Area: 5 Perovskite Solar Cells

TOWARDS ACCURATE SPECTRAL RESPONSE MEASUREMENTS OF PEROVSKITE SOLAR CELLS

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Perovskite solar cells have in recent years received much interest from the photovoltaics research community and record efficiencies above 20% have been reported. Accurate characterisation of any type of solar cell is crucial for the development process. However, perovskite solar cells are difficult to characterise accurately and repeatably. The devices respond slowly (right side of Figure 1) and are metastable under applied voltages, which requires complex measurement methodologies to measure a device repeatably and enable different laboratories to deliver comparable measurement results. This is important for both, current-voltage as well as spectral response measurements. Latter are critical as there are no stable reference cells available for PSCs. They are usually carried out on a filter or monochromator based system using a chopped monochromatic light beam with additional white bias light. Due to the slow response of perovskite devices, the frequency of the alternating light beam influences the measurement results, thus low frequency light or DC monochromatic light is the first step towards accurate measurements of such devices. Uncertainty of the measurements is, however, negatively affected when using DC measurements.

CREST utilises two separate systems, a filter based differential spectral response system and a laser light based EQE system (left of Figure 1) that are capable of AC and DC measurement modes. The aim of this work is to investigate the effects of different measurement methods and conditions on the final spectral response measurement and the resulting spectral mismatch correction. The influence of AC light frequency and DC monochromatic light is investigated using both measurement systems. The impact of bias light on the spectral response is studied to highlight possible non-linearity issues and the effects of device temperature on the measurement are examined to quantify uncertainty related to thermal instabilities. The findings lead to a set of methodology and measurement system requirements for accurate spectral response measurements.

The full paper includes a brief review of the current state of the art in perovskite solar cell characterisation with particular focus on spectral response measurements. The employed measurement systems with the methods and conditions are described. On the basis of the measurement results, the paper will discuss the methodology and measurement system requirements for accurate spectral response measurement and outline the main uncertainty contributing factors in measurements.

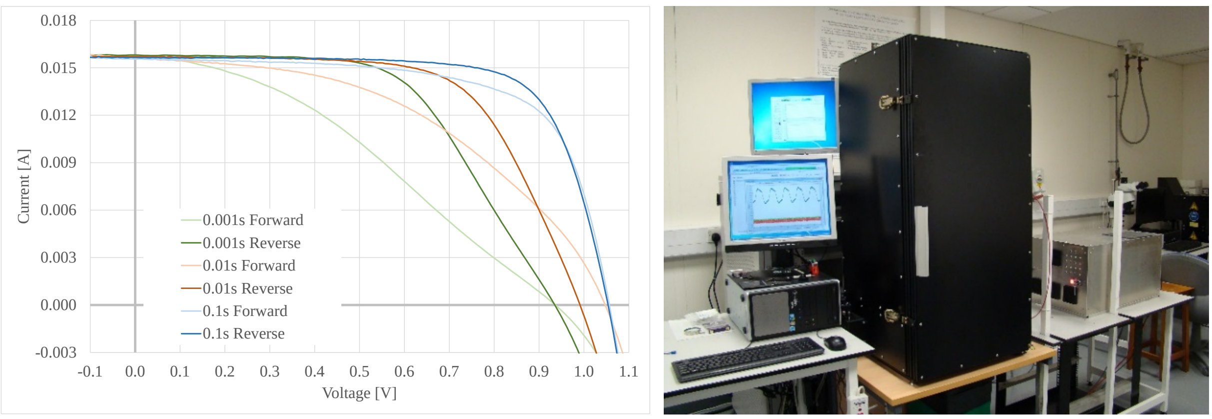

Figure 1: Left: I-V curve measurements of a perovskite solar cell at various point delay times showing strong hysteresis between forward and reverse I-V trace direction due to the device's slow response; Right: Laser based EQE system capable of spectral response measurements at varying bias light conditions and temperature using AC or DC monochromatic light