**Quantifying hysteresis: developing tools to characterize the transient response of metal halide perovskite devices on different time scales.**

A. Czudek, L. Kegelmann, M. Jost, K. Hirselandt, P. Tockhorn, E. Unger

Hysteresis is among the most debated phenomena in metal halide perovskite solar cell research[1]. Apart from being an obstacle and source of inaccuracy in reported device efficiency metrics, the underlying causes for hysteresis can be related to reversible and irreversible changes in devices. If evaluated as a quantitative metric, hysteresis can be an indicator of transient processes in devices that might affect long term stability. We employed two different approaches to quantify hysteresis phenomena in different device types prepared in our laboratory. The first is a detailed analysis of the hysteresis index as function of delay time, inspired by the work of Cahen et al.[2]. The second is the analysis of current transients upon voltage steps to extract time constants of the transient response[3].

Hysteresis indices can be a valid method of characterization of perovskite solar cells, as long as they are not used at one single scan condition, but analyzed as a function of delay time. These plots often exhibit "peaks" that indicate the temporal regimes of maximum discrepancy (hysteresis), which provides direct insight into time constants of capacitive effects causing current-voltage hysteresis. We here present a quantitative comparison between different architecture types and discuss how the nature of the interface between selective contact and and perovskite critically influence the magnitude and temporal response domain of metal halide perovskite solar cells. In comparison, we analyzed and transient photocurrent response time constants. We discuss data for different device types using these two different analysis approaches to compare the practical value of these characterization methods for the quantification of hysteresis phenomena in metal halide perovskite devices. Both can be used as quantitative tools to determine the magnitude and timescale of processes responsible for hysteresis and provide reliable comparison between different cell architectures.

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3. Christoforo, M., Hoke, E., McGehee, M. & Unger, E. L. Transient Response of Organo-Metal-Halide Solar Cells Analyzed by Time-Resolved Current-Voltage Measurements. *Photonics* **2,** 1101–1115 (2015).