Photoluminescence Excitation Microsocpy of Halide Perovskite Material

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While the recent development of perovskite based devices has seen an unprecedented progress, there are still many questions that remain unanswered with respect to how the material behaves under the influence of light. Some of the more specific questions relate to the stability and efficiency where prolonged exposure to light in different ambient environments has demonstrated to significantly alter these. When reporting on the quality of a material, typical spectroscopic characteristics such as absorption and PL quantum yield are used, but how complete of a picture do these measurements alone? Further, it has been quite well demonstrated that optical properties do not necessarily distribute homogeneously within a film, which calls for a spatially resolved optical method to study these.

Here we demonstrate a method where we employ spatially resolved photoluminescence excitation (PLE) spectroscopy with simultaneous measurement of absorption over prolonged periods of light soaking in different ambient conditions. Comparing the PLE and absorption spectra at each excitation wavelength provides more information on where charges may be lost after being absorbed by the material. If PL quantum yield is constant for all excitation wavelengths, the shapes of PLE and absorption spectra should compare. If the two spectra deviate, we are provided a clue of where (in terms of energy) losses within the material occurs. The spatial resolution helps us understand where (in terms of space) they occur.

We will show recent results relating to $MAPbI_3$ where we determine the rate of photoinduced formation of PbI_2 together with its spatial distribution and temporal evolution. We will also present preliminary results of $MAPb(Br_xI_{1-x})_3$ where spatially resolved PLE spectra may give an insight into the formation of either Iodide or Bromide rich regions within the film. We also manipulate the excitation scan and see some intriguing phenomena to which we currently lack an explanation.