Mechano-Chemical Synthesis and Characterization of Undoped and Mn^{2+} Doped $Cspb(Br_{1-x}Cl_x)_3$ Halide Perovskite for Light Source Application

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Abstract

All-inorganic halide perovskites (HPs) continue to be of current interest for light source applications (e.g. lasers, LED's) because of their high emission quantum yields and wide wavelength tunability due to compositional engineering [1]. The development of red and near-IR emitting lead halide perovskites, however, has been hampered by low emission efficiency and instability of iodine based compositions at room temperature. Recent studies employing transition metal or lanthanide

doping have demonstrated an alternative approach to achieve red and near-IR emitting HPs structures [2-4]. In this study we report results of the mechano-chemical synthesis of undoped and manganese (Mn) doped $CsPb(Br_{1-x}Cl_x)_3$ halide perovskites as emitting materials for light source development. Mechano-chemical synthesis is considered a green chemistry method avoiding the use of complex and time-consuming reactions, energetic-enabled conditions, expensive precursor sources, and hazardous reagents, catalysts, additives, and surfactants. Mechano-chemical synthesis experiments were performed employing a high energy ball-mill and 5N purity lead halide and cesium halide powders. The prepared HPs were evaluated by optical microscopy, SEM, TEM, XRD, and fluorometric measurements. Under UV optical excitation a Mn doped $CsPbCl_3$ sample exhibited a broad red emission band centers at ~615nm, which was slightly red-shifted compared to the emission from a melt-grown Mn: $CsPbCl_3$ crystals (see Figure 1). Post synthesis optimization strategies for HPs were also explored including thermal treatment, high-pressure studies, and solvent dependency. Comparative studies of the emission properties of undoped and Mn doped $CsPb(Br_{1-x}Cl_x)_3$ prepared by mechano-chemical synthesis, microwave-assisted synthesis, and melt-synthesis will also be presented.

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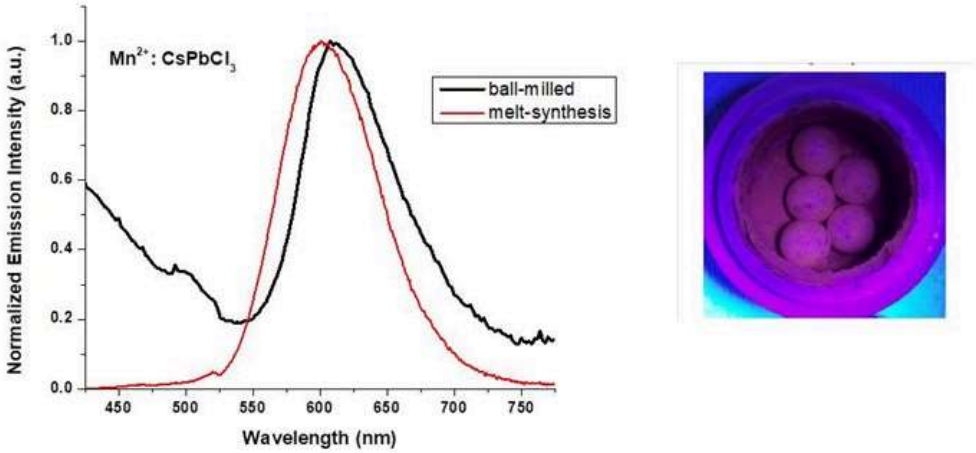

Figure 1: Emission spectra of Mn doped $CsPbCl_3$ micro-sized powders prepared by mechano-chemical synthesis and melt-synthesis (left), picture of ball-milled Mn doped $CsPbCl_3$ powder under UV light (right).

Figure 1