Self-powered and highly efficient ion-diffused $MAPbBr_3$ single crystal-based UV-Vis photodiode

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Abstract:

The p-n junction region of the perovskite single crystals (PSC) made by doping metallic ions through a solution-processed method is too large (more than 10 μm). The carrier drift length (μτE), on the other hand, needs to be greater than the detector's dimension in order to achieve high responsivity. Also, a high bias voltage is required if the p-n junction is particularly thick. For the practical use of a photodiode, a thicker pn junction is not good. So, finding a way to create a narrow p-n junction area of PSC is a need of the time. To achieve this goal, we offer a successful method for generating a narrow p-n junction area by metallic ion diffusion. By narrowing pn junction we have achieved high performance of photodiode with a low trap density (1.6108 cm^{-3}), high mobility (423 $cm^2V^{-1}s^{-1}$), and reduced dark current density (0.5 Acm^{-2}) along with remarkably enhanced responsivity (77.69 AW^{-1}) for 30 Wcm^{-2} UV light at a low applied voltage of 15 V, and detectivity of (1.6 1015 Jones). This method has given a tremendously fast switching speed with a rise/fall duration of 2/6 ns under 0 V bias and long-term stability for more than 3 months in the ambient air. The photodiode performance is studied for UV-Vis light illuminations at various intensities and compared with no diffused photodiode in order to understand the impact of illumination intensity on the narrowed junction-based devices. The results point to a technique that has the potential to create next-level photodiodes.