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Environmental Impact on the Structural and Optoelectronic Behavior of Mixed Tin-Lead Perovskites

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Mixed tin–lead perovskites are becoming incredibly popular because of their narrow bandgap (1.2 – 1.3 eV) which plays a vital role in all-perovskite tandem solar cells for achieving higher efficiencies compared to single–junction counterparts [1]. However, easy oxidation of Sn^{2+} to Sn^{4+} limits Pb-Sn perovskite stability and their performance [2]. This restricts their long-term use in all-perovskite tandem devices.

This study aims to demonstrate that mixed tin-lead perovskite structure and its optoelectronic properties respond differently to the changes in fabrication and environmental conditions. All samples were fabricated in an Argon atmosphere and subsequently measured under three different gas environments: Argon (Ar), Nitrogen (N_2), and Oxygen (O_2). The acquired absorption spectra reveal that perovskite films stored in both argon and nitrogen atmospheres remain unchanged, whereas slight variation in absorption intensity was observed after the exposing perovskite to Oxygen for 5 hours. Meanwhile, the X-ray diffraction (XRD) analysis demonstrate no structural alterations following a 24-hour exposure to a standard atmospheric environment.

Despite the structural stability of the perovskite material, the optoelectronic analysis reveals significant variations in response to environment conditions. Photoluminescence (PL) lifetime decreases by increasing oxygen concentration implying the presence of strong nonradiative channel, probably associated with energetic disorder within the material. Furthermore, transient photocurrent measurements additionally reveal that even small quantities exert a pronounced influence on the trap concentration, leading to their substantial increases as oxygen levels rises.

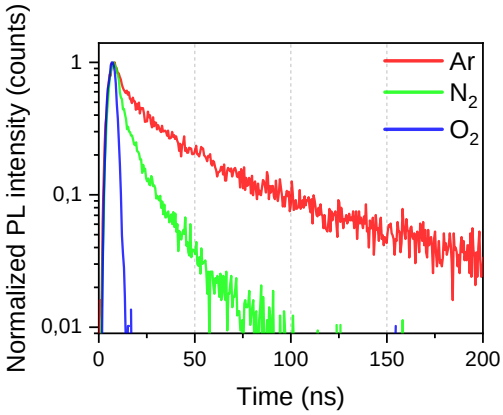

Fig. 1 Photoluminescence decay kinetics measured under Ar, N_2 and O_2 environments.

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