Two-Dimensional Materials for Improved Performance of Solution-Processed Metal Halide Perovskite Photovoltaics.

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Interest in the research of metal halide perovskite photovoltaics (MHP-PVs) has markedly intensified in recent years, driven by the exceptional promise these materials hold for next-generation solar energy technologies. MHPs are characterized by a three-dimensional (3D) crystal structure with the general formula ABX_3, where A represents a monovalent cation, B denotes a divalent metallic cation, and X signifies a halide anion.[1,2] The compelling optical and electronic properties of MHPs – such as tunable bandgaps, extended exciton diffusion lengths, broad-spectrum light absorption, solution processability, high power conversion efficiencies, and the relatively low cost of precursor materials – render this technology highly attractive.[3] However, despite these advantages, the commercial deployment of MHP-PVs remains hindered by several critical challenges, including (i) the inherent instability of the materials and devices, (ii) the toxicity associated with lead (Pb) and other precursor materials, and (iii) the hazardous nature of solvents like N, N-Dimethylformamide (DMF) and N-Methyl-2-pyrrolidone (NMP) commonly employed in their fabrication.[4,5] In this study, we present findings demonstrating more environmentally benign solvents, such as dimethyl sulfoxide (DMSO), ethanol, and isopropanol, can be utilized in the fabrication of MHP-PVs without significantly compromising their performance, offering a viable alternative to the traditionally used but highly toxic, DMF. Furthermore, we illustrate the effectiveness of a two-dimensional (2D) material (e.g., hexagonal boron nitride, hBN) in mitigating moisture and thermal degradation in MHP-PVs, enhancing their operational stability and extending their lifespan.

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