Physica B: Condensed Matter
Volume 699, 15 February 2025, 416797

Efficiency enhancement in dye-sensitized solar cells through neodymium-doped graphene quantum dot-modified TiO_2 photoanodes

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https://doi.org/10.1016/j.physb.2024.416797

Publication	:	Physica B: Condensed Matter, Volume 699, id.416797
Volume	:	699
Pub Date	:	15th of February 2025
Bibcode	:	2025 PhyB..69916797S

Abstract

This study explored the effects of Neodymium-doped graphene quantum dots (NdGQDs) on improving the performance efficiency of TiO_2 based dye-sensitized solar cells (DSSCs). By employing in-situ physical assisted mixing, DSSCs with optimized NdGQDs in TiO_2 photoanodes showed a power conversion efficiency of 8.76 %, a significant improvement compared to the 6.01 % efficiency of pristine TiO_2-based DSSCs under 100 mW cm^{-2} illumination (AM 1.5). Notably, the short-circuit current density increased by 74 %. HRTEM analysis revealed that the NdGQDs have a size range of approximately 7–9 nm. UV–visible spectroscopy and Mott-Schottky analysis revealed a positive shift in the Fermi level, promoting better electron transfer and increased photocurrent density at the expenses of the open circuit voltage. Electrochemical impedance spectroscopy characterization of DSSCs incorporating NdGQD-modified

photoanodes revealed a reduction in electron transfer resistance at the photoanode|dye|electrolyte interface, accompanied by an increase in recombination resistance within the device suppressing the electron recombination rate.

Keywords :Dye-sensitized solar cells; Graphene quantum dots; NdGQDs/TiO_2; Electron transfer