Lead-Free Quaternary Chalcohalides for Photovoltaic and Self-Powered Photodetector Applications

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Perovskite-inspired mixed-metal quaternary chalcohalides, with the general formula $A^{II}_2B^{III}Ch_2X_3$ (where A = Sn; B = Sb, Bi, In; Ch = S, Se, Te; X = Cl, Br, I), represent a promising class of materials for optoelectronic applications. Among them, $Sn_2SbS_2I_3$ is of particular interest due to its low exciton binding energy, narrow optical bandgap (~1.4 eV), and high absorption coefficient (>10^4 cm^{-1}). Its solution-processability, low toxicity, ambient stability, and unique crystal structure—combined with expected defect tolerance - position $Sn_2SbS_2I_3$ as a strong candidate for next-generation solar cells, with the potential to achieve power conversion efficiencies (PCEs) approaching the theoretical limit of 30%. [1]

In addition to photovoltaics, $Sn_2SbS_2I_3$ shows great promise for self-powered photodetector (SPPD) applications. SPPDs capable of operating at zero bias are highly desirable for use in encrypted communications, smartphones, security surveillance, environmental monitoring, and healthcare. While most previously reported perovskite-inspired materials (PIMs) have demonstrated broadband photo-detection from UV to visible wavelengths, few have extended light-detection capabilities into the near-infrared (NIR) regime. [2] Moreover, the performance of existing PIM-based SPPDs remains modest, limiting their practical deployment. In contrast, the broadband (UV–visible–NIR) absorption, strong light-harvesting capability, and excellent environmental stability of $Sn_2SbS_2I_3$ make it a suitable material for high-performance SPPDs across a broad spectral range. [3]

References:

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