Área: MAT

Synthesis of stable and lead-free all-inorganic metal halide perovskites

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Highlights

The conversion of solar energy into electrical energy has been highlighted in the last decade, and the photovoltaic processes have significantly increased using systems and devices involving perovskites. Hybrid (organic-inorganic) perovskites containing lead proved to be promising materials, with the highest efficiencies but low stability and sustainability, due to lead in their composition. Here, we describe a new route to synthesize lead-free all-inorganic perovskite nanocrystals based on the $Cs_8Au^{III}_4M^{III}X_{23}$ (M= In^{3+}, Sb^{3+}, Bi^{3+}; and X=Cl^-, Br^-, I^-) structure. Two approaches were employed and compared (i) non-aqueous (hot-injection) and (ii) acidified aqueous systems, corresponding to the desired metal halide type.

Abstract

The syntheses in non-aqueous and aqueous media were based on the methodologies of IMRAN et al., 2018 and LINDQUIST et al., 2021, respectively, adapting some conditions and reagents, such as the use of metal acetates, which have high solubility and low cost. The results showed an improvement for the systems in non-aqueous media, with the $Cs_8Au_4BiCl_{23}$ perovskite phase formation. However, a secondary phase in a small proportion was observed, indicating the need for new adjustments. On the other hand, the results in the aqueous medium system were quite promising since perovskite structures were obtained without secondary phases for the compositions $Cs_8Au_4BiCl_{23}$, $Cs_8Au_4InCl_{23}$, $Cs_8Au_4BiBr_{23}$, $Cs_8Au_4InBr_{23}$, and $Cs_8Au_4SbBr_{23}$. The addition of the surfactant 11-mercaptoundecanoic acid (MUA) optimized the octahedral particle shape. However, this negatively affected the perovskite composition with bromide ions due to the competition between the thiol group with gold ions, avoiding its structuring in perovskite. In contrast, a significant improvement was observed in particle size and shape control for the Cl^--containing composition ions, leading to their expected octahedral shape. Because it is a new composition, there is little data in the literature to compare results. The fact that success was achieved in synthesizing them with the adaptations carried out quickly should be highlighted.

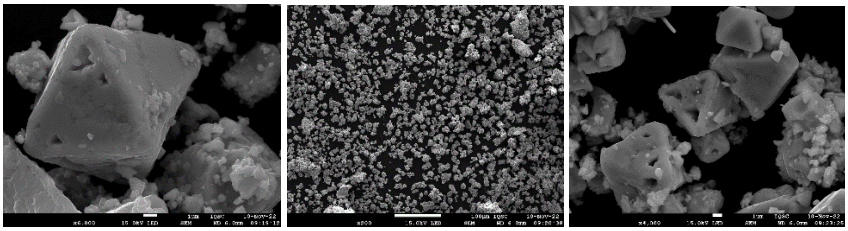

Figure 1. Scanning Electron Microscopy (SEM) images of the perovskites ($Cs_8Au_4BiCl_{23}$) synthesized in the presence of surfactant MUA.

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