

Optimization of Dye-Sensitized Solar Cells: Advanced Materials and Morphologies for Efficient Photoanodes

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Abstract

Dye-sensitized solar cells (DSSC) are once again gaining attention for capturing indoor light and powering wireless devices. They offer several advantages such as low cost, high flexibility, wide angular response, and lightweight design, which have encouraged the use of advanced photonic architectures and specific photosensitizers, while also being compatible with portable devices. However, to fully harness their potential, it is essential to focus on improving their spectral compatibility, low-light collection mechanisms, and developing efficient photoanodes through scalable, high-yield production methods. Our study focuses on the efforts undertaken to enhance the efficiency of dye-sensitized solar cells (DSSC) by integrating a variety of materials into the fabrication of photoanodes, primarily metal oxides such as TiO₂ and ZnO. Although ZnO has better electron mobility, TiO₂ is preferred due to its superior dye adsorption capacity and stability in acidic environments. Among the different crystalline forms of TiO₂ (anatase, rutile, brookite), anatase is the most commonly used in DSSC because of its better energy conversion efficiency. The morphology of the materials, particularly the use of nanoparticles to maximize surface area, also plays a crucial role. Research is focused on optimizing the structural and electronic properties of TiO₂, as well as improving electron mobility and dye adsorption through various nanoarchitectures.

Keywords

DSSC, Photoanodes, Anatase, Adsorption, Surface, TiO₂