2019 PV Systems Symposium

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Sandia National Laboratories

CFV solar test laboratory

Development of Low-Cost, Crack-Tolerant Metallization Using Screen Printing

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DuraMAT Capabilities

1. **Data Management & Analytics, DuraMAT Data Hub**
2. **Predictive Simulation**
3. **Advanced Characterization & Forensics**
4. **Module Testing**
5. **Field Deployment**
6. **Techno-Economic Analysis**

Industry Goals

- Produce screen-printable silver paste with crack-tolerance to substrate fractures.
- Incorporate low-cost, multi-walled carbon nanotubes for electromechanical reinforcement.
- Develop capability to electrically bridge cracks forming in PV cells for increased lifetime.
- Reduce LCOE by lowering cell degradation rate.

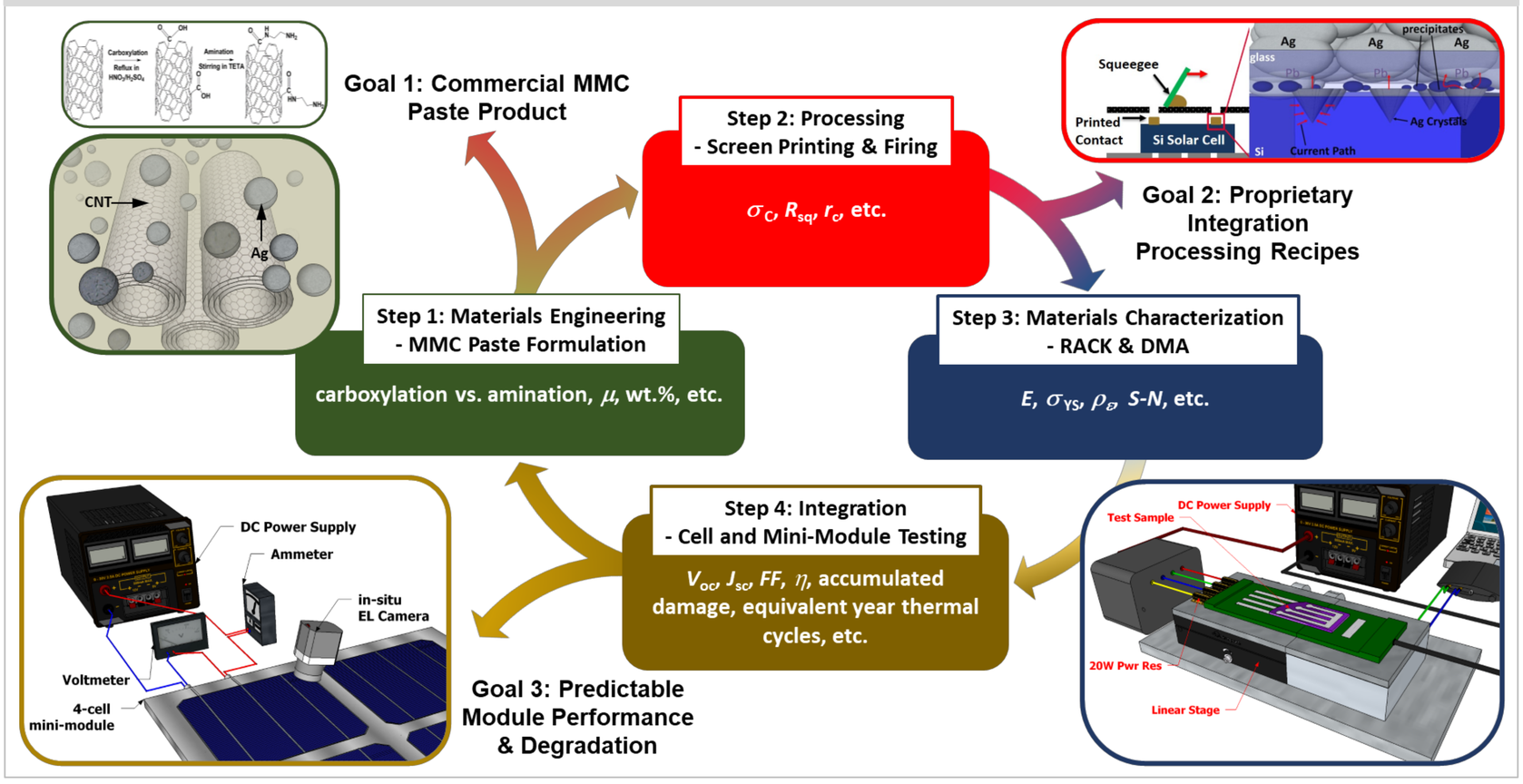
Accomplishments

- Demonstrated crack-bridging for commercial space solar cells.
- Translate the technology to silver paste used on terrestrial PV.
- Target terrestrial Si PV market > $25B for economic impact.
- Reduce module degradation for increased lifetime.
- Accomplished mini-module stress testing w/thermal cycling.

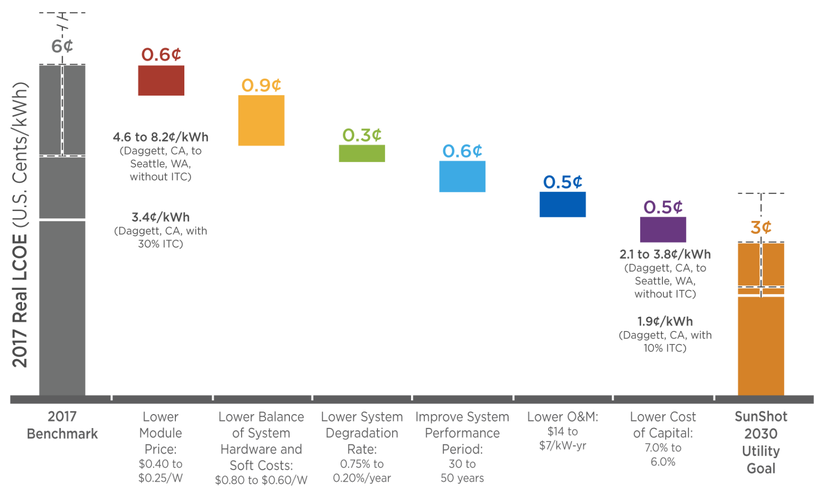
Outcomes and Impact

- Demonstrate increased module reliability against stress-induced cell fractures.
- Make specialized silver paste products available for integration on commercial Si PV modules.
- Target future partnerships with silver paste and module manufacturing companies.
- Provide new materials and integration solutions for Si PV.

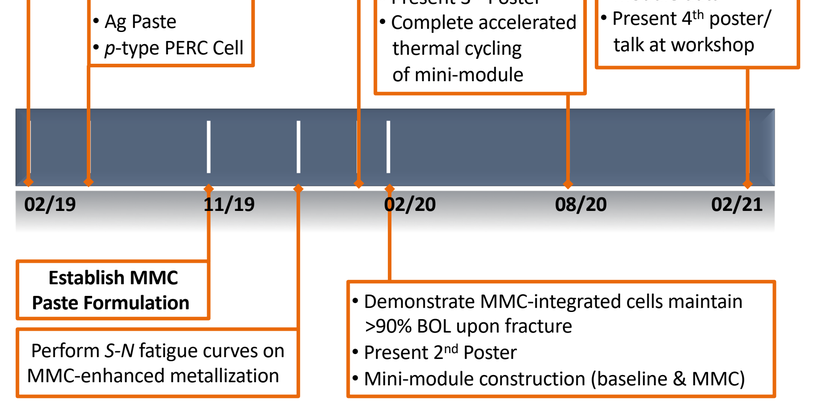
Capability Development



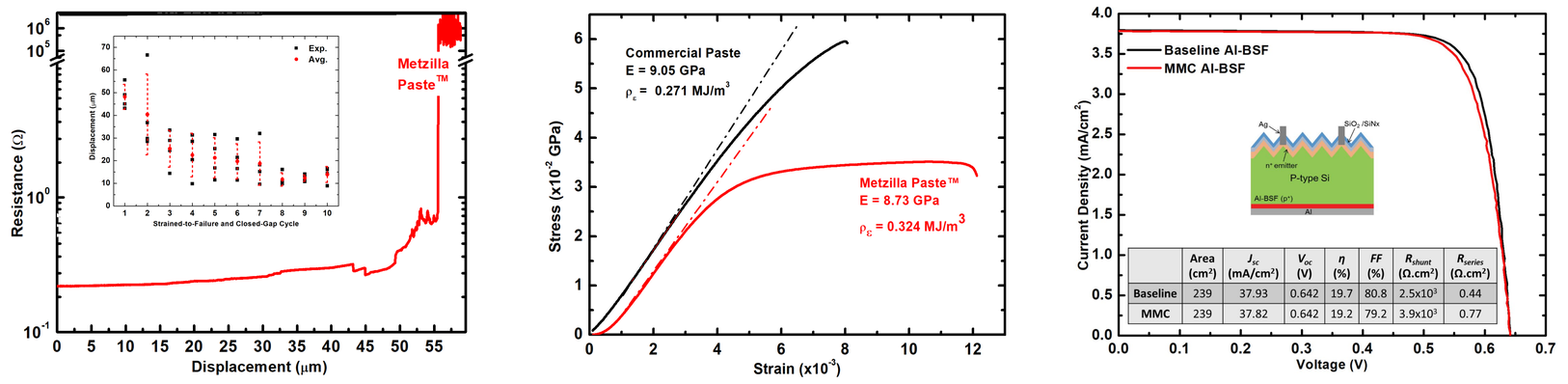
Cost Drivers



Project Timeline



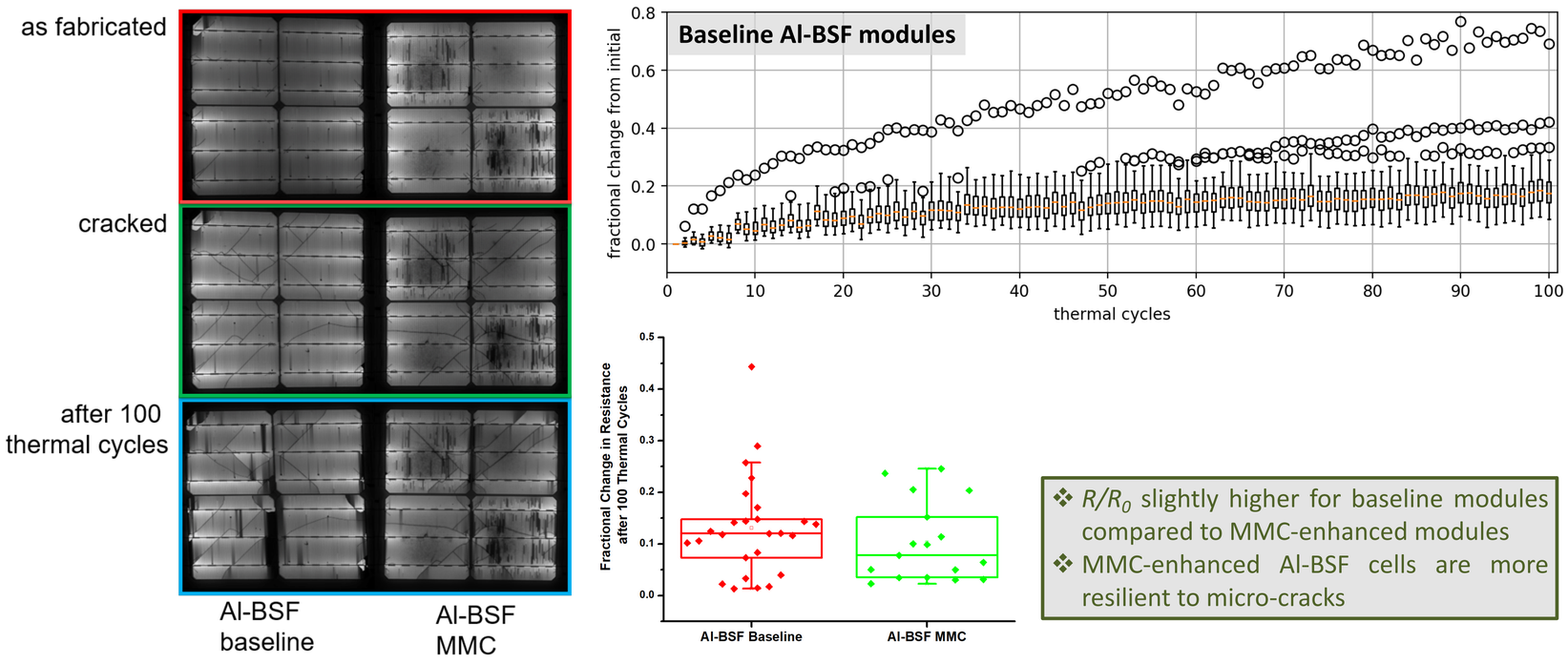
Materials Characterization



	Area (cm^2)	J_{sc} (mA/cm^2)	V_{oc} (V)	η (%)	FF (%)	R_{shunt} (Ω.cm^2)	R_{series} (Ω.cm^2)
Baseline	239	37.93	0.642	19.7	80.8	2.5x10^3	0.44
MMC	239	37.82	0.642	19.2	79.2	3.9x10^3	0.77

- Gap bridging capability up to 50 μm with proper CNT loading
- Self-healing properties after multiple strained-to-failure and closed-gap cycles
- Increased ductility with CNT incorporation (16% increase in modulus of toughness)
- Little impact on cell performance upon MetZilla Paste™ integration on commercial PERC cells

Mini-Module Characterization



- R/R_0 slightly higher for baseline modules compared to MMC-enhanced modules
- MMC-enhanced Al-BSF cells are more resilient to micro-cracks

Summary

Durability by deliberate design;
Perfecting a process that is engineered to last

Osazda Energy LLC provides materials engineering solutions to improve solar cell and solar module reliability. Our specialized metal matrix composites have been proven to electrically bridge stress-induced cracks that appear in solar cells over time; the composites also self-heal to regain electrical continuity. This MMC technology will potentially extend the lifetime of solar panels while increasing the bankability of utility-scale photovoltaic projects. This has substantial financial implications in making the price of solar electricity as low as the price of fossil-fuel-generated electricity.

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