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Predictive Defect Science for Cost-Effective Photovoltaics

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Low-cost photovoltaic materials are typically defect-rich, and defects impede electronic transport and photoconversion efficiency. Since efficiency and cost are inversely related, defect-rich materials have until recently resulted in poor-quality, economically uncompetitive solar cells. In this presentation, we review defect physics in low-cost photovoltaic absorbers. Accurate identification of performance-limiting defects requires multiscale characterization, evaluating cm-size devices while probing down to the nanometer scale for defect recognition. We will review recent advances in macroscopic CCD-based PV characterization tools, and elucidate how these can be coupled to synchrotron nanoprobe techniques. Once the nature and underlying physical behavior of these defects are known, we demonstrate how manipulation of defect distribution and state, aided by predictive modeling, can enhance solar cell performance.