

PV-FZ™ - FLOAT ZONE SILICON SHAPED FOR THE PV INDUSTRY

- solutions for high efficiency, cost effective silicon solar cells

The development of silicon solar cells with efficiencies above 20% is a key issue in the Photovoltaic Roadmap. The Roadmap calls for 20% efficient silicon solar cells modules by the end of 2004. This will mean that present process technology and silicon material for achievement of high efficiencies must be reviewed. The most viable solution to the problem of getting a stable, high efficiency and low cost cell is to use monocrystalline silicon material with a high minority carrier lifetime in the bulk (hereafter referred to as the bulk lifetime) and low amounts of performance degrading impurities.

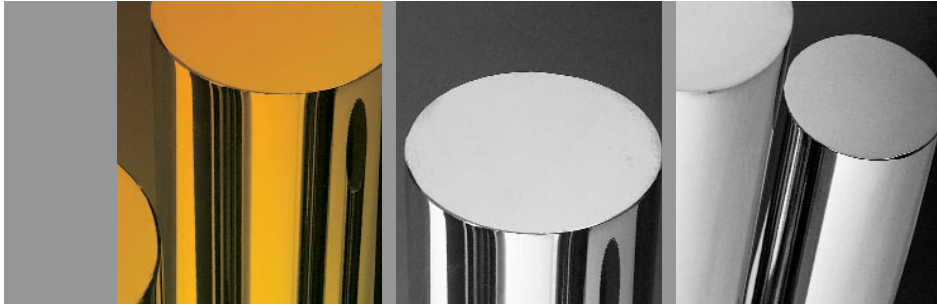
Cost effective process technology (CEPT) is the keyword in present solar cell module manufacturing. CEPT requirements is best met using screen printing technologies and Al back surface field (BSF) processing technologies in uncontrolled processing environments. None of these technologies does support high bulk lifetimes, but they are used for almost every commercially available silicon solar cell module. For that reason the monocrystalline silicon material is normally unspecified or have low values of specification with respect to the bulk lifetime. There is no extra gain in efficiency from choosing a high bulk lifetime silicon material, because the processing will have a negative impact on the lifetime and thereby make the cell efficiency the same as the cell efficiency for the lower grade silicon material.

Process technologies for maintaining a high bulk lifetime throughout the processing of the solar cells are considered costly and processing is normally performed in clean room environments. Indeed, a large number of solar cell developers have cost effective process recipes that does not severely impact the bulk lifetime, but they are using expensive electronic grade silicon to demonstrate the efficiency gain coming from their improved process.

PV-FZ™ silicon material will form the basis for the next generation of silicon solar cell modules supporting the ongoing development of stable, high efficiency and cost effective silicon solar cells. PV-FZ™ has been developed to meet both the material requirements and the cost levels required;

- **High minority carrier lifetime**
- **Low levels of performance degrading impurities**
- **Tight resistivity tolerances**
- **Cost competitive to CZ for the PV industry**

Float Zone silicon has generated the highest efficiencies ever measured for silicon solar cells. PV-FZ™ silicon have these superior material properties and will be used to set new standards in terms of efficiency and stability of silicon solar cells modules.



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Topsil is a world leading supplier of float zone silicon for a number of applications. Focus on R&D at Topsil have resulted in products with the best performances ever measured on silicon wafers. This combined with more than 40 years of experience in the production of float zone material and state-of-the-art wafering processes makes PV-FZ™ silicon the best choice for a stable, high efficiency and cost effective solar cell device.

Topsil offers Float Zone ingot and wafer substrates with the listed parameters. Other parameters than those in the table are possible on request.

Growth method	PV-FZ™ Float Zone
Minority carrier lifetime	100-6000 μs depending on bulk resistivity
Bulk resistivity	0.5-30 Ωcm
Resistivity tolerance	±20%
Ingot Diameter	5" - 6"
Crystal Orientation	<100>
Type and Dopant	N (phosphorous), P (boron)
Oxygen and Carbon concentration	< 10 ¹⁶ cm ⁻³
Wafer geometry	Semi-square, round
Wafer thickness	225-300 μm
Wafer surface finish	wire cut

The Topsil R&D group is focused on developing new processes for future float zone products by use of simulation software. Modelling of crystal growth is complex, but Topsil has developed a proprietary knowledge in close cooperation with costumers requiring high quality silicon material with superior control of dopant contents and distribution in the crystal.