Solar Degradation and Lifetime Extension (SDLE)

Accelerated Degradation in Advanced Photovoltaic Cells: A Data-Driven Approach to Enhancing Solar Cell Longevity and Efficiency

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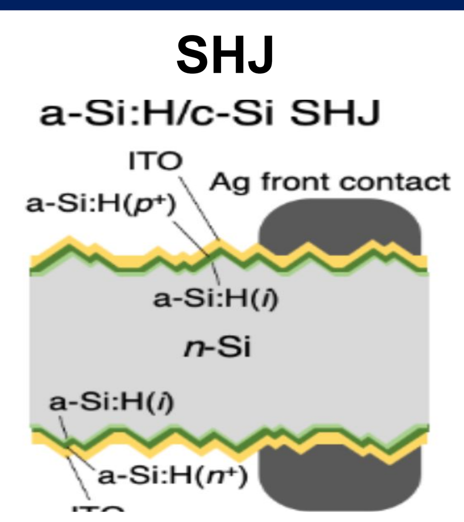
1. INTRODUCTION

Silicon Heterojunction (SHJ) cells
- High Efficiency & Low Degradation
- Improved Temperature Performance



Passivated Emitter Rear Cells (PERC)
- Enhanced Efficiency
- Compatibility with Existing Technologies

Passivated Emitter Rear Totally-diffused (PERT) cells
- Bifacial Design Capability
- Enhanced Rear Side Utilization

Study Goal : Examining the degradation in different solar cell technologies through accelerating aging, to provide insight into improving their durability and advancing the broader adoption of solar energy

2. EXPERIMENT DESIGN

Environmental Stressors:
- Feedback from academia and industry

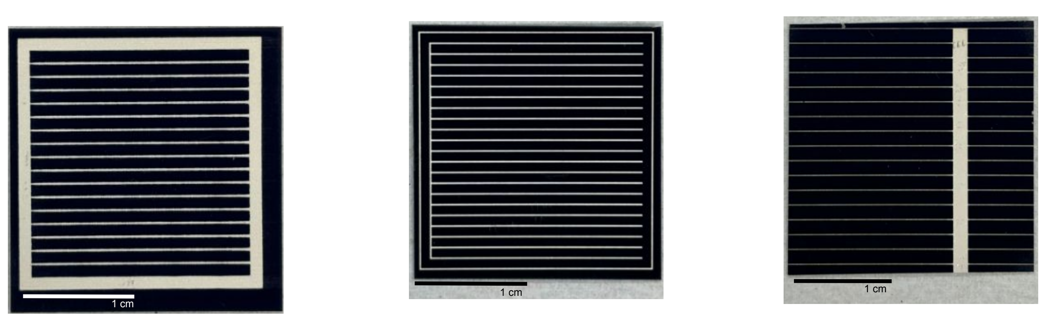
High concern
1. UV light
2. UV light and heat
3. Temperature cycles
4. Heat and humidity
5.(Acetic acid)

Low Concern
1. Sodium (Na)
2. Broadband Light
3. Heat
4. Cold (w/o. humidity)

- **Accelerated Aging Test** :

UV Exposure	Cyclic Exposure	Damp Heat (DH) Exposure	Acetic Acid
Irradiance : 1.55 W/m^2	4 hrs dark, 8 hrs at 1.55 W/m^2	Rel. Humidity = 85%	Solution: 5 vol.%
Temperature : 50°C	Temperature : 50°C	Temperature : 80° C	Total Hrs of Exposure : 3

→ 30 SHJ cells in exposure
→ 30 PERT cells in exposure
→ 30 PERC cells in exposure



SHJ PERT PERC

Exposure	Aging Steps (hours)
UV	0, 200 ,400, 800, 1200, 1600
Cyclic UV	0, 200, 400, 800, 1200, 1600
DH	0, 100, 200, 400, 800, 1000
Acetic Acid	0, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2

SHJ
PERC & PERT

- **Characterization Methods:**

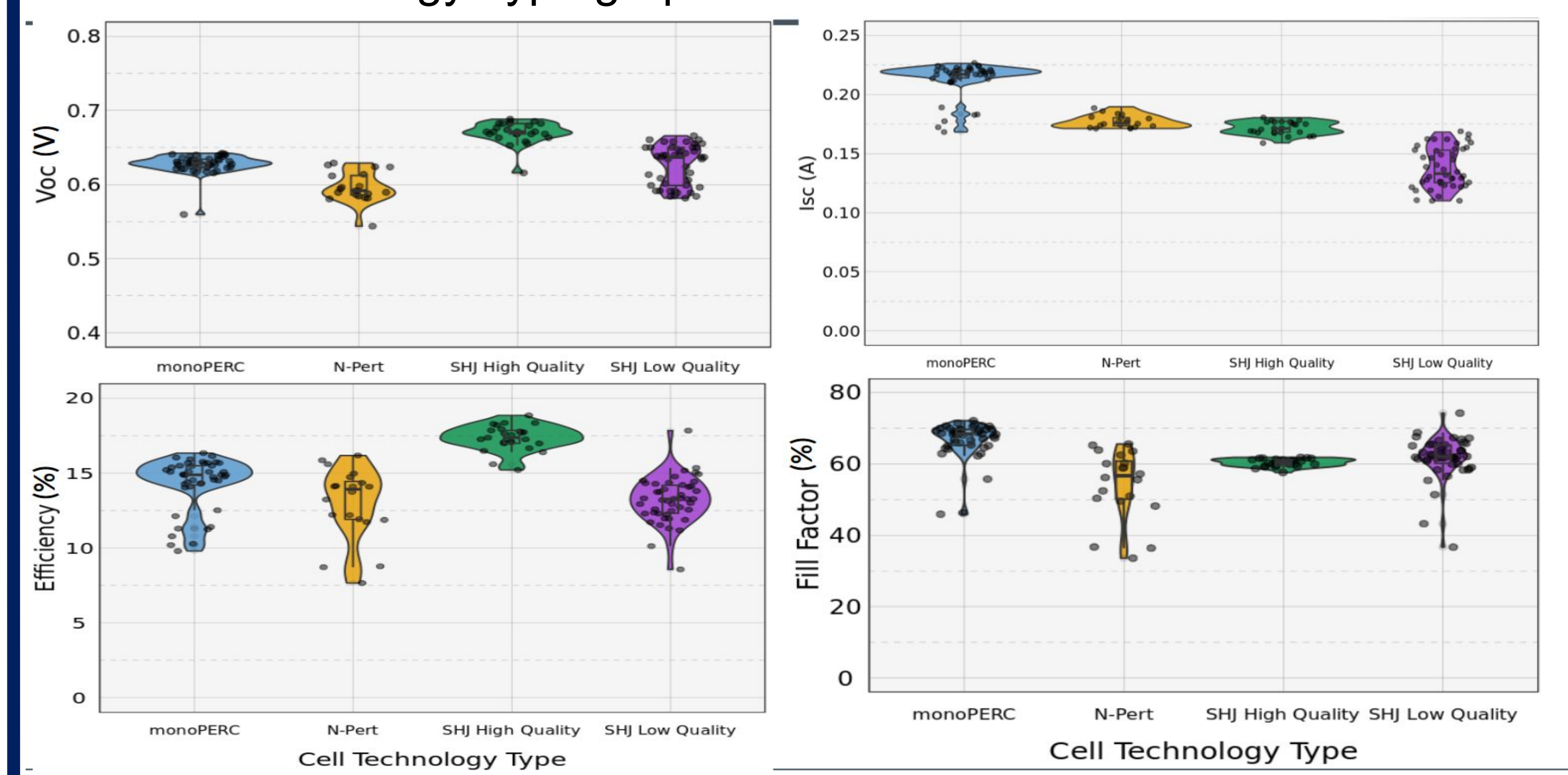
→ Current - Voltage Characterization (I-V) :
Efficiency Assessment
Performance Diagnosis

→ Suns Voltage Open Circuit (Suns-V_{OC}) :
Performance Under Realistic Conditions
Quality Control

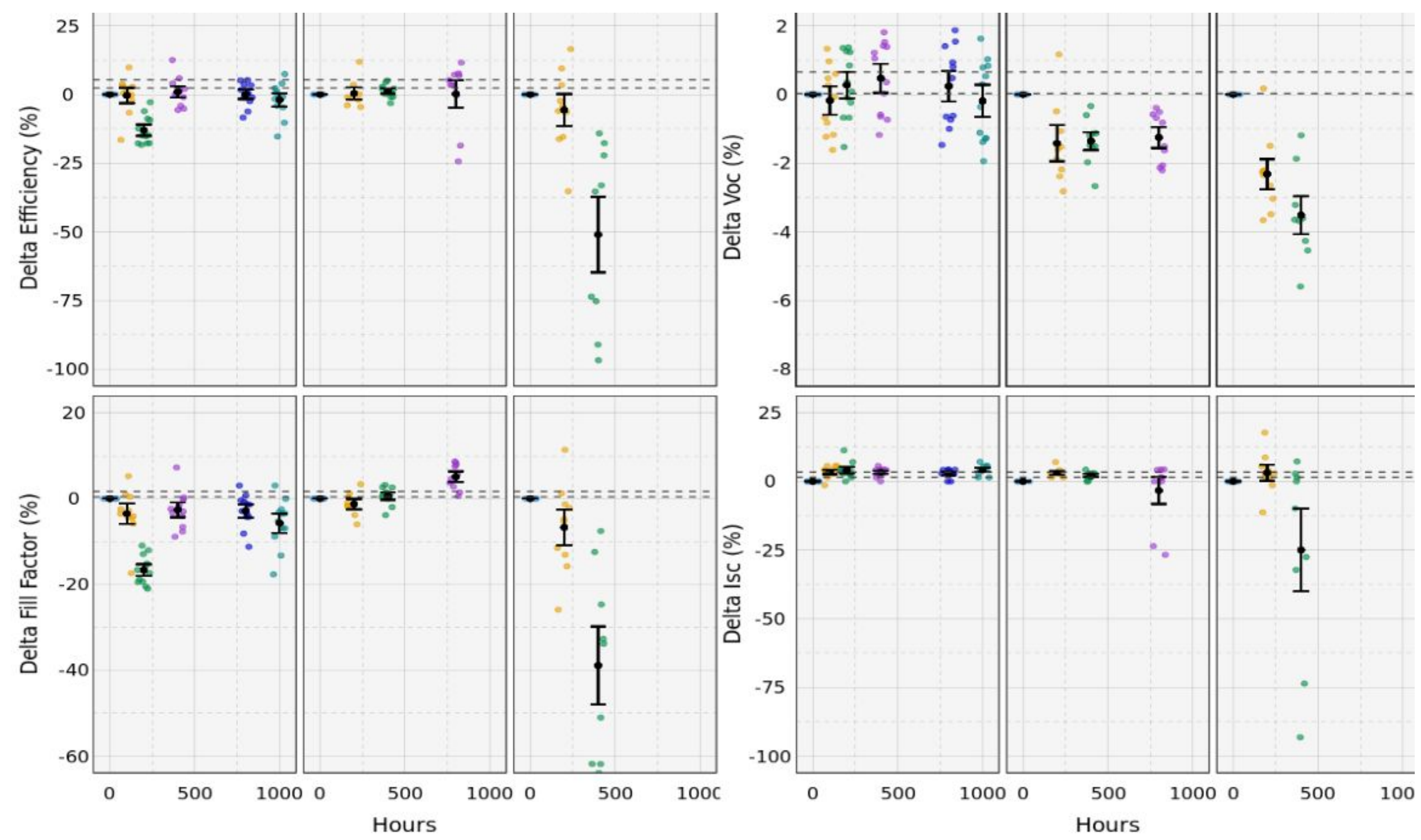
→ External Quantum Efficiency (EQE) :
Identification of Degradation Mechanism
Quantitative Assessment

3. RESULTS & DISCUSSION

- **Results:**
The research is currently on a data gathering phase.
- **Preliminary Results**:
Cell Baselining: Voc (V), Isc (A), Efficiency (%) & Fill Factor (%) Vs Cell Technology Type graphs are shown below :



- **PERC Devices : Illuminated I-V Characteristics**



DH, UV alone:
Stable/small changes

Cyclic:
Significant loss
Dominated by FF, then Isc → contact resistivity

4. CONCLUSION

- Cyclic exposure appears so far to have the most substantial degradation impact on the cells .
- PERC has a greater response to cyclic exposure than SHJ.

Future plan
- Finish accelerated aging of UV, Cyclic UV, Damp heat, acetic acid on cells and start accelerated aging on film samples
- Cross-correlate cell performance and materials degradation
  - Focus on changes of interfaces
- Finalize rapid screen methods prioritize degradation mechanism

5. REFERENCES

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