

1 Crystal, chemical and material properties

Property	Specification	Control frequency	Measuring Method	References
Crystal Growing method	CZ	-	-	-
Crystal Structure	Mono-crystalline	-	-	-
Crystal Orientation	<-1-0-0> +/- 3°	-	-	-
Conductivity Type	N-type	Each block	-	-
Dopant	Phosphorus	-	-	-
Oxygen Concentration ¹	$\leq 9,0 \times 10^{17}$ atoms/cm ³ [≤ 18 ppm]	Each mother ingot - center value, seed and tail	FTIR	(new) ASTM F121 - 83
Carbon Concentration ²	$\leq 5,0 \times 10^{16}$ atoms/cm ³ [$\leq 1,0$ ppm]	Each mother ingot - center value, seed and tail	FTIR	ASTM F1391-93a

2 Electrical and Chemical properties

Property	Specification	Control frequency	Measuring Method	References
Specific Resistivity ³	1,0 - 6,0 Ohmcm	Each mother ingot - center value, seed and tail	4-point probe	ASTM F84
Bulk Lifetime ⁴	$\geq 1000 \mu\text{s}$	Each mother ingot - surface value, seed and tail	Sinton	Transient
Defects ⁵	No slip lines	Each mother ingot - seed and tail	PL camera	BT Imaging LIS-RI

3 Geometry

Property	Specification	Control frequency	Measuring Method	References
Ingot overall shape	Pseudo square	100% - All blocks	Visual	-
Ingot Diagonal	210 mm +/- 0.25 mm	100% - All blocks	Caliper and Vision system	Intego DRION
Ingot Dimensions	156.75 mm +/- 0.25 mm	100% - All blocks	Caliper and Vision system	Intego DRION
Corner length	8.5 mm +/- 0.5 mm	100% - All blocks	Caliper and Vision system	Intego DRION
Angle between sides [Φ]	90° +/- 0.2°	100% - All blocks	Caliper and Vision system	Intego DRION
Perpendicularity	90° +/- 0.2°	100% - All blocks	Caliper and Vision system	Intego DRION
Block length	180 - 500 mm usable length	100% - All blocks	Caliper and Vision system	Intego DRION

4 Surface Properties

Property	Specification	Control frequency	Measuring Method	References
Ingot surface	As polished block	100% - All blocks	Visual	0

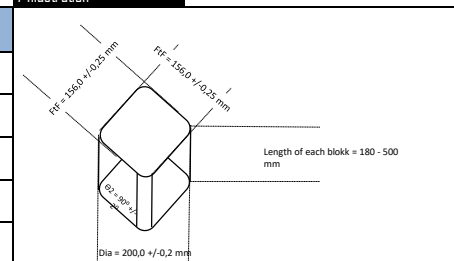
5 Appearance

Property	Specification	Control frequency	Measuring Method	References
Edge Defect	Length $\leq 0,3$ mm, Width $\leq 0,3$ mm	100% - All blocks	Vision system	Intego DRION
Surface Chipping	Length $\leq 0,3$ mm, Width $\leq 0,3$ mm	100% - All blocks	Vision system	Intego DRION
Crack	No cracks w/ size > 1 mm	100% - All blocks	Vision system	Intego DRION

6 Packaging

Property	Specification
Traceability	All lot is identified with a lot number.
Documentation	C of A pr block/lot. Di, C, Res, Lifetime, line defects/slip, Rz
Packaging method	Wood material outside and inside with stable support
Labelling on wooden box	Lot number, specification and shipment number
Labelling /marking on ingot	Lot number and specification

7 Illustration



8 Explanations

- Oxygen is measured on 1,5 mm test wafer using FTIR (after Thermal donor removal) - Measurement is done in center - Average of 5 measurements.
Note: Oxygen conc. is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for oxygen analysis. Oxygen is not characterized on prime solar wafers.
- Carbon is measured on 1,5 mm test wafer using FTIR (after Thermal donor removal) - Measurement is done in center - Average of 5 measurements.
Note: Carbon conc. is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for carbon analysis. Carbon is not characterized on prime solar wafers.
- Specific resistivity is measured on 1,5 mm test wafer by using 4-point probe after thermal donor removal (single wafer annealing, 750°C, 120 sec cyclus, Ar-atmosphere)
Note: Resistivity is guaranteed to the customer specification at crystal growing inspection using test samples specifically prepared for resistivity analysis. Resistivity is not characterized on prime solar wafers.
- Bulk lifetime is measured on as cropped (i.e as squared) surface with Sinton BCT-0087 or BCT-210 equipment. Transient method is used for all values.
Specific Minority Carrier Density [cm⁻³] is measured @ 1,4 x 10¹⁵ (characteristic for n-type).
- Slip - lines is controlled 100% by PL camera
- All chip length will be withdrawn from the total length and not included in the accepted length.