

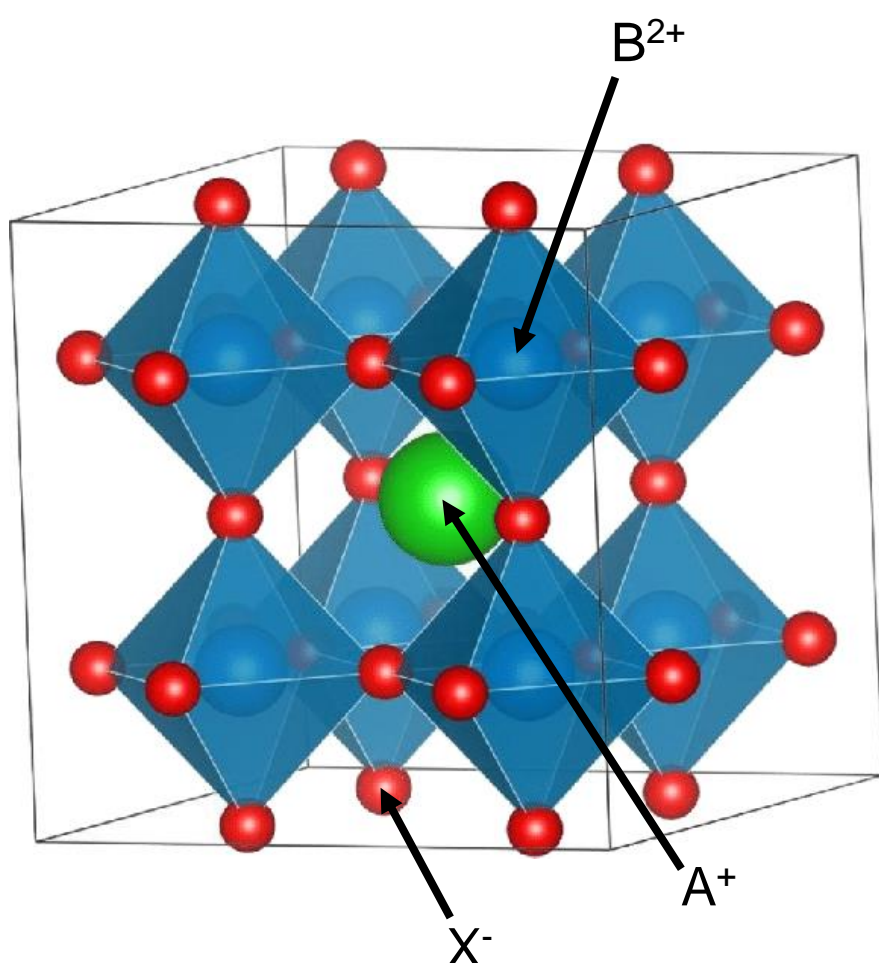
WHAT ARE METAL HALIDE PEROVSKITES?

The word 'perovskite' refers to a particular crystal structure which is shown at the bottom left. This structure contains 3 different sites in which ions can be located and these sites are named A, B and X (as indicated by the arrows).

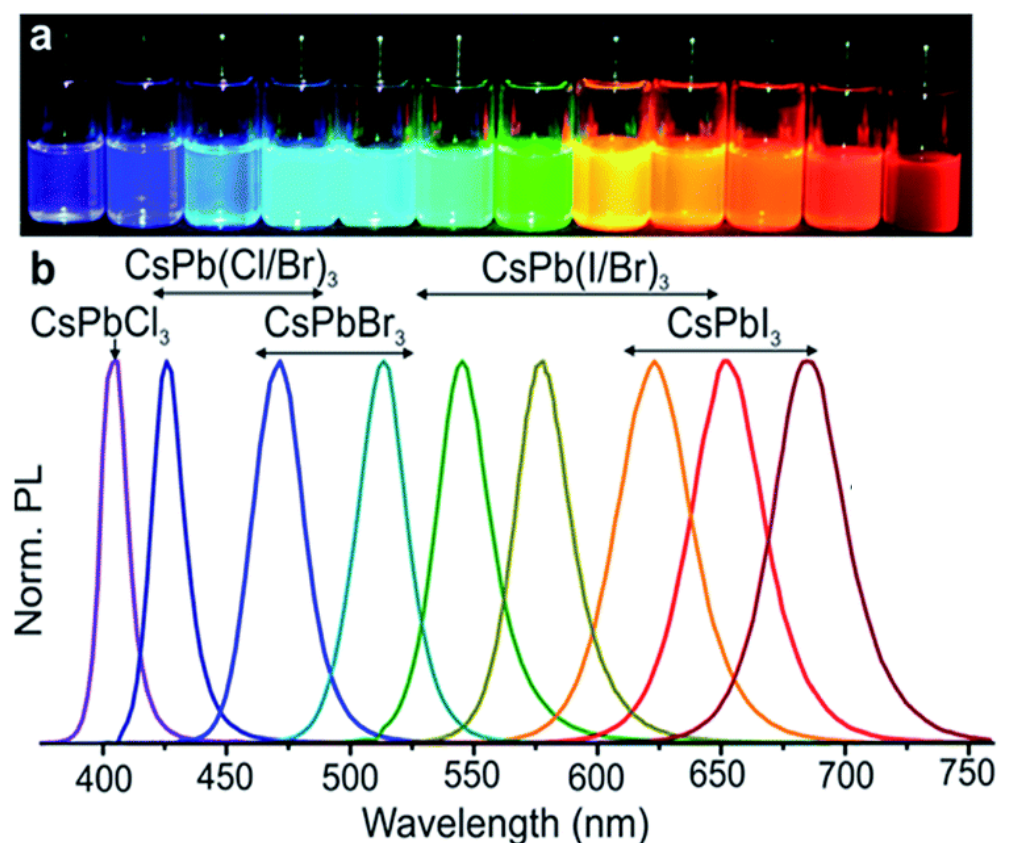
Metal halide perovskites (MHPs) are a subgroup of the perovskite family in which the A, B and X sites are frequently occupied by ions of the following elements/molecules:

- A: Caesium, Methylammonium, Formamidinium
- B (the metal): Lead, Tin
- X (the halogen): Iodine, Bromine, Chlorine

The range of possible ionic combinations means that MHPs have very tuneable properties. For example, the colour of the light they emit can be controlled by adjusting the choice of halide ion, as illustrated below.



The perovskite crystal structure¹.



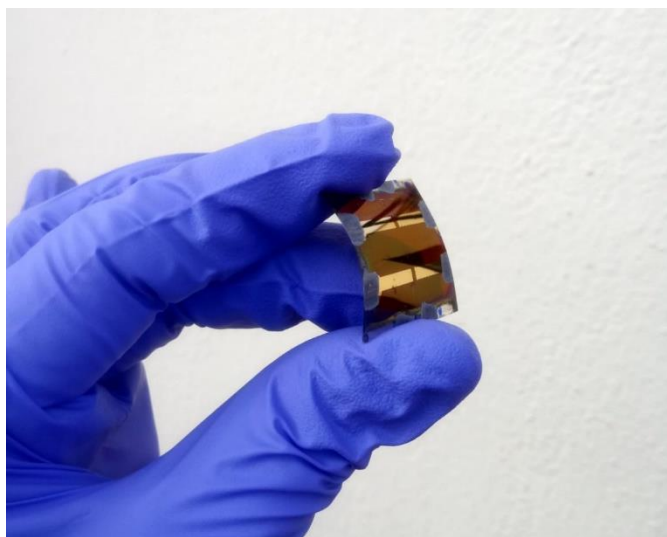
The tuneable emission of perovskite nanocrystals².

WHY ARE WE STUDYING THEM?

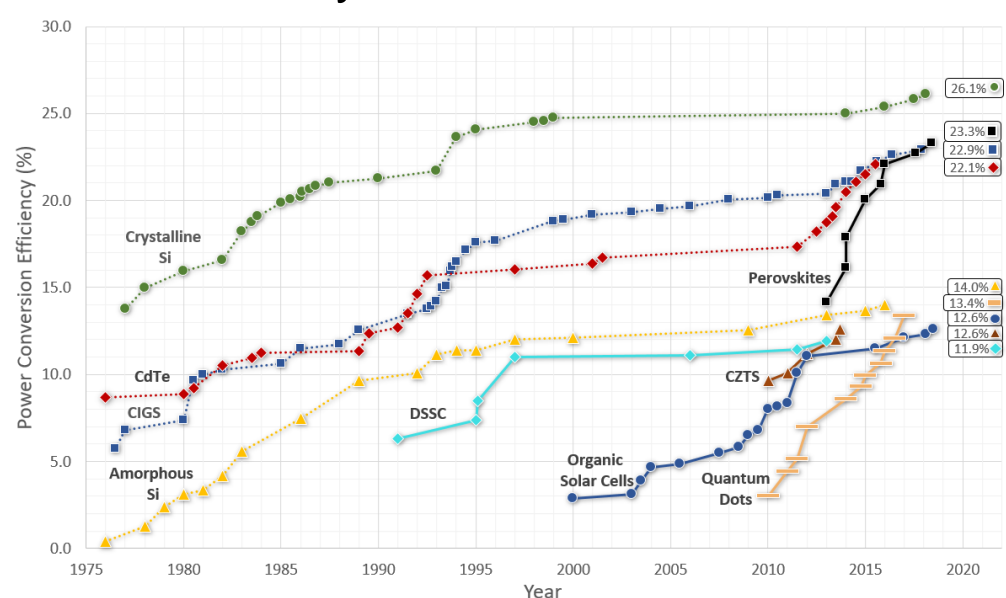
MHPs are an exciting research topic as they have the potential to make solar cells which are both more efficient than current silicon-based designs and which have a wider range of applications. For example, MHPs are much better at absorbing light than silicon and so solar cells incorporating these materials could be made very thin. This would allow for flexible solar cells, which could be incorporated into phone screens, buildings and even drones!

However, despite the rapid advances in efficiency shown in the graph below, there are still obstacles to be overcome before MHPs can be widely commercialised. MHPs are unstable materials which degrade rapidly on exposure to light, moisture and oxygen. Additionally, there are still many unanswered questions about the mechanisms underlying their remarkable performance.

Our group aims to answer some of these questions using a combination of experimental techniques and device simulations. These allow us to probe the physical processes which occur in MHP solar cells and so gain a better understanding of the factors limiting their efficiency.



A flexible perovskite solar cell module³.



This graph shows the increase in solar cell efficiency with time for a variety of technologies⁴.

References

- 1) Anupam, Spandan. (2017). Development and characterization of mixed halide perovskite solar cells.
- 2) Son-Tung Ha, Rui Su, Jun Xing, Qing Zhang and Qihua Xiong, Metal halide perovskite nanomaterials: synthesis and applications, *Chem. Sci.*, 2017, **8**, 2522-2536
- 3) Sergio Castro-Hermosa, Giulia Lucarelli, Michiel Top, Matthias Fahland, John Fahlteich, Thomas M. Brown, Perovskite Photovoltaics on Roll-To-Roll Coated Ultra-thin Glass as Flexible High-Efficiency Indoor Power Generators, *Cell Reports Physical Science*, Volume 1, Issue 5, 2020, 100045
- 4) Perovskites Solar Cell Structure, Efficiency & More | Ossila