Metal-halide perovskite single crystal for optoelectronic applications

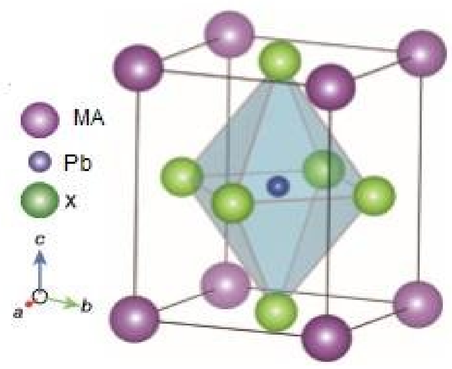
Institut de Ciència dels Materials (ICMUV), Universitat de València, Spain
Ismael Fernandez-Guillen, Jaume Noguera-Gomez, Pablo P. Boix
*isfergui@alumni.uv.es

Abstract

With power conversion efficiencies of above 24%, solar cells based on thin film polycrystalline perovskites have reached a quasi-saturation point, with incremental improvements based on compositional and interfacial modifications. The use of monocrystalline material based on perovskite single crystals could represent an important leap in the technology, similar to the case of silicon photovoltaics. In order to evaluate this new technology, we have focused on the synthesis and study of perovskite crystals, in particular methylammonium lead bromide single crystal, $CH_3NH_3PbBr_3$. We analyze the influence of humidity in the optoelectrical properties, with a significant improvement of key characteristics such as photoluminescence upon humidity exposure. This work leaves an open path for the improvement of these materials that can translate into an increase in the efficiency in the application of solar cells.

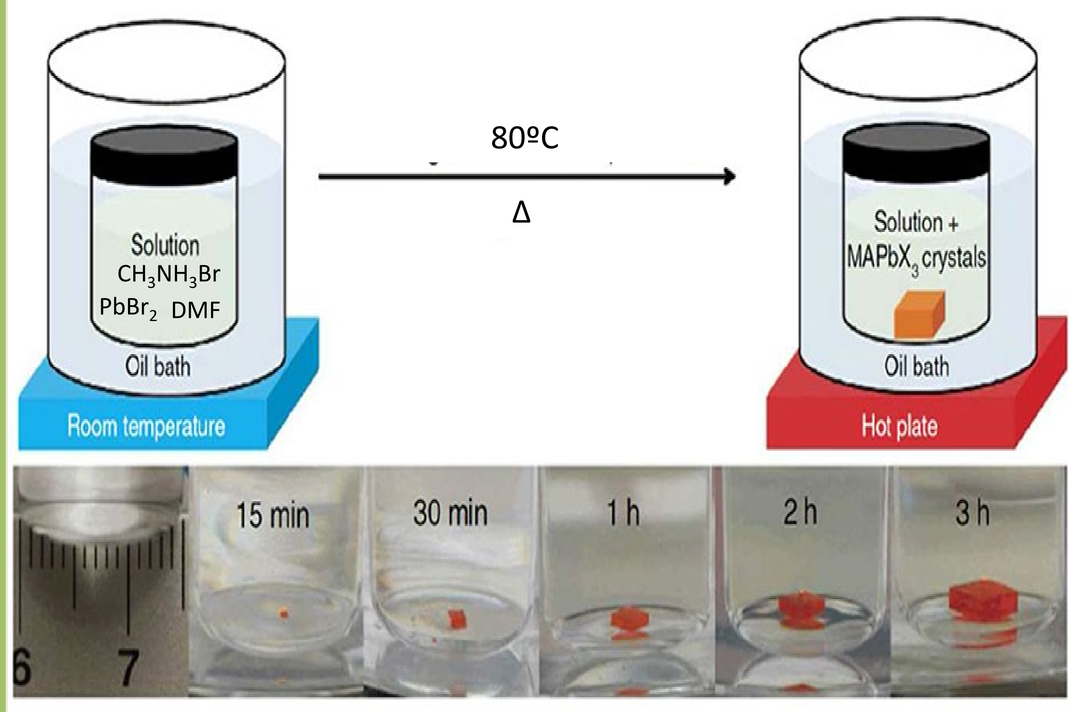
Why perovskites?

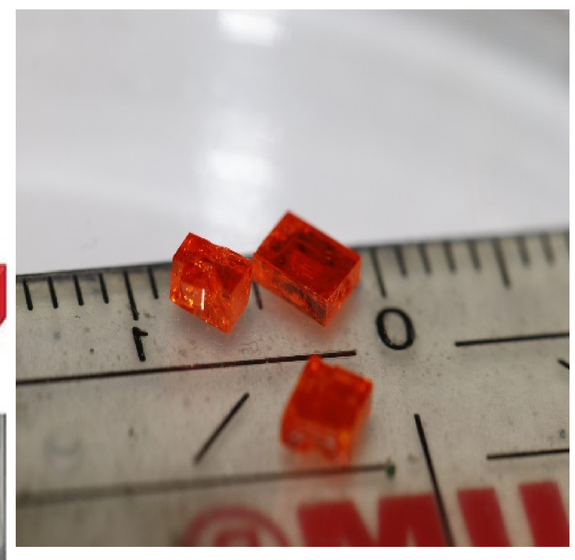
Halide perovskites, with chemical formula ABX_3, form an interesting subgroup within perovskite family where the A position is occupied by 1^+ ions or molecules, B is a 2^+ metal such as Ge, Sn or Pb and X is a 1^- halide. Perovskites are promising to photovoltaic technology due to their potential low-cost, nature-abundant raw materials, low-temperature and scalable solution fabrication processes, and, in particular, the very high-power power conversion efficiencies.



Perovskite Single Crystal Preparation Method

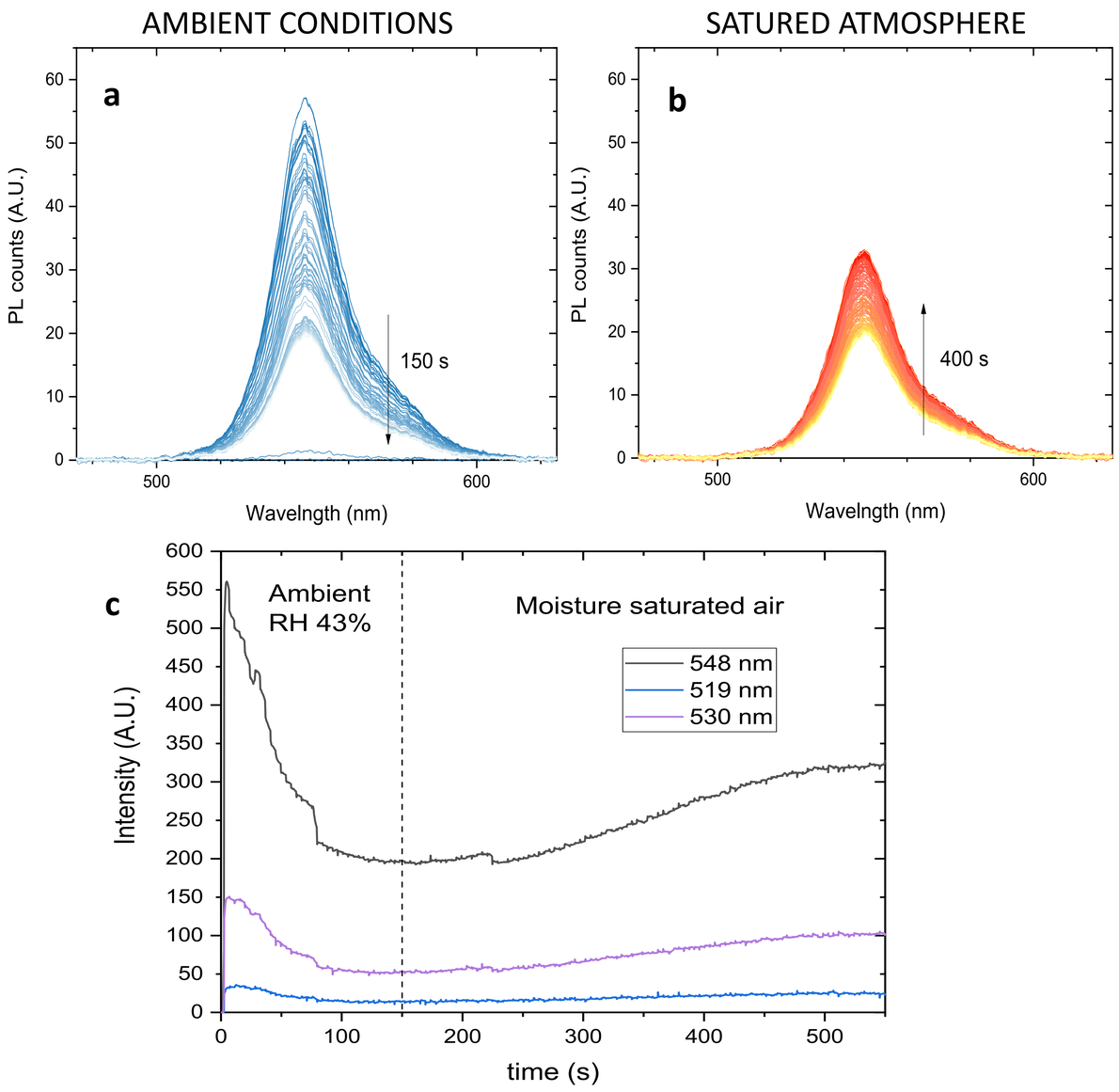
Inverse Temperature Crystallization (ITC) Method[1], this method provide a viable way to produce large perovskite crystals, $MAPbBr_3$ in our case, from the precursors in solution by increasing the temperature.





1. Saidaminov, M. I. *et al.* High-quality bulk hybrid perovskite single crystals within minutes by inverse temperature crystallization. *Nat. Commun.* **6**, 7586 (2015).

Photoluminescence study with moisture saturated atmosphere



First, in ambient conditions, when laser excites the sample, a high PL signal appears, followed by a slight decrease and final stabilization (**a**). Under high humidity, the PL increases and reaches the stabilization stabilized (**b**).

To gain insight of this trend, we measure the PL of three specific bands as a function of time (**c**) where 548 nm band is associated with the maximum absorption.

Conclusions

- Synthesis of single perovskite crystals is a low-cost, eco-friendly and viable method to be carried out on a large scale.
- Optoelectronic properties improvement when the perovskite single crystal is exposed to a water saturated environment.
- These results certify the feasibility of using metal halide perovskite single crystals grown from solution for high efficient optoelectronic devices.

ICMUV INSTITUT DE CIÈNCIA DELS MATERIALS de la Universitat de València

GENERALITAT VALENCIANA
Conselleria de Innovación, Universidades, Ciencia y Sociedad Digital