15-year Review of Field Performance of EVA-based Encapsulants

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STR Solar

Contains no confidential information

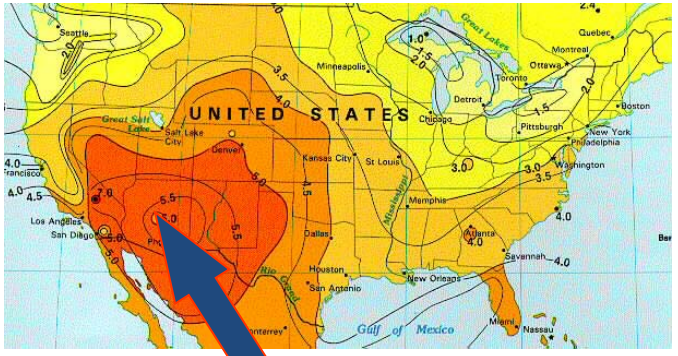
Introduction

- As part of PVMaT subcontract, STR fielded modules with various EVA-based formulations at Tempe, Arizona
- 36 modules with 5 different EVA-based formulations currently on test
- Module fielding initiated on September 6, 1996
- Visual inspection and I-V measurements performed on periodic basis

Introduction

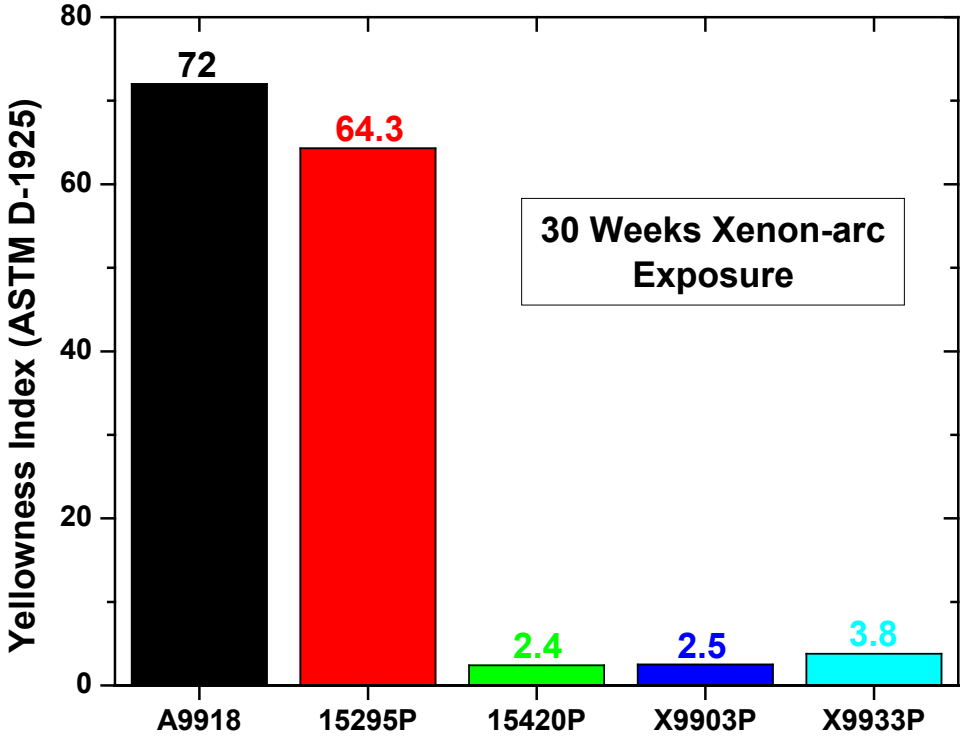
- Modules installed on two-axis tracker
- 4 PV module manufacturers
- 5 encapsulant formulations

Formulation	Curing Schedule
A9918P - control	Standard
15295P	Fast
15420P	Fast
X9903P	Standard
X9933P	Standard



Introduction

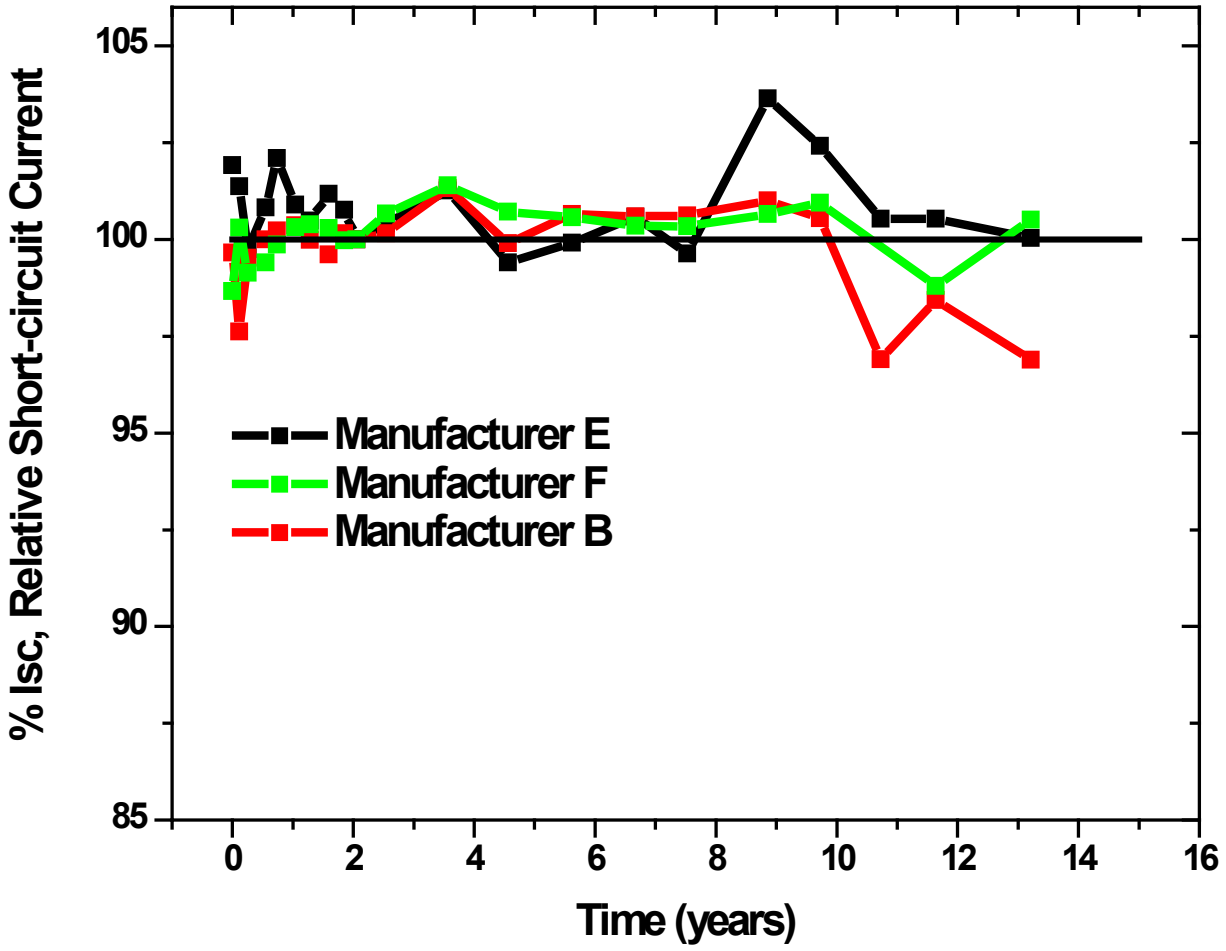
- All fielded formulations evaluated under Xenon-arc accelerated aging
- How does accelerated aging data correspond to data from fielded modules?



Accelerated aging performed in Xenon Arc Weather-o-meter with glass/glass constructions. Irradiance at 340 nm is 0.55 W/m^2; equal to an exposure of ~2 suns. Glass/glass laminates. Non-UV-screening glass utilized.

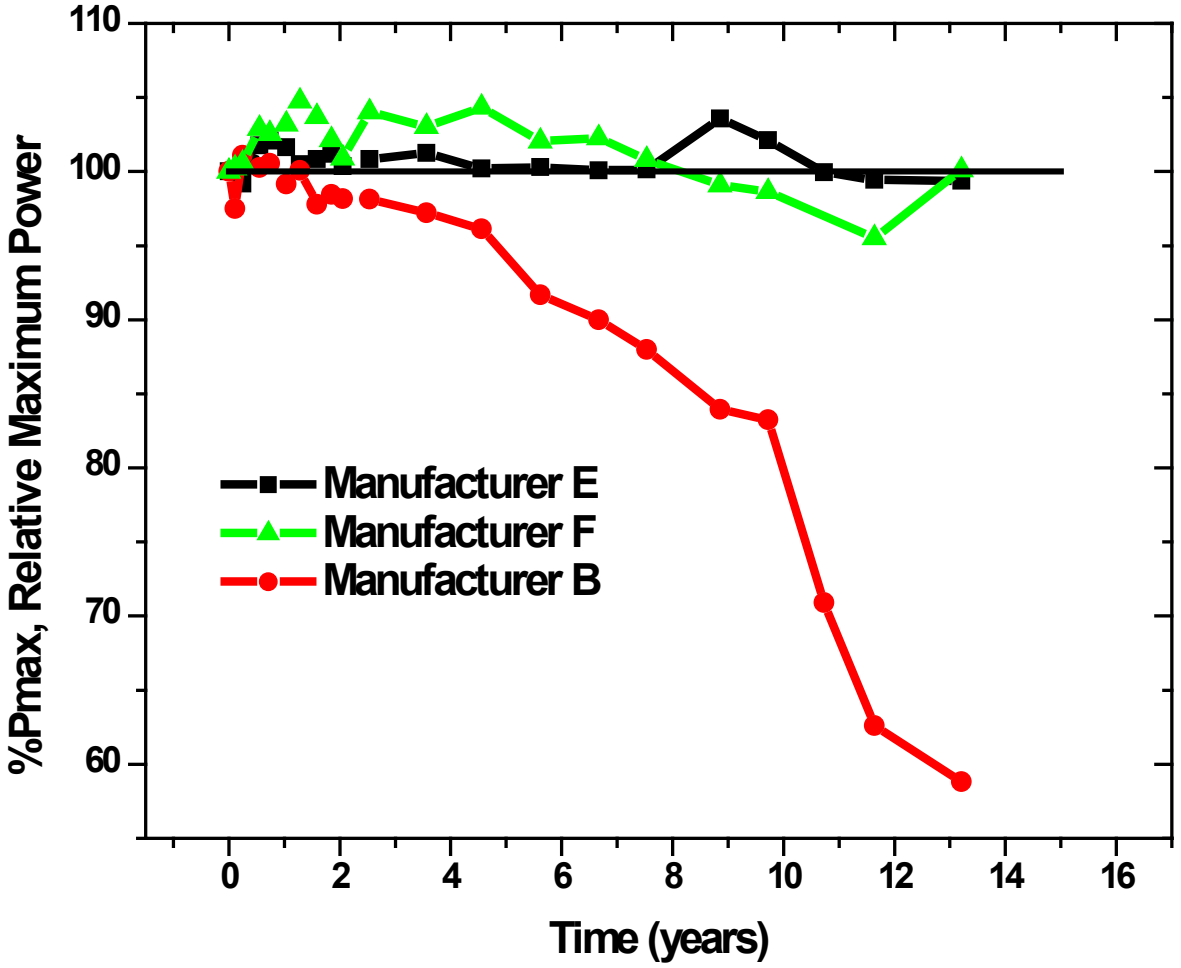
15420P

- 3 module manufacturers
- Relative Isc (short-circuit current) performance:
  - **E = 100.04%**
  - **F = 100.51%**
  - **B = 96.89%**
- Isc related to incident light reaching PV device



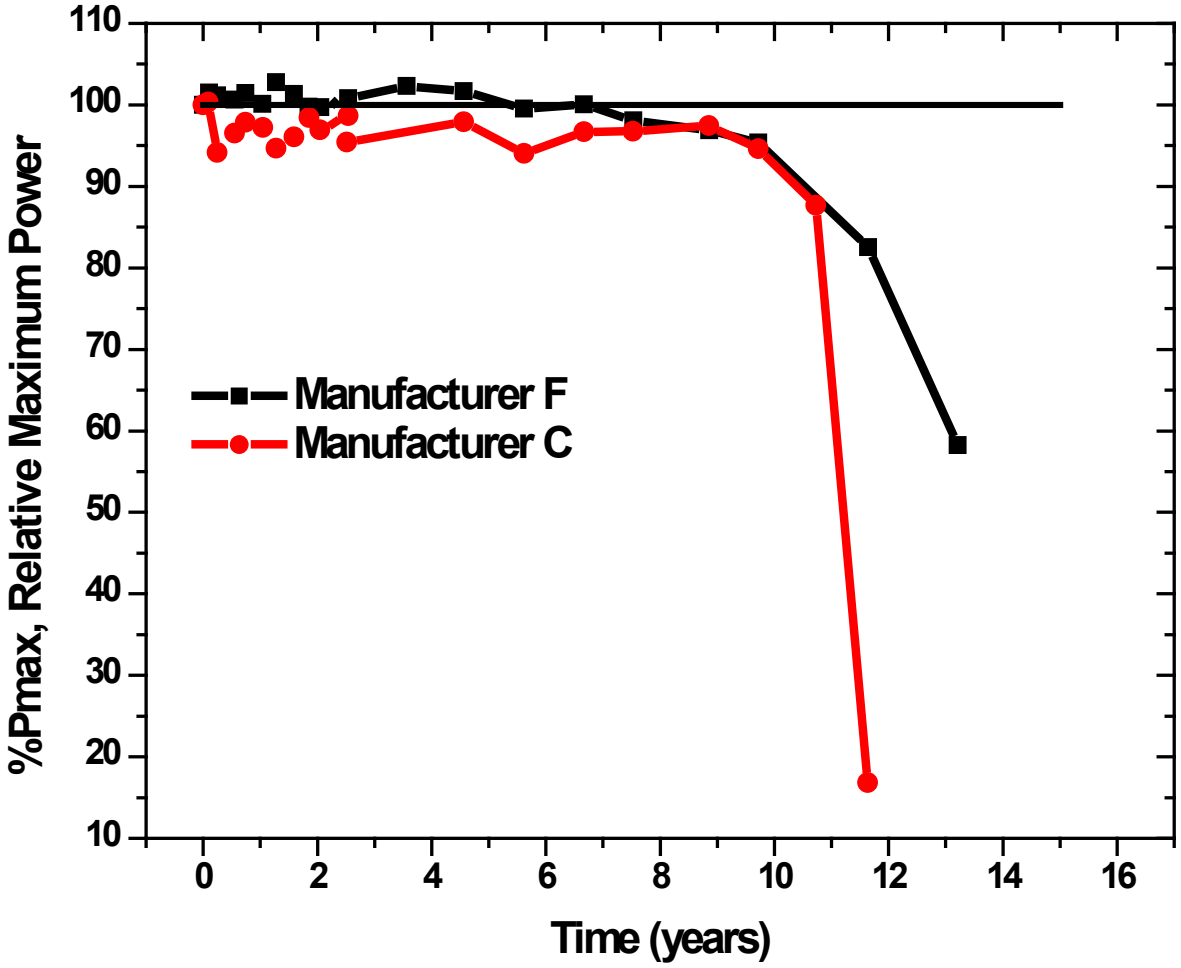
15420P

- Relative Maximum Power (Pmax)
  - **E = 99.39%**
  - **F = 100.12%**
  - **B = 58.81%**
- Cell backside corrosion observed only in modules from Manufacturer B



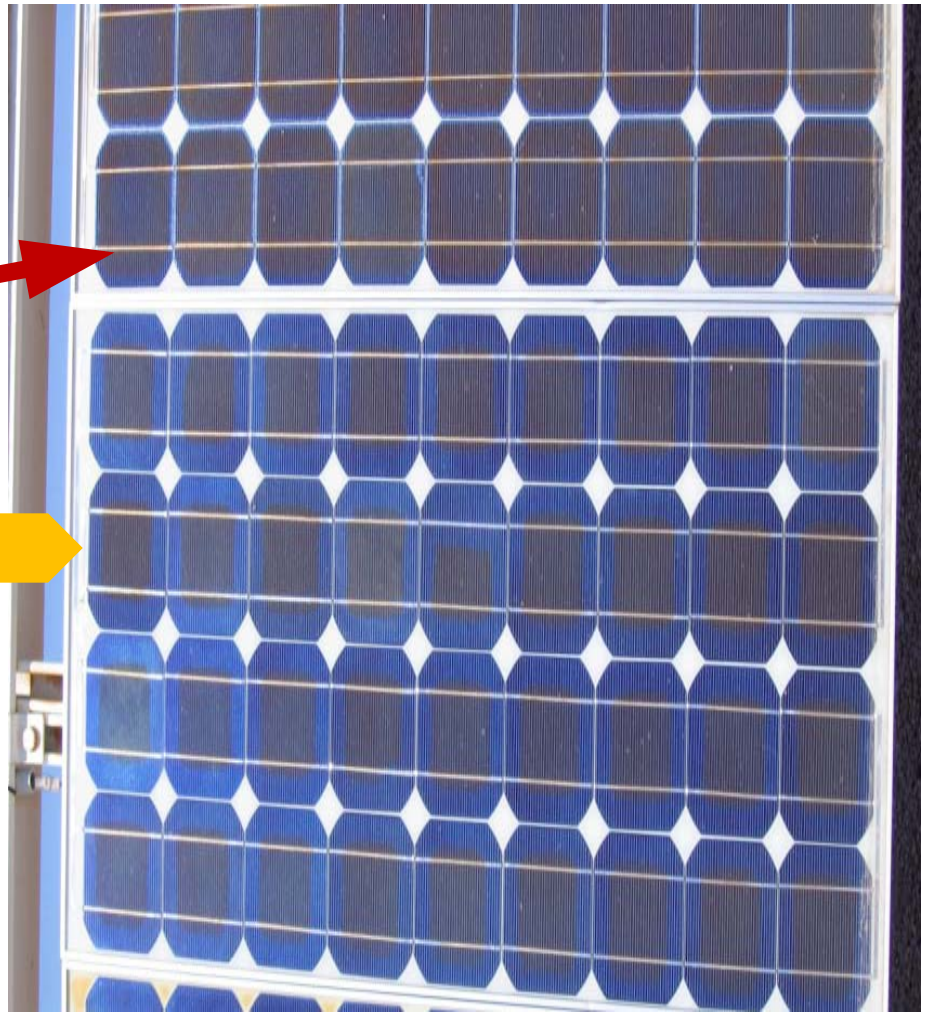
15295P

- Pmax performance corroborates poor accelerated aging data
- Discoloration observed over PV cell
- Manufacturer C modules also had corrosion within junction box



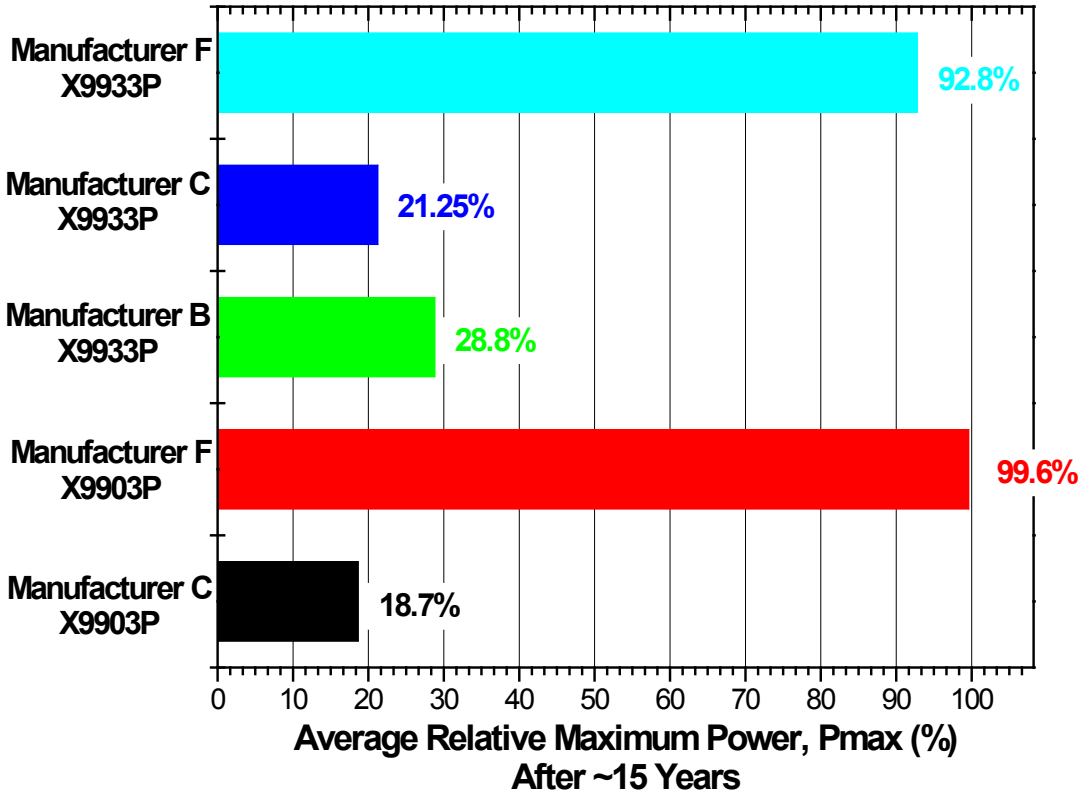
15295P

- Module discoloration of 15295P
- Typical discoloration is over cells
- Discoloration between cell ribbons only in “F” modules
  - Further investigation needed

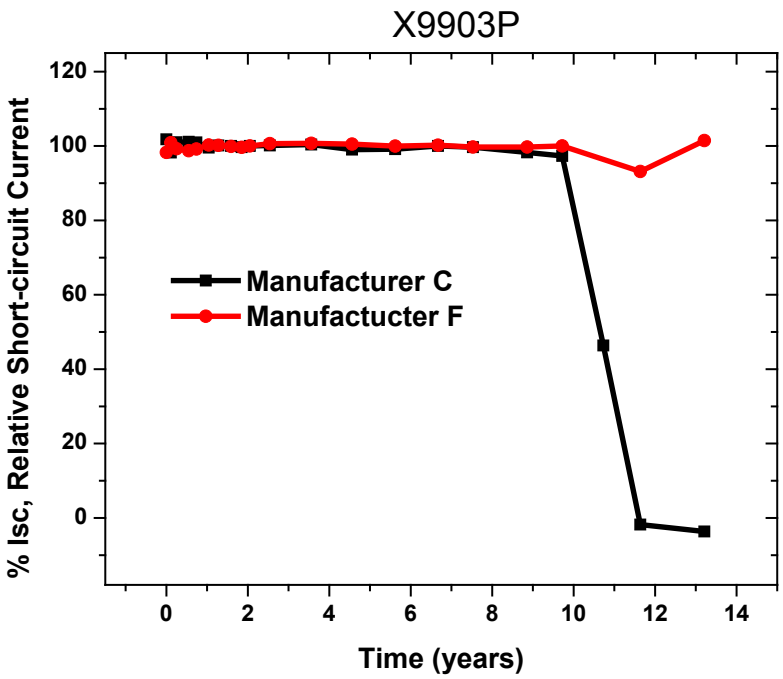


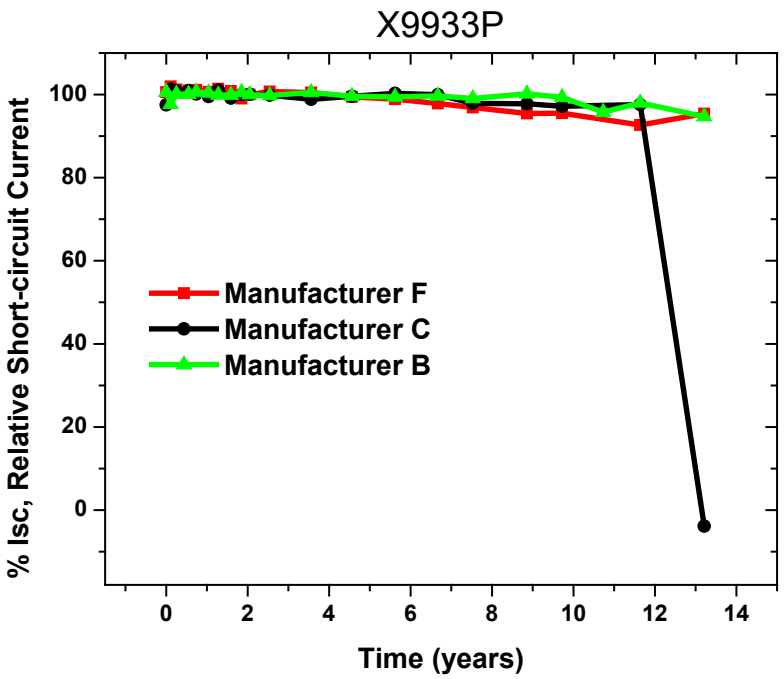
Experimental Standard-cure Formulations

- Experimental standard-cure formulations
  - X9903P, X9933P
  - Typically utilized in 2-step processes
- Manufacturer C = corrosion at junction box
- Manufacturer B = dark areas and delamination behind every other cell string



Experimental Standard-cure Formulations





Relative Isc is consistent with accelerated aging data

- Low YI for X9903P and X9933P after 30 weeks XAW
- J-box corrosion in Manufacturer C Panels

A9918P - Control

- Modules fielded in 1997
- Half of modules utilize UV-screening (i.e., cerium) containing glass
- Isc performance correlates with glass type and XAW accelerated aging data - A9918P high YI after 30 weeks XAW

Glass	Module ID	Relative Isc at ~ 14 years (%)
UV-screening	68	99.94
	64	94.59
	66	98.20
	72A	94.80
	71A	97.48
Non-UV-screening	67	85.97
	70A	87.13
	73	89.03
	70B	86.67

Conclusions

- Stabilization strategies developed demonstrate effectiveness in minimizing encapsulant discoloration
- 15420P (2nd gen. encapsulant) performing well; no statistical loss of Isc
- Discoloration with 15295P observed as predicted by Xenon-arc accelerated aging
- Relative short-circuit current correlates well and is consistent with Xenon-arc accelerated aging data
- Presence of UV-screening glass improves photothermal stability of encapsulant