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REVIEWER'S REPORT

Manuscript No.: IJAR-52956 Date:23-07-2025

Title: Cross-Influence of Temperature and Front Layer Thickness on the Performance of a Heterojunction Solar Cell

Recommendation:
Accept as it is ....
Accept after minor revision...yes..............
Accept after major revision ....
Do not accept (*Reasons below*) ....

Rating	Excel.	Good	Fair	Poor
Originality		yes		
Techn. Quality		yes		
Clarity		yes		
Significance		yes		

Reviewer Name:Dr.Shaweta Sachdeva **Date:** 23-07-2025

Reviewer's Comment for Publication. Accepted with Minor Revisions

(*To be published with the manuscript in the journal*)

The reviewer is requested to provide a brief comment (3-4 lines) highlighting the significance, strengths, or key insights of the manuscript. This comment will be Displayed in the journal publication alongside with the reviewers name.

Significance and Strengths of the Manuscript

1. **Relevance to Next-Generation PV Technology:**
    - The study focuses on silicon heterojunction (HJT) solar cells, a high-efficiency and industrially relevant photovoltaic architecture. By examining the **combined influence of temperature and FSF layer thickness**, it addresses real-world operating challenges for solar cells exposed to fluctuating thermal environments.
2. **Comprehensive Simulation-Based Analysis:**
    - Utilizing the TCAD SILVACO-Atlas platform, the manuscript offers **detailed numerical modeling** of charge transport, recombination mechanisms, and temperature-induced performance degradation, providing robust insights beyond empirical trends.
3. **Novel Parametric Focus:**

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- The work explores the **cross-dependence of FSF layer thickness (2–20 nm)** and **temperature (275 K–330 K)**—a pairing rarely analyzed together in existing literature. This dual-variable approach enables a deeper understanding of thermal and passivation trade-offs in heterojunction design.

4. **Clear Identification of Optimal FSF Regime:**
   - A key finding is the identification of an **optimal FSF thickness range (13–20 nm)** that balances passivation, field-effect strength, and thermal stability. This insight is valuable for optimizing both **device fabrication** and **field deployment** of HJT cells.
5. **Quantitative and Qualitative Correlation:**
   - The results are grounded in both **theoretical equations** (e.g., temperature dependence of Voc, Jsc) and **simulation outputs** (e.g., efficiency curves, FF trends), creating a cohesive and well-validated interpretation of physical mechanisms.
6. **Practical Design Guidance:**
   - By correlating FSF thickness with photovoltaic metrics under realistic temperature ranges, the study offers **practical guidelines for tailoring front surface field layers** to improve device resilience and efficiency in real-world conditions.

Detailed Reviewer's Report

1.In Table 1 (page 6), clarify units and use consistent scientific notation (`1e-6` instead of `1. 10-6`, for example).

2. Provide brief justifications for choosing specific defect density values in amorphous layers.

3. Add more detail about the meshing scheme and boundary conditions used in the SILVACO Atlas simulation (e.g., grid size, time step if applicable).

4. Briefly mention convergence criteria for simulation accuracy.

5. Some observations in Section 4 (Results and Discussion), such as thermal stability for 3 nm FSF, are described qualitatively. Consider adding quantitative data or exact % variations from the graphs.

6. Improve spacing and formatting in equations (e.g., Equation 1), and ensure consistent symbol usage across text and figures (like *J*sc vs Jsc).

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7. Make citation formatting uniform (e.g., consistent use of brackets: [1] or (1), not both).Some references have broken or excessively repeated links (e.g., [20]–[21]); ensure clean formatting and remove redundancy.

8. **Add a Table Summarizing Key Results:**A table showing Voc, Jsc, FF, and η values at specific temperatures for key FSF thicknesses (e.g., 2 nm, 5 nm, 10 nm, 20 nm) would consolidate insights.