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SOLVENT-FREE MECHANOCHEMICAL SYNTHESIS OF $CSPBBR_3$ QUANTUM DOTS WITH SURFACE-PASSIVATING LIGANDS

Pijus Domantas Valentukevičius[1], Simas Šakirzanovas[1]

[1]Institute of Chemistry, Faculty of Chemistry and Geosciences, Vilnius University, Lithuania
pijus.valentukevicius@chgf.stud.vu.lt

Inorganic metal halide perovskites which have the general formula ABX_3 (where A = Cs^+, Rb^+, K^+; B = Pb^{2+}, Sn^{2+}, Ge^{2+}; X = I^-, Br^-, Cl^-) are semiconducting materials with a high potential for optoelectronic applications. $CsPbBr_3$ nanoparticles (quantum dots) are promising for the development of LEDs [1], liquid crystal displays [2] and solar cells [3]. Metal lead halide perovskites are synthesized using various procedures such as hot-injection, microwave assisted synthesis, solvothermal, sonochemical and co-precipitation methods. In comparison, the mechanochemical synthesis method, which is also employed as ball-milling, is highly advantageous due to the ease of up-scaling for industrial production, no need of solvents and simplicity of procedure. Additionally, conventional methods often require the use of long-chain passivating-ligands which brings limitations for material post-processing and applicability [4]. In this work $CsPbBr_3$ quantum dots were successfully synthesized with the direct use of a short-chain ligand DDAB. Moreover, the influence of various solvent-free mechanochemical synthesis parameters were analyzed for the production of photoluminescent $CsPbBr_3$ quantum dots with two surface-passivating ligands (DDAB and an equimolar mixture of oleylamine and oleic acid). The resulting nano or microscopic-sized particle morphology was analyzed with SEM, phase purity – by XRD analysis and photoluminescence – by spectrofluorimetry. Our findings suggest that initial particle morphology of the $CsPbBr_3$ powder before the addition of surface-passivating ligands and subsequent ball-milling has a significant influence on the obtained nanoparticle morphology. Furthermore, the type of ligand being used for the synthesis influences the optimal material to ligand ratio, position of emission maxima (519 nm for the mixture of OLA with OA and 536 nm) and the resulting particle morphology.

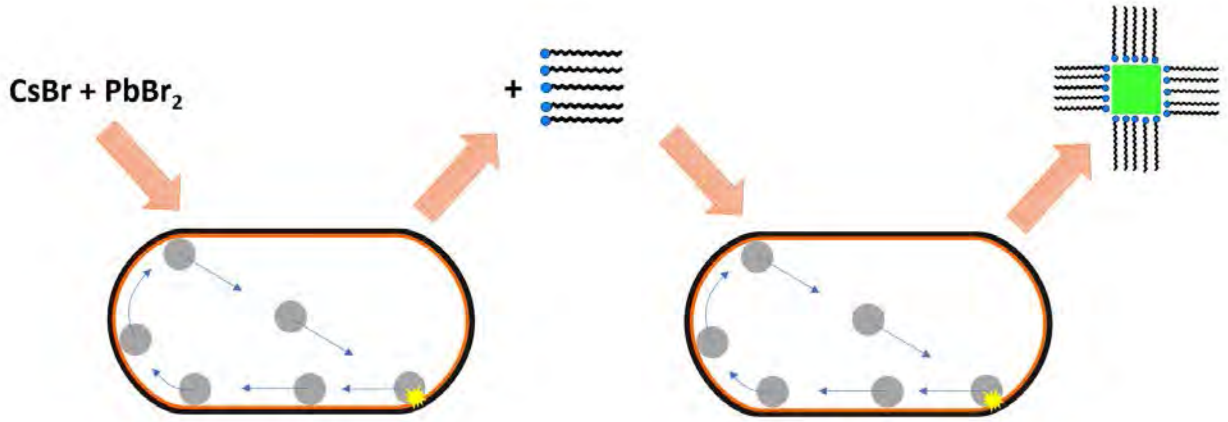

Fig. 1. Schematic diagram of the applied mechanochemical synthesis method with the use of surface-passivating ligands.

[1] W. Cai et al., High-performance and stable CsPbBr3 light-emitting diodes based on polymer additive treatment, RSC Adv., 2019, 9, 27684.
[2] L. Protesescu et al., Low-Cost Synthesis of Highly Luminescent Colloidal Lead Halide Perovskite Nanocrystals by Wet Ball Milling, ACS Applied Nano Materials 2018 1 3, 1300-1308.
[3] S. Ullah et al., All-inorganic CsPbBr3 perovskite: a promising choice for photovoltaics, Mater. Adv., 2021, 2, 646-683.
[4] S. Peng et al., Pure Bromide-Based Perovskite Nanoplatelets for Blue Light-Emitting Diodes, Small Methods, 3. 1900196.