# Single Particle Microscopy & Spectroscopy of Morphology and Size Controlled Perovskite crystals: PEROVSKOPY

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After seminal reports of their interesting physical properties (published in 2009 and 2012, [1–3] ), an explosion of scientific interest into metal halide perovskites (MHPs) in the past decade has seen this family of materials emerge as the most exciting avenue for next-generation solar cells. The strong promise for MHP materials arise of course from their fundamental physics; from high absorption coefficients at visible wavelengths, long carrier diffusion lengths and small exciton binding energies, to its simple solution-based processing. Justifiably, an early surge of research activity was inspired by an empirical race to produce photovoltaic devices with ever-higher photo-conversion efficiencies. Consequently, early research saw perovskite engineering significantly outpace the understanding of their physical properties. In response, the focus of researchers is steadily shifting toward the intrinsic properties of perovskites, as these will ultimately define their performance in any photonic application. In this light, recent research in my laboratory aims at connecting the microstructure of perovskite crystals with their physical properties, by addressing three overarching goals: (1) Development of systematic experimental protocols for controlled and reproducible synthesis of a variety of highly crystalline, monodisperse and defect-poor perovskite crystals with well-defined morphology, with sizes covering a few nanometres over microns to millimetres. (2) In-depth investigation on these materials using an arsenal of single particle microscopy and spectroscopy techniques. Specifically, complementary information obtained from such experiments will provide true understanding of how perovskite composition and grain morphology influence the fate of the photo-generated charge carriers, and this structure-property relationship can be used to develop better perovskite materials. (3) Finally, the knowledge base generated will be applied to the development of better-performing photonic devices. In this contribution, I will report recent progress in perovskite synthesis[4] and single particle spectroscopy.[5–8]

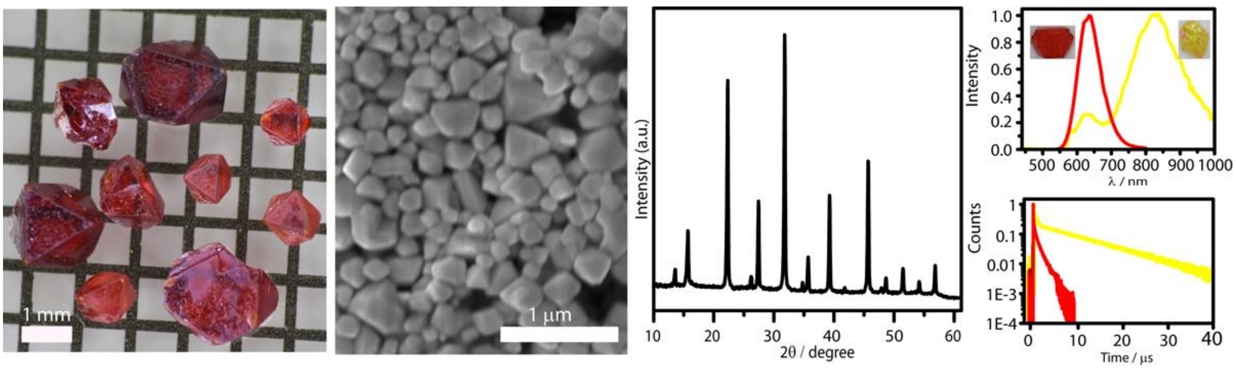


**Figure 1.** pictures of mm sized and micrometer sized high quality crystals of a Bismuth containing perovskite, together with XRD, luminescence and time resolved decays of these materials.

[1] A. Kojima et al., *J. Am. Chem. Soc.* **2009**, *131*, 6050–6051. [2] H.-S. Kim et al., *Sci. Rep.* **2012**, *2*, srep00591. [3] M. M. Lee et al., *Science* **2012**, *338*, 643–647. [4] E. Debroye et al., *ChemNanoMat* **2017**, *3*, 223–227. [5] H. Yuan et al., *ACS Omega* **2016**, *1*, 148–159. [6] H. Yuan et al., *J. Phys. Chem. Lett.* **2016**, *7*, 561–566. [7] H. Yuan et al., *Adv. Mater.* **2018**, 10.1002/adma.201705494. [8] A. Merdasa et al., *ACS Nano* **2017**, *11*, 5391–5404.