

Excitonic Emission in Organic-Inorganic Lead Iodide Perovskite single crystals

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Improvement of the performance of perovskite solar cells and optoelectronic devices may benefit from a better understanding of the intrinsic photophysics of materials. To the best of our knowledge, all previous studies on the low temperature emission of $\text{CH}_3\text{NH}_3\text{PbI}_3$, except one[1], concern polycrystalline thin films.[2] However, the properties of films are very dependent of the grain structure.[3] In order to investigate the intrinsic properties of $\text{CH}_3\text{NH}_3\text{PbI}_3$, we have performed steady state and time- resolved photoluminescence spectroscopy of large single crystals as function of temperature. Single crystals present at 10K a sharp emission line with FWHM of ca. 5 meV comparable to high quality inorganic semiconductors (Figure 1). In comparison, the emission of thin films shows only trap state emissions at low energy. From the thermal evolution of the FE emission intensity and linewidth, we extract an excitonic binding energy of 28 meV and demonstrate a strong broadening connected to exciton- LO-phonons coupling. Besides, the FE emission presents a fast, non-exponential decay with sub-nanosecond leading time. The results highlight the importance of single crystals as a reference material for the study of hybrid organic-inorganic perovskites.

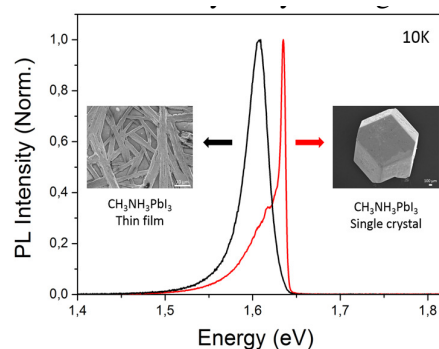


Figure 1 Photoluminescence spectra of $\text{CH}_3\text{NH}_3\text{PbI}_3$ thin film (black) and crystal (red) at 10K.

References

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