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Unconventional Nanoscale Photoresponse and Degradation Process in Hybrid Organic-inorganic Perovskites.[1] ZHAODONG CHU, University of Texas at Austin, MENGJIN YANG, PHILIP SCHULZ, National Renewable Energy Laboratory, DI WU, University of Texas at Austin, KAI ZHU, National Renewable Energy Laboratory, XIAOQIN LI, KEJI LAI, University of Texas at Austin
— The remarkable performance of organic-inorganic perovskite solar cells (PSCs) is challenging the dogma that solution-processed thin films are inevitably associated with inferior energy conversion efficiencies. The surprisingly low impact of polycrystallinity on the film quality highlights the unusual photo-response of intrinsic defects and grain boundaries in these materials. Here, we report the first quantitative nanoscale photoconductivity imaging on methylammonium lead triiodide ($MAPbI_3$) thin films by microwave impedance microscopy with light stimulation. The local photoconductivity as a function of the above-gap laser power is consistent with the high carrier mobility and long lifetime of $MAPbI_3$. The photo-response is largely uniform across grains and grain boundaries, which is direct evidence on the inherently benign nature of microstructures in the perovskite thin films. For encapsulated $MAPbI_3$ films, the observed long-term degradation in photoconductivity begins with the disintegration of large grains due to the diffusion of water molecules through the capping layer. Our work suggests that the striking PSC performance is deeply rooted in the nanoscale optoelectronic properties of $MAPbI_3$.

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