Ultra-Low Frequency Raman Spectroscopy and Transient Photon Lifetime - The Promising Tools to Understand Phase Transformation Induced Stability in Organometal Halide Perovskites

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Organometal halide perovskites have been a promising breakthrough that have resulted in unprecedented evolution of photovoltaics. These class of materials with ABX₃ structure are reported for their broad absorption band, high tunability, ease of chemical synthesis and more recently, their lasing behaviour. However, low stability of these materials is a humongous challenge. Very recently, Caesium doping (Cs- doping) is reported to enhance the intrinsic stability of methylammonium lead iodide (MAPbI₃). However, the reason for the enhanced stability is less understood.

This study mainly focuses on characterization of Cs doped MAPbI₃ perovskites using Ultra Low Frequency Raman Spectroscopy (ULFRS) and Transient Lifetime Measurements (TLM) with laser excitations at 532nm and 514nm respectively. ULFRS and TLM respectively indicate incremental shift in intensity of the peaks and considerable increase in transient life time with increase in Cs- doping level. However, highly unstable, pure MAPbI₃ shows no ULFRS peaks at room temperature and has a shorter transient lifetime. We present that, upon Cs doping, the perovskite changes from an unstable non-rigid to more stable rigid phase. The change in stability, therefore is a result of phase transformation which can be easily observed through ULFRS combined with TLM. Moreover, we present that, ULFRS combined with TLM is a promising tool in understanding the phase transformation behaviour and thus the stability for organometal halide perovskites.





Figure 1 (a)Transient lifetime at various stages of phase transformation. (b) ULFR Spectra at various stages of phase transformation. Arrow indicates transition from non-rigid to rigid phase.

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