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Experimental Validation of an Electro-Thermal Small-Signal Model for Large-Area Perovskite Solar Cells

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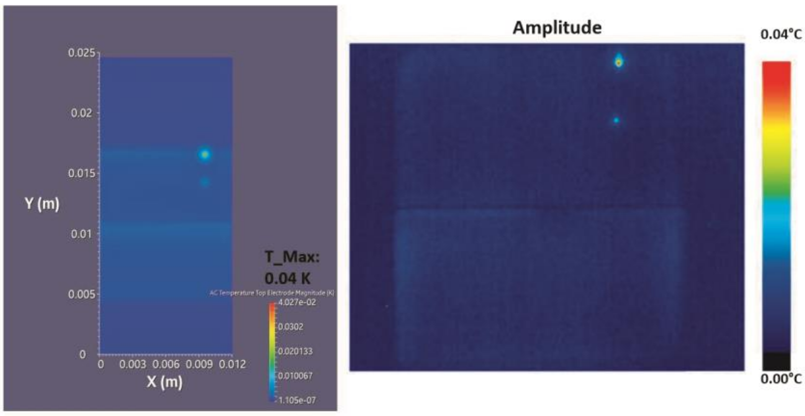
Perovskite thin-film solar cells have attracted a lot of attention in recent years due to rapidly increasing efficiencies. The upscaling of this technology from small laboratory cells to large-area devices without compromising efficiency and stability, however, is still a challenge to be solved for commercialization.

For this purpose, we use the FEM (Finite Element Method) software Laoss that supports the upscaling process from small- to large-area devices by solving for the potential and temperature distribution in 2D top and bottom electrode domains, which are coupled by a vertical coupling law. We are presenting electrical and thermal DC and AC simulations of a reference cell without an interconnection anddual cells and compare the simulation results with measurements.

We also introduce the small-signal dark lock-in thermography (SS-DLIT) method to measure and simulate electro-thermal effects in perovskite solar cells in the dark with high accuracy. We therefore apply a small, periodic voltage modulation at a certain offset voltage. This adapted DLIT method can be simulated with the thermal AC module in Laoss and allows for a quantification of various defects, such as shunts or the quality of the interconnection of perovskite solar cell modules.



Small-signal DLIT simulation (left) and measurement (right) showing the temperature amplitude of a perovskite dua cell with two shunts in the upper cell and a interconnection in the center. The simulati allows to better understand the nature of t defects and to quantify them.