Exploring Oxygen Instability in Tin Perovskites: Insights and Advances in Sensing Applications

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Abstract: Metal halide perovskites are highly promising solution-processed semiconductors for photovoltaic and other optoelectronic applications. Among the alternatives to lead (Pb)-based perovskites, tin (Sn)-based perovskites have emerged as strong candidates. However, their susceptibility to oxygen-induced instability presents significant challenges. In our recent study, we investigated the interactions between oxygen and PEA_2SnI_4 across various oxygen concentrations. By integrating experimental results with theoretical analysis, we clarified the impact of oxygen concentration on the structural stability of PEA_2SnI_4 and unveiled the interaction mechanisms between the PEA_2SnI_4 film and oxygen. Furthermore, we developed a halide perovskite-based oxygen optical fiber sensor, combining PEA_2SnI_4 with a tilted fiber Bragg grating (TFBG), thereby extending the application of tin-based perovskites to trace oxygen detection. We also enhanced the stability of two-dimensional layered Sn-based perovskites through ligand engineering and successfully demonstrated color-stable pure-red PeLEDs with a maximum external quantum efficiency (EQE) of 3.51%. Additionally, we prepared PEA_6SnI_8 derivative single crystals with a heterogeneous structure for the first time, revealing their potential in trace humidity detection applications.