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Dimensionality Engineering of hybrid perovskites for photovoltaics and optoelectronic applications

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Abstract

Organic-inorganic lead halide perovskites with over 23% power conversion efficiency have attracted enormous academic and industrial research activity due to low-cost fabrication using solution and sublimation methods. However, commercialization of perovskite solar cells is still hindered by their poor stability. In this talk, we present an innovative approach to control the growth of a low dimensional perovskite capping layer at the bottom and on the top of a bulk three-dimensional (3D) perovskite film. The distinct layered low dimensional perovskite thin film is observed in the form of layer by layer, and the influence between the formation of the new perovskite layer and charge recombination are investigated. The photovoltaic cells of layered perovskite exhibited an enhanced power conversion efficiency when compared to pristine 3D perovskite film. The devices retained 85% of the initial efficiency under one sun illumination for 800 hours at 50°C in an ambient environment. By optimizing the crystallinity of the films, we achieved an unprecedented power conversion efficiency of 22.1% in planar perovskite solar cells (21.4 ± 0.7% certified efficiency by Newport).

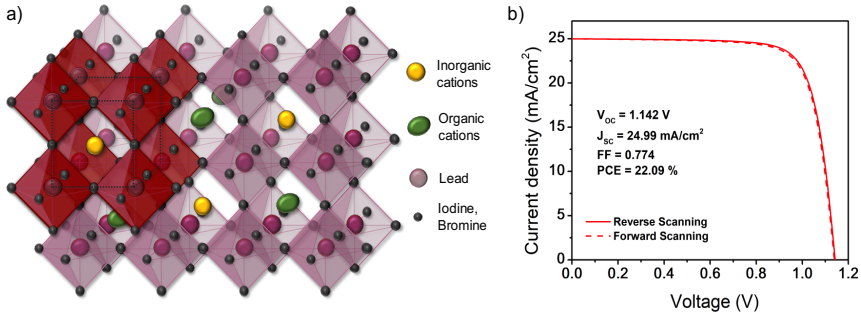

Figure 1. (a) Perovskite crystal structure ABX_3 (A is the organic/inorganic cation, B is the metal Pb^{2+} cation and X is the halide anion). **(b)** J-V curve of $(FAPbI_3)_{0.80}(MAPbBr_3)_{0.15}$ $(CsPbI_3)_{0.05}$ perovskite using PTAA as hole transporting layer (Source: M. K. Nazeeruddin, EPFL, unpublished data)