

Excitonic emission of hybrid lead iodide perovskite single crystals

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Since 2012, hybrid organic perovskites (HOPs) represent a “material breakthrough” for photovoltaics and more broadly, HOPs have also high potentialities for light-emitting devices such as electroluminescent diodes and lasers. Improvement of the performance of perovskite solar cells and optoelectronic devices may benefit from a better understanding of the intrinsic photophysics of materials. However, the properties of films are very dependent of the grain structure. We will discuss here about the optical properties of HOPs single crystals and compare them to those of thin polycrystalline films. In particular, the main feature in $\text{CH}_3\text{NH}_3\text{PbI}_3$ crystals is the appearance, in the low temperature luminescence spectra, of a sharp emission line (FWHM ~ 5 meV) at high energy which is attributed to the free exciton signature (figure 1). Experiments performed as a function of temperature confirm the existence of a strong electron-phonon coupling.

A critical point for the design and fabrication of high-performance perovskite devices is related to the moisture sensitivity of HOPs. In particular, it is known that, under ambient conditions, $\text{CH}_3\text{NH}_3\text{PbI}_3$ degrades producing some PbI_2 . Using the low temperature photoluminescence spectroscopy as a powerful tool to detect small PbI_2 traces in hybrid perovskite thin layers and single crystals, we highlight the extremely high stability of the single crystals compared to the thin layers. Defects and grain boundaries are then thought to play an important role in the degradation mechanism.

These results highlight the importance of single crystals as a reference material for the study of hybrid organic-inorganic perovskites.

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