

Crystalline Silicon Terrestrial Photovoltaic Cells – Supply Chain Procurement Specification Guideline

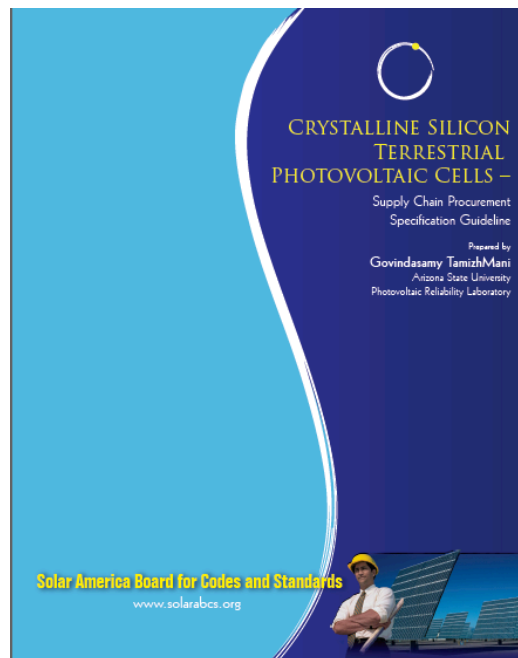
A study report prepared

for



by

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<http://www.solarabcs.org/cellprocurement/>

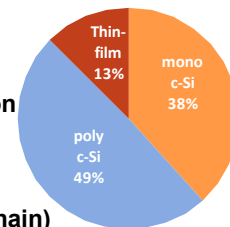
Background

Need for a common, detailed cell specification standard

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Industry Status:

Many photovoltaic module manufacturers depend on third-party solar cell manufacturers for their supply of c-silicon



Issue:

No common, detailed, baseline cell procurement (or supply-chain) specification exists for the industry

Impacts:

Change in cell specification impacts

- Module production line
- Module certification validity

This report is a systematic (procurement specific) compilation of literature including:

- EN 50461 - Datasheet information for c-Si cells
- EN 50380 – Datasheet information for PV modules
- IEC standards and retest guidelines of PV modules (IEC 61215, IEC 61730)
- SEMI standards – silicon wafers
- DIN/VDE standards – solar wafers
- Cell specifications obtained from a few manufacturers

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Proposed Cell Specification Standard

Scope and Content

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c-Si Cells – Supply Chain Procurement Specification Guideline

The proposed standard contains 6 sections.

1. Scope
2. Packing, marking, and storage
3. Wafer characteristics, process characteristics and module packageability
4. Cell characteristics
5. Declaration letter/form for modifications
6. Documentation

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1. Scope

Purpose of the section:

To provide the scope and limitation of the standard

This standard

- Provides minimum requirement for prequalification of c-Si cells
- Applies to c-Si cells only, not thin-films
- Is not applicable to c-Si cells used in CPV modules (> 3x)
- Recognizes that the module manufacturer may require additional specifications
- Is not intended to waive or replace any tests of qualification standards (IEC 61215 & IEC 61730-2) or their retest guidelines

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2. Packing, Marking and Storage

Purpose of the section:

To ensure that the cells are protected as they are fragile and sensitive storage conditions

Each smallest packing unit shall carry detailed markings including

- Name of manufacturer
- Cell type (mono- or poly-Si) and its designation
- Date and place of manufacturing
- Ambient conditions for storage
- Maximum recommended time for storage
- Quantity in each pack
- Cushioned boxes suitable for handling and shipping
- Cells in each pack should have originated from not more than 2 ingots
- Etc.

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3. Wafer characteristics, cell process characteristics and module packageability

Purpose of the section:

To ensure that the wafer, process and cell packageability characteristics are acceptable

Wafer characteristics shall be provided which include

- Crystal growth technique
- Wafer sawing technique
- Conductivity type and dopant
- Impurity concentration range

Cell process characteristics shall be provided which include

- Adhesion strength
 - Composition of surface layers for soldering
 - Adhesion force of surface layers – e.g. 2-4 N/cm or acceptable to module manufacturer
- Solder connection
 - Suitable solder compositions
 - Soldering conditions
 - Solder tab peel strength (> 1 N per mm of solder tab)

Packageability of cells in a module shall be demonstrated through

- Passing IEC 61215 (ed. 2) in at least one package
- Passing IEC 61730 (part 2) in the same package as that of IEC 61215

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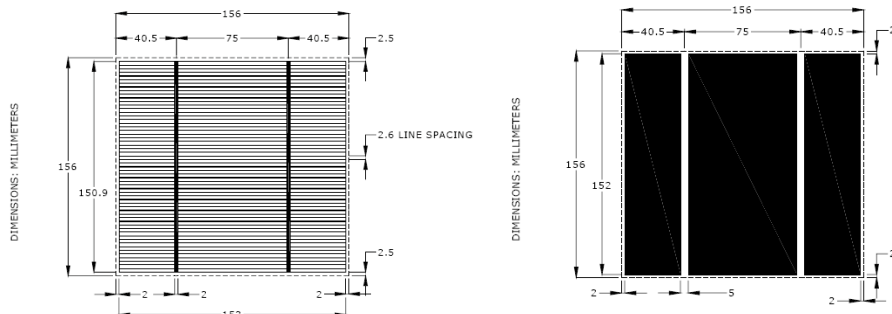
4. Cell characteristics

Purpose of the section:

To ensure that all datasheets related cell characteristics are included in the documentation

Non-performance related characteristics shall be provided which include

- Dimensions of the cell including tolerance
- Shape of cell (square, pseudo-square etc.)
- Extent of warping
- AR coating material and thickness
- Nominal series resistance
- Low shunt cut-off resistance
- Diagrammatic representation of metallization including busbars



4. Cell characteristics

Purpose of the section:

To ensure that all datasheets related cell characteristics are included in the documentation

Performance related characteristics shall be provided which include

- Light conditioning (> 5 kWh/m²)
- Performance parameters as shown in the table (next page)

	PERFORMANCE PARAMETER	SYMBOL (UNIT)	VALUE
	Short circuit current @ STC	I_{sc} (A)	
	Open circuit voltage @ STC	V_{oc} (V)	
	Current at maximum power @ STC	I_{mp} (A)	
	Voltage at maximum power @ STC	V_{mp} (V)	
	Maximum power @ STC	P_{mp} (W)	
	Fill factor @ STC	FF (%)	
	Cell efficiency @ STC	(%)	
	Cell efficiency tolerance @ STC	(%)	
TABLE 1	Production Tolerance @ STC	I_{sc} (%)	
		V_{oc} (%)	
		I_{mp} (%)	
		V_{mp} (%)	
		P_{mp} (%)	
Measurement Tolerance @ STC	I_{sc} (%)		
	V_{oc} (%)		
	I_{mp} (%)		
	V_{mp} (%)		
	P_{mp} (%)		
Temperature Coefficients @ STC	α_{sc} (%/°C)		
	β_{oc} (%/°C)		
	β_{mp} (%/°C)		
	δ_{mp} (%/°C)		
	ϵ_{sc} (%/°C)		
	Short circuit current @ 25°C, 200 W/m ²	I_{sc} (A)	
	Open circuit voltage @ 25°C, 200 W/m ²	V_{oc} (V)	
	Current at maximum power @ 25°C, 200 W/m ²	I_{mp} (A)	
	Voltage at maximum power @ 25°C, 200 W/m ²	V_{mp} (V)	
	Maximum power @ 25°C, 200 W/m ²	P_{mp} (W)	
	Fill factor @ 25°C, 200 W/m ²	FF (%)	
	Cell efficiency @ 25°C, 200 W/m ²	(%)	
	Reverse breakdown voltage	V	

5. Declaration letter/form for modifications

Purpose of the section:

To determine if the cell modifications warrant module design change or retesting of already qualified/certified modules

The declaration letter/form shall declare various parameters including...

Parameter	Changed? (YES/NO)	If yes, provide details
Manufacturing site of cells not under same QA system		
Cells from a different manufacturer		
Major reduction in cell thickness (> 25%)		
Metal lization m aterials and/or process		
AR coating materials		
Type of diffusion process		
Order of cell process		
Shape of cell		
Dimensions of cell		
Extent of warping		
Adhesion strength of surface layers		
Nominal series resistance		
Minimum shunt resistance		
Performance parameters of TABLE 1 etc. etc.		

6. Documentation

Purpose of the section:

To ensure a common, baseline ISO 17025 documentation procedure is followed

The documentation shall include at least the following information....

- Title & name and address of supplier
- All the parameters identified in sections of 2 through 4 of this standard
- Declaration letter/form for cell changes as identified in this standard
- Commitment letter to declare significant cell modifications
- Certificate of conformity for full compliance with specifications of this standard
- Test report and certificate meeting requirements of IEC 61215, IEC 61730 or their retest guidelines
- Name and address of test laboratory
- Any deviations from, additions to, or exclusions from this standard
- Measurements traceability as per ISO 17025 requirements
- Signature and title of the person(s) accepting the responsibility for the content of the report, and date of issue.
- Etc.

Current Status

SEMI standards group is currently considering to convert this Solar ABCs' report into a standard with appropriate format modifications.