I₂-vapor induced degradation to methylammonium lead iodide perovskites

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Organic-inorganic halide perovskites (such as CH₃NH₃PbI₃, hereafter, MAPbI₃) have attracted considerable attention because of their unique opto-electronic properties (e.g., large absorption, long diffusion length, and high mobility) and low-cost fabrication methods (e.g., vapour deposition and solution spin coating). However, instability issues impede their further development and application. At this stage, it is not possible to say whether PSCs can meet the stringent international norms for outdoor photovoltaic applications; however, extensive studies regarding stability of PSCs are urgently needed.

Previous studies reported that volatile species (e.g., iodine, I₂) were generated when perovskites were subjected to moisture, oxygen, light illumination, applied electric field, and thermal stress (all of which are relevant to the operation of PSCs in practical applications). Because of the relatively high vapor pressure of I₂ at room temperature, it is believed that perovskite films are self-exposed to I₂-vapor, as shown in Fig. 1.[1] We found that I₂-vapor has a detrimental effect on MAPbI₃ perovskite, leading to perovskite degradation. Furthermore, I₂-vapor could also induce degradation of other iodide-based perovskites (such as FAPbI₃ and FA₀.₈Cs₀.₂PbI₃), suggesting the generality of I₂-induced degradation. The results reveal a universal degradation factor for iodide-based perovskite by I₂. Because the release of I₂ is nearly inevitable during practical applications, this work suggests that MAPbI₃ may not be suitable for long-term stable solar cells. To achieve long-term stability of PSCs, it is vital to develop other types of perovskite materials in which I₂-induced reactions can be avoided. This work provides important information for the degradation mechanisms of PSCs, and sheds the light on effective strategies to improve the stability of perovskite-based opto-electronic devices.

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