# Differentiating Capacitive, Inductive, and Switching Hysteresis Mechanisms in Perovskite-based Devices

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## Abstract

The complex interplay of ionic and electronic motion in metal halide perovskites gives rise to dynamic resistance behaviors, often manifesting as current-voltage hysteresis. Various hysteresis effects have been reported in perovskite devices, including solar cells, LEDs, X-ray detectors, and memory devices, yet a clear framework for distinguishing these behaviors is still lacking. In this presentation, we identify four distinct resistance behaviors within a simple perovskite device with silver contacts: capacitive behavior in the dark, inductive behavior under illumination, and, under prolonged light and bias exposure, a transition first to ohmic behavior and eventually to switching behavior. In-situ microscopy reveals structural changes at the interface during the transition from inductive to ohmic behavior, suggesting an interfacial origin for inductive effects. These changes lead to the formation of conductive filaments that bridge both electrodes, causing a short circuit and enabling the switching behavior. Electron microscopy and conductive AFM confirm that these filaments are primarily composed of silver and are significantly more conductive than the perovskite. While cyclic voltammetry provides an initial assessment, transient voltage and impedance spectroscopy offer detailed characterization of the resistive behaviors, particularly between inductive and switching responses. Furthermore, similar behaviors in gold-contact devices confirm the broader validity of these mechanisms. Our findings provide a comprehensive framework for categorizing resistive behaviors in perovskite devices, offering deeper insight into their underlying mechanisms.

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