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# ENHANCING DSSC PERFORMANCE THROUGH CHLOROPHYLL AND PORPHYRIN DYE INCORPORATION ON $TiO_2$-ZnO: Al COMPOSITES

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**Abstract.** This research systematically investigates the impact of porphyrin and chlorophyll dyes on Dye-Sensitized Solar Cells (DSSC) performance, aims to achieve maximum solar cell efficiency. This investigation involved the use of Fluorine-doped Tin Oxide (FTO) coating with $TiO_2$–ZnO composite, incorporating Al doping, and introducing variations in the concentration of chlorophyll SP and porphyrin (2:2:0.1 and 2:2:0.2). Synthesis of Al-doped ZnO was carried out via the sol-gel method, which involves mixing and heating at 65°C, followed by degradation at 150°C. $TiO_2$ and ZnO: Al composites were formed using the sonication method at 45°C for 60 minutes. This study evaluates the impact of dyes on the growth of $TiO_2$ and ZnO: Al composites and examines their characteristics - including UV-Vis, band gap, current versus voltage curves, DSSC efficiency-using EDX, and FTIR analyses of solar cells. The DSSC efficiency testing utilizes a photon light source from a halogen lamp with an intensity of 328-580 lux. The results showed that DSSC based on $TiO_2$–ZnO: Al + chlorophyll produced an efficiency of 13.3%, while porphyrin (2:2:0.1) and (2:2:0.2) produced an efficiency of 8.9% and 13.9%, respectively. In conclusion, this study shows that adding dye to the $TiO_2$–ZnO: Al composite significantly improves DSSC performance and shows optimal characteristics. The highest DSSC efficiency of 13.9% underscores the interdependence of absorber layer quality with photovoltaic performance, providing valuable insights for future solar cell design and optimization.

**Keywords:** $TiO_2$ and ZnO fluorine-doped tin oxide, porphyrin, ZnO with Al doping.

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