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Comprehensive Analysis of Energy Conversion in MOCVD-Deposited Eu-Doped Barium Fluoride Thin Film

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In recent years, there has been a significant push towards the development of novel functional materials to enhance the efficiency of photovoltaic (PV) devices and maximize solar radiation utilization. One advanced method to improve PV system efficiency involves converting photons with energies beyond the absorption capabilities of photoactive materials, like silicon, into a more suitable optical region. Lanthanide (Ln)-doped fluoride materials have emerged as promising candidates for energy conversion (EC) applications due to their unique luminescent properties when exposed to light. Previous research indicates that fluorides are more efficient inorganic hosts for EC processes than other inorganic matrices. BaF_2 is considered a standout host for incorporating luminescent Ln^{3+} ions due to its low phonon energy (comparable to or lower than commonly used hosts like $NaYF_4$), high chemical stability, wide transparency, and versatile synthesis methods. Trivalent lanthanide ions can easily integrate into the BaF_2 crystal structure due to their comparable coordination sphere, though a charge compensation mechanism is needed to offset the additional charge. This study explores the fabrication of Eu-doped BaF_2 thin films using the metalorganic chemical vapor deposition (MOCVD) technique, focusing on the production process and down-shifting (DS) luminescent properties. The production of BaF_2 thin films doped with Eu^{3+} uses a multicomponent mixture of metalorganic adducts in an appropriate molar ratio to fine-tune the chemical compositions of the films. Structural, morphological, and compositional characterizations of the films were conducted using X-ray diffraction (XRD), field-emission scanning electron microscopy (FE-SEM), and energy-dispersive X-ray analysis (EDX). Luminescence spectroscopy was employed to assess the functional properties of the films.