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Properties of Ferroic Domains in Metal Halide Perovskites

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Organic-inorganic metal halide perovskites have gained considerable attention for next-generation photovoltaic cells due to rapid improvement in power conversion efficiencies. Even though there have been immense efforts towards fabricating high performance solar cell devices, fundamental understanding of underlying mechanisms related to light and bias induced effects at the nanoscale is still required. In this study, structural deformations of the perovskites induced by light and bias are systematically investigated using scanning probe microscopy techniques. Piezo-response force microscopy shows that periodically striped ferroelastic domains are present in some grains of the polycrystalline metal halide perovskites, while un-corrugated flat grains also exist, which could be attributed to compositional differences. The corrugated surfaces due to presence of the well-ordered stripe domains can be modulated significantly under illumination as well as electric bias. Peak broadening analysis of X-ray diffraction results shows that strain-induced disorder occurs upon applying external stimuli, i.e. photo-illumination and applied external electric field. These findings provide fresh microscopic insight into the external stimuli-induced structural-disorder governing the superior performance of the metal halide perovskites solar cells.