

## **Graphite/ TiO<sub>2</sub> counter-electrodes assembled with TiO<sub>2</sub> multilayer photoelectrode for low-cost quasi solid-state dye-sensitized solar cells**

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Investigation and development of platinum free counter-electrodes are highly important in preparing low-cost Dye-Sensitized Solar Cells (DSSCs). In this study, low-cost Graphite and TiO<sub>2</sub> composite counter-electrodes are investigated along with photo-electrodes containing dye-photosensitized (N719) TiO<sub>2</sub> multilayers (five, six, and seven layers).

The highest DSSC efficiency is observed for the cells assembled using the counter-electrode that contains 80% of Graphite and 20% TiO<sub>2</sub>, for all the multilayer photo-electrode series investigated. When comparing different series of multilayer photo-electrodes assembled with this optimized counter-electrode composition, the DSSC efficiency for the six-layer series is greater than the five and seven-layer electrodes.

This best composition of electrodes optimizes the efficiency by fine-tuning between the charge carrier transport properties and catalytic activity of the electrode. The Graphite content plays a significant role due to its catalytic activity. In 3 hours under irradiation, open-circuit voltage got reduced by 8.0%, while the current density and efficiency got improved by 43.2% and 7.0%, respectively, as observed for the cells with the optimum electrode combination. It can be determined that Graphite/TiO<sub>2</sub> 80%/20% counter-electrodes with six-layer photoelectrodes optimize the performance of platinum free low-cost DSSCs.

**Keywords:** Dye-sensitized Solar Cell, Low-Cost Counter-electrode, and Graphite/TiO<sub>2</sub> Composite.

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