

Excitonic Emission and Electron-Phonon coupling 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. Thin polycrystalline films present a variability of properties connected to their grain structure.[1] In order to investigate the intrinsic properties of CH₃NH₃PbI₃, high quality single crystals are ideally suited. Low temperature photoluminescence spectroscopy of CH₃NH₃PbI₃ single crystals reveals the existence of a sharp free excitonic peak, with a full width at half maximum of only a few meV at 10K. This emission line is completely absent of the thin films spectra which are dominated by trap state emission. We highlight a strong thermal broadening of the free exciton (FE) emission connected to exciton-LO-phonons coupling down to low temperatures. Additionally, the FE emission presents a fast, nonexponential decay with subnanosecond characteristic time, connected to the efficient trapping of excitons. In comparison, trap state emission spectra and recombination dynamics are very similar in thin films and single crystals, showing that trap states are likely formed at the surface/interface of material. The results highlight the importance of single crystals as a reference material for the study of hybrid organic-inorganic perovskites.

References

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