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Investigation of photocurrent relaxation in MAPbBr3 perovskites with Cr/SnO2/, Cr/ contacts

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During the measurement of the hole photocurrent relaxations (illuminated anode), we noticed an unusually high current after the bias polarity was switched. Our setup was designed to suppress the majority of effects tied to parasitic capacitances and is expected to have RC=100ns-1μs depending on the capacitance of the sample. The majority of the observed effects on a scale of 10s of μs, therefore, have to be the relaxation of the sample itself. The most surprising fact is that the photocurrent right before the polarity switch is close to zero once the illumination is switched off. A thorough investigation of this transient event revealed that its width and amplitude are bias dependent. During the measurement, the bias before the polarity switch is always +150V. The amplitude changes only after the polarity switch, which ensures that the illumination always generates the same number of free carriers. The general shape of the transient events looks very similar to hole current waveforms measured by the Laser-induced transient currents technique (L-TCT). Their respective transit times (positions of the falling edges) are a great match too.

We believe that this effect can be explained by the barrier-induced accumulation of the photogenerated holes beneath the cathode. After the bias switch, accumulated holes drift towards the new cathode, which results in the observed transient event. The accumulated electrons can also cause this effect. However, we did not observe any electron signal –L-TCT or photocurrents.

Finally, with this model in mind, we endeavoured to find out the dissipation rate of the accumulated mobile holes and its dependence on contact material. In this experiment, both Cr and Cr/SnO2 electrodes were illuminated and several different switch delays (relative to the end of the optical pulse) were used. Obtained results show that the accumulated mobile holes dissipate with a characteristic time of 600 μs-1.5 ms regardless of the cathode material. For comparison the hole lifetime in the bulk determined by L-TCT is 50μs. There are several mechanisms that can be responsible for the decaying of the transient signal –tunnelling through the barrier, gradual trapping of holes in the surface defects or recombination with injected electrons. Unfortunately, we are not able to distinguish these models.

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