Temperature-resolved study of luminescence blinking in methylammonium lead iodide

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Over the last years, organo-metal halide perovskites have attracted considerable attention due to their promising performance as light harvesting materials, but their photophysical properties are also of great interest from a fundamental point of view. Although typically fabricated from solution, perovskite films show excellent semiconducting properties with high carrier diffusion lengths, suggesting that trap states and grain boundaries do not limit their performance. On the other hand, the perovskite structure is less rigid than the crystal lattice of conventional semiconductor materials, giving rise to phenomena such as phase transitions, ferroelectricity and ion migration.[1,2] These phenomena should be taken into account for future applications, as they are relevant for the material performance and long-term stability.

In this contribution, we study photoluminescence blinking in samples comprised of methylammonium lead iodide ($MAPbI_3$) using fluorescence microscopy. Blinking in perovskites has been reported before[3] and very recently, this process has been attributed to the presence of donor-acceptor pairs in close proximity, acting as very efficient luminescence quenchers. It has been suggested that blinking, i.e. the “switching” between and “on” and an “off” state emerges, because these quenchers can be temporarily deactivated by migrating ions.[4] Here, we investigate the blinking process in greater detail by varying the excitation conditions and the sample temperature. We present a methodological framework to quantify the blinking activity in the studied area of laser excitation and moreover, we analyze the blinking rates of individual crystallites. As an important result we find that the blinking process is thermally activated, which is consistent with the previously suggested picture of ion migration.

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References:

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