanode, dye molecules anchored to a mesoporous $TiO_2$ layer collect photogenerated electrons from excited dye molecules. The performance of DSSCs is influenced by the properties of the $TiO_2$ film, including surface area, morphology, grain size, and grain boundary density. The fabrication method used for the $TiO_2$ layer also plays a critical role in optimizing these properties. Significant progress has been made in the development of $TiO_2$-based nanomaterials and film preparation techniques to improve DSSC performance. To further enhance light harvesting, various modifications can be applied to $TiO_2$-based photoanodes, such as surface treatment, co-sensitization, and material incorporation.

In this study, $TiO_2$-based photoanodes were enhanced by incorporating Reduced Graphene Oxide (RGO), and DSSC performance was optimized with an iodide-based liquid electrolyte. A $TiO_2$ nanofiber layer was deposited on the $TiO_2$/RGO composite using electrospinning, followed by a P25 $TiO_2$ layer via the doctor-blade technique. The DSSC performance of these photoanode configurations was evaluated, with the highest performance achieved for the multi-layer structured photoanode incorporating both RGO and $TiO_2$ nanofibers. Incorporating RGO improved DSSC efficiency from 8.57% to 9.18%, while the multi-layered photoanode achieved a maximum efficiency of 10.09%. The photoanode was characterized using scanning electron microscopy with elemental mapping, and electrochemical performance was studied through electrochemical impedance spectroscopy (EIS).

**Keywords**: Dye-sensitized solar cells; Reduced Graphene Oxide; Photoanode, $TiO_2$ nanofiber

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