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Inverse problem for photovoltaics

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Understanding why novel solar-cell materials and architectures underperform relative to expectations requires a detailed knowledge of each component material and interface, and necessitates a suite of in-depth characterization techniques. However, accessing important properties while the full device is in operation can be difficult and time-consuming, and the results are not always statistically significant. Now, Riley Brandt and colleagues from the US and Germany propose using basic device characterizations and advanced computing methods to track down the material and interface properties of novel devices.

The key is to hold a good physical model for the device stack — a set of equations that accurately relates the material and interface properties to basic device characteristics, such as current–voltage curves. The problem is then inverted: the most likely range of material and interface properties is extracted from a set of experimental current–voltage curves under various illumination intensities and temperatures. The researchers apply their Bayesian inference approach to thin-film SnS solar cells, extracting the minority carrier mobility and carrier lifetime in the SnS absorber, in addition to the energetics and effective surface recombination velocity at the interface between the absorber and the Zn(O,S) buffer layer. The approach can identify cross-correlated parameters and is about ten times faster than traditional spectroscopy techniques. The main limitation to extending the approach to novel materials and architectures is to develop physically sound and complete device models.

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