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# Application Performance Study of Carbon Nanotube-Reinforced Composites in Flexible Photovoltaic Devices

With the rapid growth of renewable energy demand, flexible photovoltaic (PV) devices have emerged as a key technology due to their lightweight, bendable, and integrable characteristics. Flexible PV devices can be applied in wearable electronics, portable devices, and building-integrated PV systems, offering new possibilities for distributed energy and smart energy management. However, challenges in mechanical flexibility, electrical conductivity, and durability still limit their large-scale application.

Carbon nanotubes (CNTs), as novel nanomaterials, exhibit excellent electrical conductivity, high mechanical strength, and superior thermal conductivity. Incorporating CNTs into composite materials for flexible PV devices can significantly enhance their electrical, mechanical, and thermal performance. CNT-reinforced composites improve the integrity of conductive networks and carrier transport efficiency, while enhancing mechanical stability under bending, stretching, and cyclic loading. This contributes to longer device lifetimes and higher photovoltaic conversion efficiency.

In practical applications, the performance of CNT-reinforced composites in flexible PV devices is influenced by factors such as CNT concentration, dispersion uniformity, interfacial bonding, and device structural design. Systematic experimental studies and numerical simulations can evaluate how different composite formulations and structural designs affect photoelectric performance, mechanical flexibility, and thermal stability. This approach provides scientific guidance for material optimization and device design of flexible PV systems.

This study aims to investigate the application performance of CNT-reinforced composites in flexible PV devices. The research includes preparation and characterization of CNT composites, assembly of flexible PV devices, evaluation of photoelectric properties, and analysis of mechanical and thermal performance. By comparing different design schemes and assessing performance, this study seeks to provide theoretical guidance and technical support for developing high-performance flexible PV devices, promoting their applications in wearable electronics, portable energy systems, and building-integrated photovoltaics.