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Alcohol-catalyzed growth of lead halide perovskites for energy harvesting

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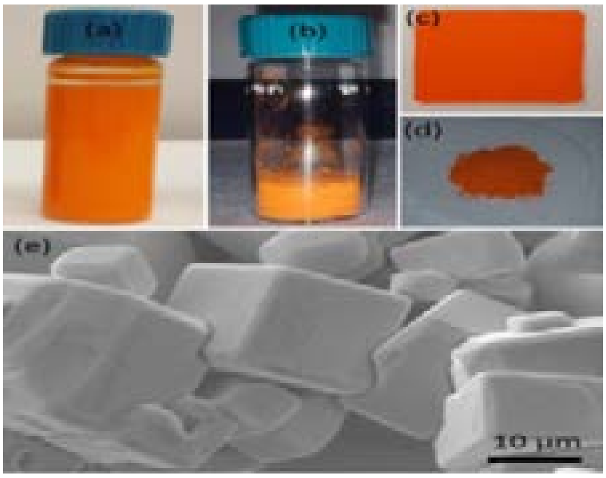
Methyl ammonium lead trihalide (MAPbX3) perovskites have great potential as light harvesters for energy harvesting due to their unique optical and electronic properties. The conventional growth techniques apply spin-coated precursors on a substrate followed by annealing for the processing of the lead halide perovskites; however, use of toxic solvents and high temperature hinder device stability and performance. To avoid annealing processes, the solution-based methods have been developed. I will introduce a new one-step solution technique to facilitate *in situ* crystal formation of methyl ammonium lead bromide and methyl ammonium lead chloride perovskites at the micron (~1-10 μm) to nano scale (< 500 nm) (Fig.1).1 As a substrate-free approach, the crystal pre-growth allows crystallization in alcohols (methanol, ethanol, 2-propanol, 1-butanol, and 2-butanol) at room temperature followed by a direct precipitation of the perovskite material for a large-area deposition. This room-temperature process able technique, however, differs from the *in situ* growth of methyl ammonium lead iodide crystals in alcohols that eliminates treatment at the boiling point of the alcohols.2 The high-energy synchrotron XRD, wide angle x-ray scattering (WAXS), Fourier transform infrared (FTIR) in transmission/reflection geometry (ATR, % R), UV-Vis-NIR (% R), micro Raman spectroscopy, and the solid state 1H, 13C, and 207Pb –MAS NMR are performed for characterization. The perovskite crystals show improvement in air/moisture for their chemical stability (<1.5 months). The thermo gravimetric analysis and *in situ* techniques also determine their thermal stability (~150-300°C). The poor yield of methyl ammonium lead iodide in toluene confirms that the alcohols catalyze the growth process through a substitutional reaction mechanism. Indeed, the theoretical calculations reveal that the growth of the perovskites in alcohols is exothermic. These materials will eventually find their use in applications of photovoltaics,3,4 photo detectors, optical-thermal sensors, light emitting diodes, light-emitting field-effect transistors, lasers, solar fuels, batteries, super capacitors, radiation detectors, data storage, hydrogen fuel cells, and photo catalysis.



Biography

Muge Acik is currently an Argonne Scholar-Named Fellow at Argonne National Laboratory. She obtained a B.S. in chemistry from Izmir Institute of Technology (Turkey), a M.S. in materials science and nanoengineering from Sabanci University (Turkey), and a Ph.D. in materials science and engineering from the University of Texas at Dallas. Prior to Argonne, she also worked for Texas Instruments Inc. as a Process Development Engineer for memory device production. Her work as the PI covers the analysis of surfaces and interfaces of the graphene-based thin films using *in situ* spectroscopy, and the discovery of new perovskite growth methods for energy harvesting and nanoelectronics. Indeed, she is the recipient of 2015 Distinguished Joseph Katz Postdoctoral Fellowship, 2011 MRS Graduate Student Silver Award, and 2011 MRS Best Poster Award.

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