Debye lenght domain for ion migration in metal halide perovskites for X-ray detection

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The research on metal halide perovskites as absorbers for X-ray detection[1] is an attractive subject due to the optimal optoelectronic properties of these materials for high-sensitivity applications. However, the contact degradation and the long-term instability of the current limit the performance of the devices, in close causality with the dual electronic-ionic conductivity of these perovskites. Herein, millimeter thick metal halide perovskite (e.g. $MAPbI_3$,[2] $MAPbBr_3$,[3] $CsPbBr_3$)[4] samples are approached by characterizing their long-term dark current upon biasing and afterwards at short circuit. Experimental measurements and numerical MATLAB's Driftfusion simulations are employed. First,[5] the mobile ion concentration and mobility are correlated with three main transport regimes and interpretation and parameterization are provided to the current saturation time in terms of the ionic screening of the electric field toward the interfaces upon biasing. The final steady-state under reverse biasing is found as diffusion-limited electronic current, which results from abrupt mobile ion depletion proportional to the Debye length in the vicinity of a contact. The conclusions suggest the material optimization of the contact interfaces as a pathway to reduce the long current saturation times in these devices. Subsequently,[6] upon removal of the biasing, it is shown how both the dark current and the sensitivity of the detectors follow similar trends at short-circuit (V=0 V). Large ionic-related built-in fields not only produce relaxations to equilibrium lasting up to tens of hours, but also continue to affect the charge kinetics under homogeneous low photogeneration rates. Furthermore, a method is suggested for estimating the ionic mobility and concentration by analyzing the initial current at short-circuit and the characteristic diffusion times.

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