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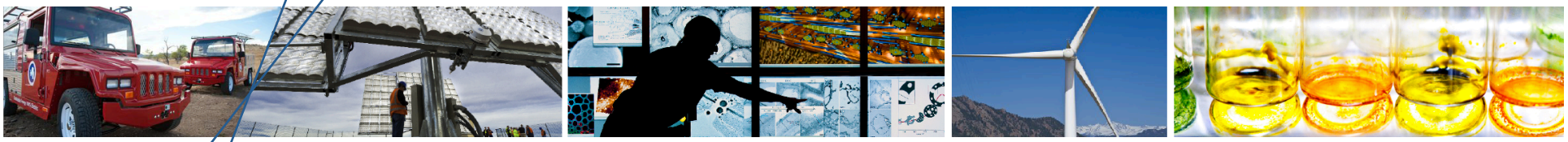
International PV Module QA Task Force



John Wohlgemuth & Sarah Kurtz

July 11, 2013

Solar ABCs PV Stakeholders Meeting

Outline

- What is the International PV Module QA Task Force?
- Summary of the July, 2011 meeting in San Francisco
- Charter of 10 Groups
- Activities of QA Task Force
- Conclusions

International PV Module QA Task Force

- Effort to develop a PV module rating system that meets needs of all countries and customers – A Single Test Protocol
- Define concepts for creation of standards that allow stakeholders to quickly assess a module's ability to withstand regional stresses.
- Participation open to all who want to contribute to the effort.
- Program relies on research done by volunteers around the world.
- Effort is to guide world wide research to answer important questions related to testing that predicts outdoor performance of PV modules.

International PV Module QA Forum

- **Held in San Francisco, CA July, 2011.**
- **Approximately 150 people from around world participated.**
- **Established the International PV Module QA Task Force.**
- **Defined goals of the QA Task Force**
- **Prioritized field failure modes observed for crystalline silicon modules**
- **Established 6 Task Groups, 4 of which were specifically chartered with addressing the prioritized failure modes.**
- **Provided for future creation of additional Groups.**
- **Established a Steering Committee and Team Leaders for each Task Group.**

Goals of International PV Module QA Task Force

1. ***To develop a QA rating system that provides comparative information about the relative durability of PV modules to a variety of stresses as a useful tool to PV customers and as a starting point for improving the accuracy of quantitative PV lifetime predictions.***
   1) Compare module designs
   2) Provide a basis for manufacturers' warranties
   3) Provide investors with confidence in their investments
   4) Provide data for setting insurance rates
2. **Create a guideline for factory inspections of the QA system used during manufacturing.**

Task Group 1: Guideline for Manufacturing Consistency

PV-Specific Version of ISO-9001

- **Builds on Japanese standard**
- **Published as a report at www.nrel.gov/publications**
- **Working with IEC to create a Technical Specification.**

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Proposal for a Guide for Quality Management Systems for PV Manufacturing: Supplemental Requirements to ISO 9001-2008

Paul Norum
Amonix

Ivan Sinicco
Tokyo Electron

Yoshihito Eguchi
Japan Electrical Safety and Environment Technology Laboratories (JET)

Sumanth Lokanath
First Solar

Wei Zhou
Trina Solar

Gunnar Brueggemann
Tokyo Electron

Alex Mikonowicz
Powermark

Masaaki Yamamichi
National Institute of Advanced Industrial Science and Technology (AIST)

Sarah Kurtz
National Renewable Energy Laboratory

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Technical Report
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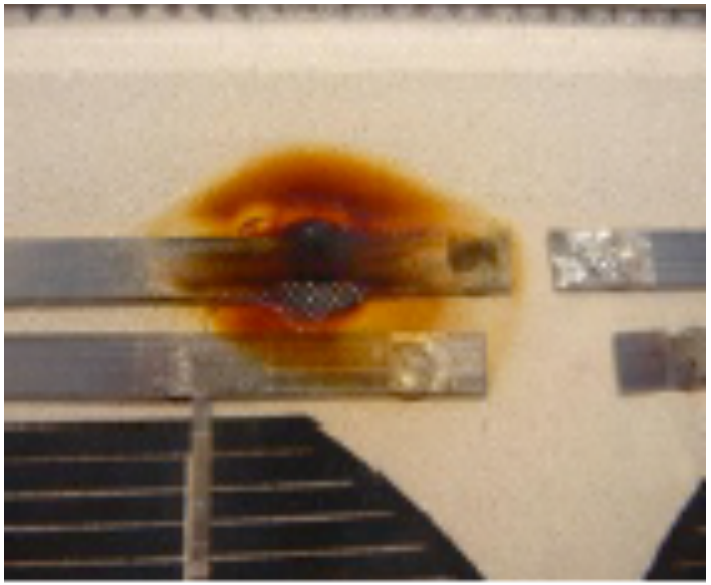
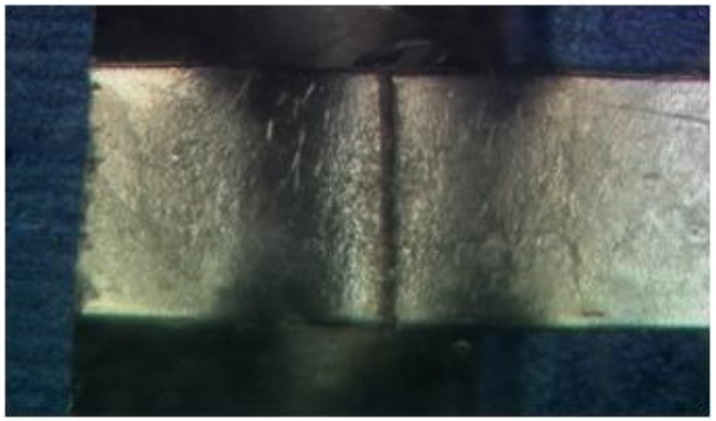
Task Group 2 –
Testing for Thermal and Mechanical Fatigue

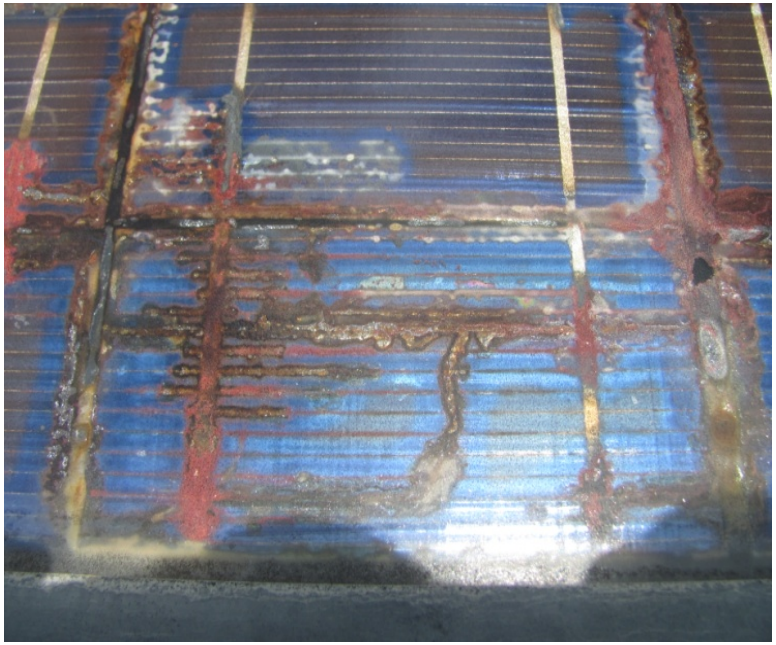
- **200 thermal cycles are not enough cycles to test for 25-year lifetime.**
- **In new standard will propose increasing cycles to 400 or 500 and adding dynamic mechanical loading test before 50TC/10HF for all terrestrial applications.**





Task Group 3 – Humidity, Temperature & Voltage

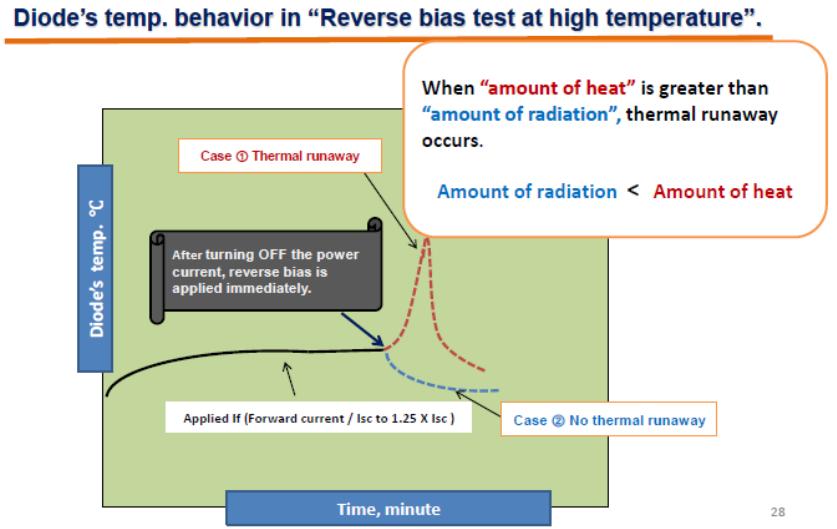
- **Focusing on developing test sequences that accelerate delamination of encapsulants, especially using UV exposure.**
- **Continue to assess the performance of field-aged modules to identify humidity-driven failure modes.**
- **Do not extend damp-heat (85/85) testing beyond 1000 hours unless we can validate that same failure mode is observed in field.**



Corrosion accompanied by delamination

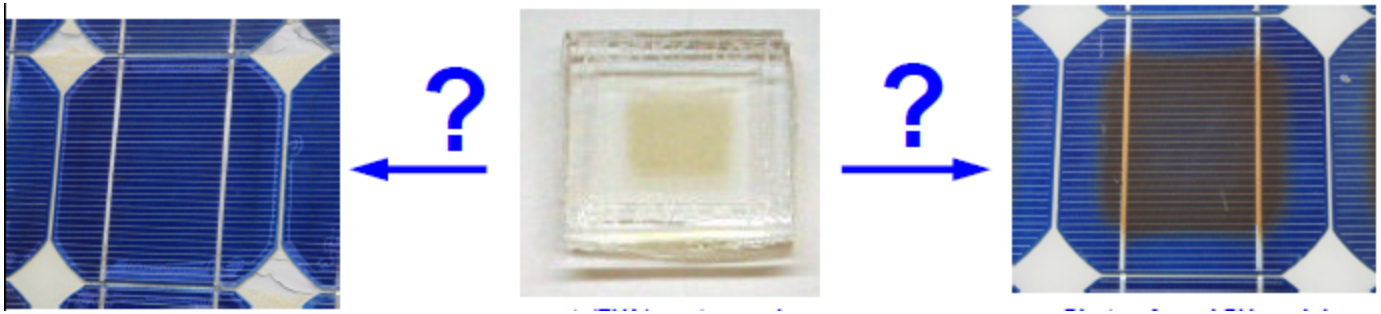
Task Group 4: Testing for diodes, shading and reverse bias

- Damage due to electro-static discharge identified.
- ESD test procedure being submitted to IEC as Technical Specification.
- Planning to propose longer By-pass Diode Thermal Test (increase from 1 hour in present Qualification Test).
- Have developed a new draft test procedure for Diode Thermal Runaway.



Task Group 5: Testing for UV, temperature and humidity

- Equivalency of light sources.
- Can we accelerate via increased UV intensity?
- Can we accelerate by increasing the sample temperature – determine activation energy.
- Impact of humidity on degradation.
- Two round robins under way (encapsulants and backsheets)
- Evaluating optical transmission, mechanical properties, and adhesion.



Activities of Task Group 6 and Steering Committee

- **How should the test system be organized?**
- **How should the results be communicated?**
- **Comparative tests versus Qualification Tests**
- **Don't know enough yet to define service life prediction tests.**

	Qualification	**Comparative**	**Lifetime**
Purpose	Minimum design requirement	Comparison of products	Substantiation of warranty
Quantification?	Pass/fail	Relative	Absolute
Mechanisms studied	Infant mortality	Wear out	Wear out
Climate or application	No differentiation	Differentiated	Differentiated

Task Group 6: Communication of PV QA ratings to the community

Climates proposed for rating system

	New Tests Require Additional Stress	Differentiation of Durability		
IEC 60721-2-1 Climate Designation		**C**	**B**	**A**
Moderate	Thermal cycling, UV, diodes	Comparable to qualification test	Better than qualification test	Most durable
Warm Damp, Equable	Tests for delamination & moisture ingress in humid climates			
Extremely Warm Dry	Tests for higher temperatures			

Use climate standards already referenced by qualification tests

Differentiate 3 climates:

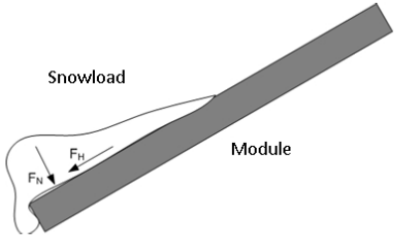
1) Moderate
2) Tropical
3) Desert

Classes	
Rack mount	Close-roof mount

Task Group 7: Wind and Snow Loading

Cause and Effect of inhomogeneous Snow Loads

- Snow accumulates on the modules surface
- Snow slides down the sloped surface until it is stopped by the frame's edge.
- → The inhomogeneous load results in a force with two directions on the lower module part (frame).
- → If the frame detached from the laminate, the module may be destroyed completely.



- ***Wind stress depends on mounting system, as well as the module.***
- **Present static mechanical load test is not a good simulation of wind forces.**
- ***Will need to do wind-tunnel tests on systems to provide inputs for modeling.***
- **Wind-tunnel tests cannot be required in a Qualification test, so we must develop a new test that includes impact of mounting system.**

Task Group 8: Testing of Thin Film Modules

- **Assigned thin-film experts to Groups 2, 3, and 7.**
- **Established specific TF Subgroups:**
  - **Semiconductor junction degradation**
  - **Micro-delaminations of device layers**
  - **Shading effects in thin films**
  - **Monolithic Integration**
  - **Flexible packages**
- **Experimental efforts just beginning.**

Task Groups 9 and 10:

Group 9: Testing of CPV Modules

- Conducted survey of failure modes to pick projects to work on.
- Created a first draft of a test method for differentiating the die attach quality

Group 10: PV Connectors

- New Group just getting started based on reports of field failures of PV connectors.

Conclusions

- QA Task Force has involved hundred of PV scientists around world.
- Working to develop consensus test sequence that provides comparative performance data.
- Work designed to lead to IEC standards.
- Looking for volunteers to work on the different groups or even to create new groups in PV reliability areas of interest.

Questions?

http://www.nrel.gov/ce/ipvmqa_task_force/index.cfm