

How Halide Perovskites Expanded the Frontiers of Photovoltaic Solar Energy

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The discovery of halide perovskite materials as exceptional solar-absorbing semiconductors stemmed from the drive to develop more stable, all-solid-state dye-sensitized solar cells. What began as a modest goal led to far more than anticipated, resulting in the emergence of a remarkable new class of photovoltaic devices. Three-dimensional (3D) and two-dimensional (2D) halide perovskites have become standout semiconductors in recent years, known for their excellent carrier lifetimes and structural adaptability. Yet, the roles of Pb^{2+} and Sn^{2+} ions, along with the impact of organic spacer cations on structure and performance, remain areas that demand deeper investigation. Meanwhile, perovskitoids, a related but structurally distinct class of materials, offer expanded design flexibility through even richer structural and compositional diversity. Recent studies have shown that certain organic cations can stabilize these frameworks effectively. This presentation will explore the latest findings on structure–property relationships in halide perovskites and perovskitoids, providing practical insights into the rational design and integration of organic spacers in crystalline semiconductors and optoelectronic devices.