ACTIVITIES OF TASK GROUP 8 ON THIN FILM PV MODULE RELIABILITY

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INTRODUCTION

• Task Group 8 of the International PV Module QA Task Force has been working on thin film module reliability.
• Thin film task group kick-off meeting was held on February 28, 2013.
• In the breakout session 1, field failure modes for thin film modules were identified and prioritized. The important failure modes are listed below:

Delamination: "micro" delamination of TCO / Mo films as well as macroscopic delamination of structural components such as encapsulant, edge seal etc.
Semiconductor Junction Degradation: Diode quality degradation by diffusion of impurities.
Corrosion: Moisture facilitated corrosion around scribe lines, degradation of contact layers (TCO, Mo film)
Interconnect Degradation: Increased shunting at scribe lines, poor edge delete leading to ground faults,
Glass Breakage: Residual stress, use of diurnal temperature cycling and hotspots leading to glass breakage.

• The breakout session #2 consisted of discussion on identifying an appropriate accelerated stress test or test sequence for predicting long term field performance for every failure mode.
• Four subgroups have been formed to focus on specific areas such as micro-delamination, shading, semiconductor junction degradation and monolithic interconnects.

STRATEGY

1. **Field Inspection:** Identifying field failure modes, Using I-V measurements, visual inspection and EL/IR imaging whenever possible.
2. **Failure Mode Analysis:** Statistical analysis of field inspection data to understand impact of each failure mode on module degradation.
3. **Failure Mechanism Determination:** Probing to the materials level to decipher the failure mechanism.
4. **Development of Accelerated Tests:** Based on the failure mechanisms, designing accelerated tests to replicate the observed field failure modes.

PLAN

• It is essential to determine whether the newly defined IEC test sequences in proposed rating system will require modifications to cover thin films specific stressors that would influence the failure modes.
• Therefore, subgroups have been assigned to investigate various failure modes specific to thin-film module.

Label\ Stress	Humidity	High Temperature	Thermal cycling	UV
IEC 61215 or 61646	IEC 61215 or 61646	IEC 61215 or 61646	IEC 61215 or 61646	IEC 61215 or 61646
Temperate	IEC 61215 or 61646	IEC 61215 or 61646	IEC 62XXX -2 Task Group 2	IEC 62XXX -3 Task Group 5
Hot & Dry	IEC 61215 or 61646	IEC 62XXX -4 Task Groups 2, 3 and 5	IEC 62XXX -2 Task Group 2	IEC 62XXX -3 Task Group 5
Hot & Humid	IEC 62XXX -5 Task Group 3	IEC 62XXX -4 Task Groups 2, 3 and 5	IEC 62XXX -2 Task Group 2	IEC 62XXX -3 Task Group 5

MICRO-DELAMINATION

• Delamination is defined as the separation between dissimilar materials in a given system
• Fracture occurs within the same material /cohesive failure.
• Delamination has a variety of different meanings within Thin-Film PV.
• Stressors and micro-delamination caused by them are described below:

General Interface	Specific Interfacial Example	Moisture	Diffusion Temperature	Bias (electrical)	Pure Mechanical	Thermo-mechanical (cycling)	Light
Glass/EVA	Same as c-Si module	X			X		X
Superstrate Glass/TCO	Glass/SnO_2:F (Bar Graphing)	X	X	X			
EVA/TCO(Cell)	Organic/Inorganic	X		X	X	X	X
TCO/Semiconductor	ZnO/CdS	X	X				
Heterojunction (P-N)	CdTe/CdS, CIGs/CdS		X	X			
Back Contact/Semiconductor	(Ni, Mo, Al)/CdTe or Mo/CIGS		X	X			
Back Contact/ Substrate	Mo/Glass		X			X	
Back Contact/EVA	Ni/EVA	X					
Front-Back Contact/Bus Bar	Bus Bar Delamination				X	X	

EFFECT OF SHADING ON THIN FILM MODULES

This group is working closely with the Task Group 4 on Diodes and Shading on the following goals:

1. Identification of field failure modes in thin film modules that can be attributed to shading.
2. Studying the long-term degradation in thin film modules due to hot spots.
3. Designing new /improved tests to reproduce the failure modes observed in field.

Following field failure modes have been identified:

1. Hotspots caused by shading resulting in glass breakage, loss of electrical insulation and long term degradation due to high temperature.
2. Permanent damage caused to the semiconductor junction and shunting due to application of reverse bias during shading.
3. Current crowding through small areas during event of shading leading to degradation of semiconductor material.

- The effect of worst case shading scenario where shaded cell has to withstand the reverse voltage generated by the rest of the module is being investigated further.
- The role of current crowding caused by shading in degradation of cells is also being studied.