2-D and 3-D TCAD simulations of defect-tolerant solar cell architectures

- We use 2-D and 3-D TCAD simulations in Sentaurus Device to determine the injection-dependent device performance impacts of point defects (e.g., Fe) and extended defects (e.g., grain boundaries).
- We identify features of device design that contribute to defect tolerance.

References:

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calculation of grain boundary model

We model grain boundaries in 3-D as mid-gap recombination centers \(N_{deep}\) at an interface 2 nm from the simulated domain boundary [1].

- Modified capture cross-sections account for defect charging.


calculation of heterojunction vs. thick and thin PERC

- Heterojunction more tolerant to \(N_{deep}\) at grain boundary.
- 20 µm thin PERC more defect-tolerant at all decoration concentrations.
- \(\uparrow\) injection \(\rightarrow\) \(\downarrow\) charging \(\rightarrow\) \(\downarrow\) bulk recombination in heterojunction.
- 20 µm thin PERC \textit{not} in high injection.

- Higher injection levels also reduce the impact of point defects.
- Thinner devices:
  1) are higher-injection
  2) have a smaller volume of defective material
  3) require shorter diffusion lengths

- Our simulated Al-BSF device agrees well with experimental results from literature [2].

Grain size (microns)

- Our simulated Al-BSF device agrees well with experimental results from literature [2].

References: