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Comparative Analysis of Light-harvesting Efficiency and Photovoltaic Efficiency of N719 and D719 Dyes in Dye-sensitized Solar Cells

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Dye-sensitized solar cells (DSSCs) are cost-effective, thin-film solar cells that use photosensitive dye to absorb sunlight and generate electricity through electron transfer to a semiconductor. Solar cells based on dye-sensitization technologies demonstrate a significant potential for replacing traditional photovoltaic technologies because they offer affordable production methods. This research addresses the lack of research on the comparison of commercially available dyes. The SnO_2/ZnO composite was used as the photoanode to compare the dyes. The efficiency and performance were evaluated in N719 and D719 dyes in dye-sensitized solar cells to identify which dye performs better under specific conditions and how their properties influence overall solar cell efficiency. The SnO_2/ZnO composite was coated on the FTO glass substrate by the spray-coating method. The photoanodes were sintered at 500°C for 30 minutes. The sintered cells were dipped in N719 and D719 dye with concentrations of 0.3 mM for 24 hours. The cell was assembled with a dye-absorbed photoanode, platinized counter electrode, a 0.20 cm^2 mask with a window, and I^-/I_3^- electrolyte. The performance evaluation was done using *J-V* measurements with a solar simulator. The SnO_2/ZnO composite showed a conversion efficiency of 4.33% for the N719 dye. The D719 dye demonstrated an overall energy conversion efficiency of 5.79% for the SnO_2/ZnO composite. Photocurrent spectra revealed peaks of incident photon-to-current efficiency (IPCE) of 30.8% and 47.6% for N719 and D719 dyes, respectively, for SnO_2/ZnO composite. UV-Vis spectroscopy and Raman spectroscopy confirmed the characteristic peaks for N719 and D719 dyes. Raman spectra verified the presence of characteristic vibrational peaks, indicating successful dye adsorption. The maximum absorbance peak in the UV-Vis spectrum indicates the strongest absorption in the visible region. Overall, this study highlights the improved performance of DSSCs with D719 dye when using the SnO_2/ZnO composite. The findings indicate that D719 dye is a superior alternative for N719 dye.

Keywords: Dye-sensitized solar cells, SnO_2/ZnO composite, N719 dye, D719 dye, energy conversion efficiency