SYNTHESIS AND CHARACTERIZATION OF PEROVSKITE NANOCRYSTALS USING LEAD FROM SPENT CUPELS

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Abstract:

Lead halide perovskites have attracted wide interests for their excellent optoelectronic properties in solar cells and light-emitting devices. However, their synthesis commonly depends on high-purity commercial lead salts, which are costly and raise environmental concerns associated with lead mining and processing. Meanwhile, spent fire assay cupels produced from fire assay contains high amount of lead oxide and is regarded as dangerous waste, which can cause environmental pollution. Here, a sustainable waste to resource strategy was designed for the recovery of lead from the spent fire assay cupels to prepare lead halide perovskites. XRF and XRD revealed that spent fire assay cupels contain 45.1 wt.% of PbO and lead exists as litharge and massicot phase. The lead recovery from the cupels was done via leaching using 4 M acetic acid at solid/liquid ratio of 1:4 with an 88% recovery. The recovered lead was precipitated as PbCO3 and calcined at high temperature into PbO. The obtained lead precursor then used with Cs2CO3 and methanol as solvent in a ligand-free, room-temperature solvent evaporation technique for the preparation of perovskite nanocrystals. XRD revealed that the perovskites synthesized using commercial PbBr produced CsPbBr3 and Cs4PbBr6 phases, while the derived lead precursor gives the multi-phase composite including CaTiO3, MgSiO3 and Cs4PbBr6 perovskite structures. Bright green fluorescence is emitted when UV light is irradiated to the material. This research demonstrates that the hazardous waste cupels can be recycled as the secondary lead resource to prepare the perovskite nanocrystals.

Keywords: Perovskite nanocrystals, spent cupels, lead, acetic acid leaching.