



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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Thesis Title: **CONTROLLED GROWTH AND CHARACTERIZATION OF LEAD-FREE HALIDE DOUBLE PEROVSKITES FOR OPTOELECTRONIC APPLICATIONS**

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SHORT ABSTRACT

This thesis presents comprehensive studies on the controlled growth, characterisation, and optoelectronic applications of lead-free halide double perovskites, particularly Cs₂AgBiBr₆ (DPs). The work focuses on developing environmentally stable and non-toxic alternatives to conventional lead-based perovskites for next-generation optoelectronic devices. High-quality DP thin films were successfully grown on various substrates by chemical vapour deposition (CVD), while nanoparticles and low-dimensional structures were synthesised via mechanical ball milling. Detailed structural, optical, and thermal investigations were conducted using Raman spectroscopy and other characterisation methods to understand the material properties and their influence on device performance. The thesis further explores the fabrication of advanced photodetectors and heterostructure devices. In-situ grown Cs₂AgBiBr₆-WS₂ heterostructures exhibited significantly enhanced photoconduction compared to bare DP devices, showing improved responsivity, specific detectivity, and current on/off ratio under visible light illumination. The work also demonstrates the novel application of DP films as efficient surface-enhanced Raman scattering (SERS) substrates, where enhanced Raman signals were attributed to self-trapped exciton-assisted charge transfer. Additionally, heterostructure photodetectors based on Cs₂AgBiBr₆ single crystals and Cs₃Bi₂I₉ nanocrystals revealed efficient type-II band alignment and enhanced charge separation, further supported by density functional theory calculations. Overall, this thesis explores interfacial charge-transfer-mediated high-performance photodetection and SERS applications of lead-free double perovskites, highlighting their potential for advanced optoelectronic devices.