Investigation of Charge Transport Mechanisms in Lead-Free Perovskites in Presence of Carbon Nanotubes for Optoelectronic Device Applications

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Abstract

This thesis investigates the potential of lead-free perovskite materials, especially when integrated with carbon nanotubes (CNTs), to improve optoelectronic properties. This research focuses on perovskite materials because of their tuneable features, low production costs, and excellent energy conversion efficiency, driven by the global desire for sustainable energy solutions. However, challenges such as stability, environmental effect, and charge transport must be addressed. Lead-free perovskites, while environmentally friendly, usually underperform due to defects and inhomogeneities developed during synthesis. The use of CNTs, known for their extraordinary characteristics, is being incorporated and investigated as a solution to these limitations.

The thesis is presented into several chapters, starting with an introduction to perovskite structures and their significance. It reviews the current state and challenges of lead-free perovskite devices and various charge transport models. Experimental chapters detail the synthesis, characterization, and analysis of different lead-free perovskites (e.g., $CH_3NH_3SnI_3$, $CsSnCl_3$, and Cs_2SnCl_6) and their composites with CNTs. The research includes developing devices to study charge transport mechanisms and the impact of CNTs on device performance.

Key findings highlight that the inclusion of CNTs significantly enhances the electrical and optoelectronic properties of lead-free perovskite devices. For instance, a MWCNT- Cs_2SnCl_6 composite demonstrate improved charge transport and optoelectronic properties in a UV detector. The comprehensive analysis presented in this thesis underscores the importance of refining material synthesis and device interfaces to advance lead-free perovskite-based technologies.

This work contributes to the growing body of knowledge on lead-free perovskites and CNTs, offering insights that may inspire further innovation in sustainable optoelectronic devices.

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