

Optical Characterization of Mechanochemically Synthesized Tin-Based Perovskite Semiconductors

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Abstract

Metal halide perovskites are considered as promising materials for light harvesting or light emitting applications [1]. However, the presence of lead raises many questions regarding its commercialization. Therefore, less toxic alternatives are also being intensively researched [2]. In particular, tin is considered a promising candidate here, but the production of tin-based perovskites poses further challenges. The usual processing of thin films from the solution phase results in high defect densities for tin-based perovskites. As tin perovskites are also highly sensitive to oxygen, the formation of crystal defects due to oxidation is problematic and presumably intensified by the presence of structural defects. Alternatively, “dry” methods without the use of solvents can potentially contribute to improved material quality. In this context, mechanosynthesis (MCS), which is based on mechanical grinding of the precursors, is a cost-effective approach. While MCS has already been successfully used to produce lead-containing perovskites, the approach for tin-based perovskites is not yet well explored [3]. In particular, it is not yet clear to what extent the parameters of MCS, such as the duration of the grinding process, the forces applied or the use of additives affect the material properties. In this work, we aim to establish controlled MCS of lead-free perovskites. In addition to methods of structural characterization, a particular focus is on low-temperature luminescence spectroscopy, which is particularly sensitive to disorder and defect states. Our work contributes to the fundamental understanding of the relationship between structural and optical properties in mechanically synthesized perovskites.