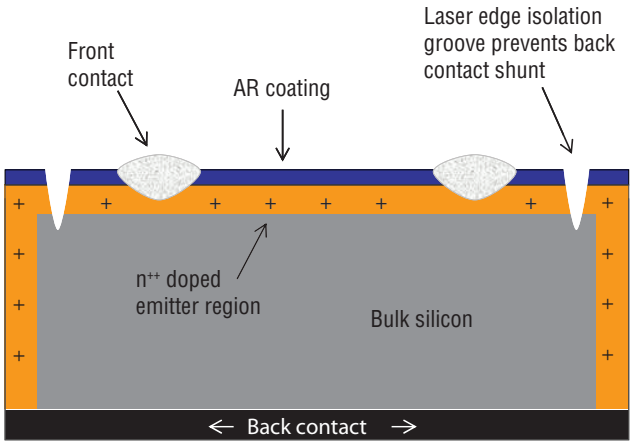
Laser Edge Isolation Scribing for Crystalline Silicon Solar Cell Production

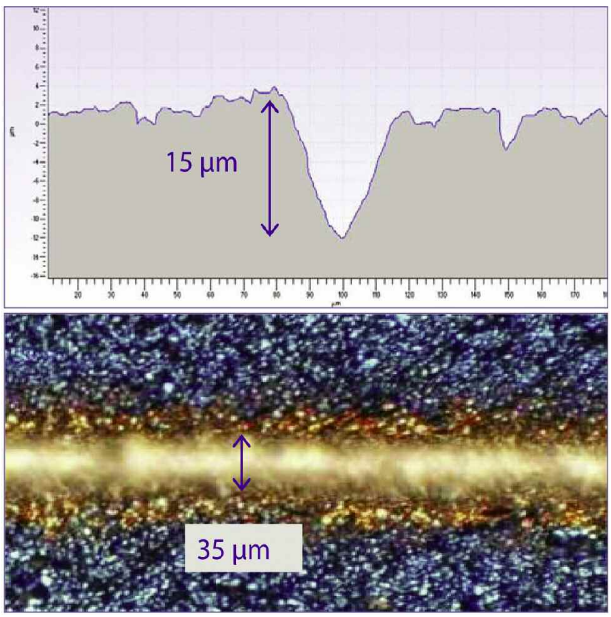
With steady growth in c-Si solar cell production, lasers continue to be considered for improving cell performance or lowering manufacturing costs. Growth areas for laser processing include laser-fired contacts (LFC), laser-grooved buried contact (LGBC), and metal/emitter wrap-through (M/EWT). One very common laser process used extensively in c-Si solar cell manufacturing is laser edge isolation.

The need for edge isolation arises from the ion doping/diffusion step of the c-Si cell manufacturing process, in which a shallow (~μm's) layer of the bulk p-type silicon is infused with negatively doped ions. This doped region surrounds the entire wafer, and causes electrical shunting between the front and back electrical contacts without the isolation scribe.

Laser edge isolation is typically achieved by scribing a groove around the perimeter of the solar cell, as close to the edge of the wafer as possible. The groove depth must extend some distance beyond the ion diffusion layer in order to give the best result. Typical groove dimensions are 20–40 μm wide x 10–20 μm deep. While a variety of Spectra-Physics' laser products are up to the task, highest-speed and best-quality edge isolation scribing requires the latest Q-switched diode-pumped solid state (DPSS) laser technology, such as the Pulseo® 355-20.



Without edge isolation groove, current shunt occurs between front and back contact through the ion diffusion layer



Depth profile (top) and microscope photo of edge isolation groove machined with Pulseo 355-20 laser system.

With a 355 nm wavelength and <23 ns short pulse width, the Pulseo laser is an ideal candidate for this process. Laboratory tests have show that, when coupled with high-speed scanning galvanometer technology, edge isolation times for the Pulseo 355-20 are in the 1–2 second range for 156 mm wafers. Depending on the system optical design (spot size, etc.), isolation scribes can be machined at speeds from 500–1000 mm/sec or higher.

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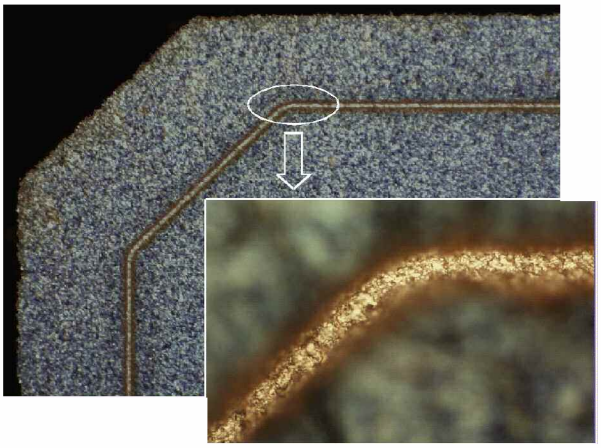
For laser edge isolation, the Pulseo UV laser offers very high precision due to the short pulse duration and the very shallow absorption depth in silicon of the 355 nm wavelength. As an alternative, a 532 nm wavelength laser can also be used while still maintaining good speed and quality.

For the "green" option, we offer the Pulseo 532-34—a high-power Q-switched laser system. When combined with a galvo scanner, high-speed cornering with minimal "burn-in" is achieved. And with excellent power and performance at 120 kHz pulse repetition frequency and beyond, a smooth scribe floor is machined even with high speeds and small focus spot sizes. The shorter pulse widths coupled with low energy / high rep rate laser output provides very clean and effective isolation scribes.



Low- and high-magnification optical microscope images of 532-nm laser edge isolation scribe

Product: Pulseo Laser

The Spectra-Physics Pulseo laser family continues the tradition of high power, high repetition rate Q-switched DPSS laser products. With high peak power, short-pulse width, and high-quality manufacturing, the Pulseo line is ideal for demanding industrial applications that require a high degree of precision.

Model	Wavelength	Peak Power	Average Power	Pulse Width	Repetition Rate (nominal)
Pulseo 532-34	532 nm	>13.5 kW	>34 W	<30 ns at 120 kHz	120 kHz
Pulseo 355-20	355 nm	~10 kW	>20 W	<23 ns at 100 kHz	100 kHz
Pulseo 355-10	355 nm	~5 kW	>10 W	<23 ns at 90 kHz	90 kHz

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