Abstract

Photovoltaic solar technologies offer a promising solution to the global energy crisis and the increasing demand for clean energy sources. Studies suggest that zinc oxide (ZnO) and silver nanoparticles (Ag-NPs) can enhance the properties of dye-sensitized solar cells (DSSCs) due to their abilities in electron transport and light absorption. This study aims to synthesize and characterize a ZnO-Ag hybrid structure to improve photocurrent production.

This study focuses on the synthesis and characterization of silver nanoparticles (Ag-NPs), zinc oxide nanoparticles (ZnO-NPs), and their hybrid structure (ZnO-Ag) for enhanced photocurrent production. Ag-NPs were synthesized using a polyvinylpyrrolidone (PVP) and ethylene glycol system, while ZnO-NPs were prepared via a microwave-assisted method followed by calcination. The hybrid structure was formed by combining Ag-NPs with ZnO-NPs under controlled conditions. UV-Visible spectroscopy confirmed the successful synthesis, with Ag-NPs exhibiting a peak at 461 nm and ZnO-NPs showing a peak at 370 nm, reflecting their optical and semiconducting properties.

The fabricated samples were tested using a potentiostat to evaluate their photocurrent performance. I-V curve analysis revealed a significant improvement in short-circuit current (Isc) and open-circuit voltage (Voc) for the hybrid structure (Isc = 3.34 A, Voc = 2.23 V) compared to single-layer samples of ZnO or ZnO-Ag. This enhancement, reaching up to 50%, is attributed to improved charge transport, plasmonic effects of silver nanoparticles, increased surface area, and reduced charge loss within the hybrid structure.

These results demonstrate the superior performance of the ZnO-Ag hybrid, showcasing its potential in photovoltaic and optoelectronic applications. The findings pave the way for future research to further optimize hybrid nanostructures for energy conversion technologies.