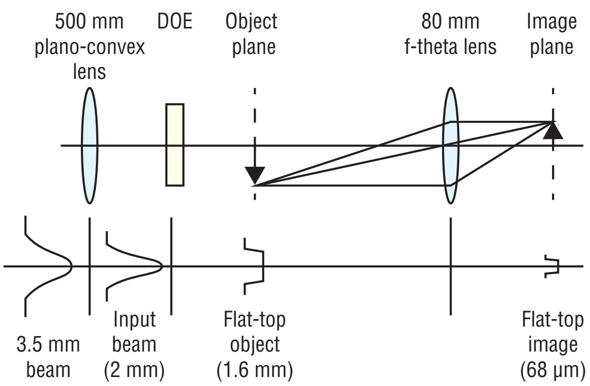
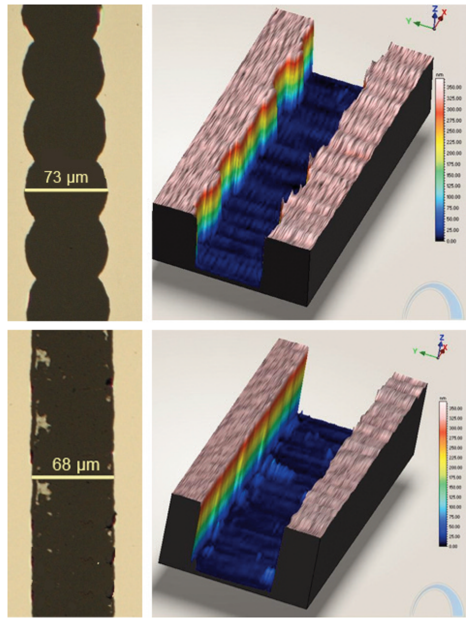
Gaussian Versus Flat-top Beam Processing

Laser processes have proven to be a major contributor in reducing manufacturing cost while increasing the efficiency of solar cells. Laser scribing of various thin film materials is a key process in manufacturing thin film solar cells. From a manufacturing perspective, there is a need for a robust integrated laser scribing system to accommodate 1–3 mm depth variations of large size glass solar panels while maintaining the quality of scribes.

In recent years, diode-pumped solid state (DPSS) Q-switched lasers are the most widely used lasers for P1, P2, and P3 scribe processes. This article highlights the results from our recent study about the effects of laser beam shape (Gaussian versus flat-top) on process depth of focus. In this study, the scribe process involves micromachining of ~70 µm wide scribes on ~300 nm thick Molybdenum thin film deposited on a glass substrate at various defocus planes.



Schematic illustration of flat-top experimental optical setup and intensity distribution



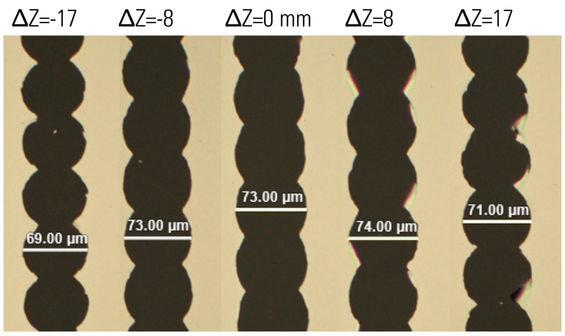
Gaussian machining (top) and flat-top machining (bottom) microscope image and 3D depth profile trace

With the Spectra-Physics Pulseo® 532-34 laser system operated at 100 kHz, we achieved using a Gaussian beam shape, ~70 µm wide scribes at a scribe speed of 6 m/sec, and using a flat-top beam shape ~68 µm wide scribes at 5.6 m/sec.

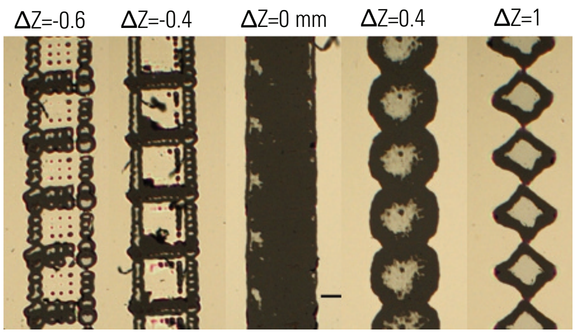
We characterized the process depth of focus in terms of quality and electrical resistance of the scribes. High quality scribes were achieved within ±17 mm defocus range using Gaussian beam machining whereas only <±1 mm defocus range was observed while flat-top beam machining was used. Electrical resistance of scribes at various defocus planes was measured to determine electrical isolation of scribes. In case of Gaussian beam machining, all the scribes within ±17 mm defocus range showed good electrical isolation whereas in case of flat-top machining, scribes only within <0.5 mm defocus range were electrically isolating.

Spectra-Physics®
A Newport Corporation Brand

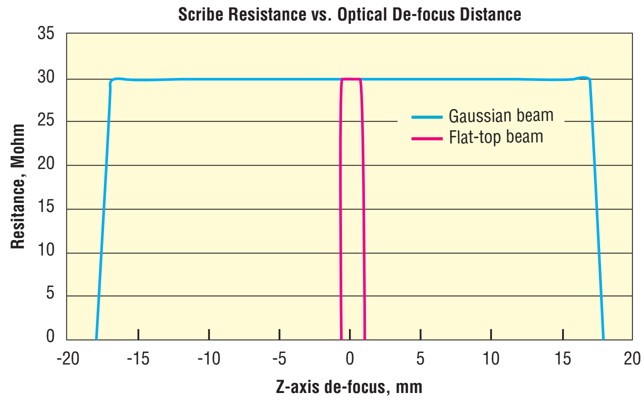
Gaussian Versus Flat-top Beam Processing



Microscope pictures of Gaussian beam scribes at different defocus positions (ΔZ) w.r.t focal plane showing quality of scribes



Microscope pictures of flat-top beam scribes at different defocus positions (ΔZ) w.r.t flat-top plane showing quality of scribes



Electrical resistance measurement of scribes processed at various defocus positions

While both Gaussian and flat-top laser beam shapes can produce high quality electrically isolating scribes, a very limited process depth of focus tolerance exists for flat-top beam scribing process. This is undesirable from a system design perspective since systems are commonly required to accommodate up to 1–3 mm variations associated with processing of large glass panels with thickness variations and other system tolerances. With Gaussian DPSS laser beams, once acceptable process parameters are defined, the process window is large and can accommodate large process defocus variations for high yield, low cost laser scribing.

Product: Spectra-Physics DPSS Q-Switched Lasers

Spectra-Physics is a leading supplier of DPSS Q-switched lasers. Our lasers deliver superior reliability and are proven in demanding 24/7 industrial applications. With one of the broadest portfolios of Q-switched lasers in the industry and a deep applications expertise, we can help you find the right laser solution for your industrial applications.

Power	1064 nm	532 nm	355 nm/349 nm	266 nm
0.5 W		Explorer	Explorer	
1 W			Tristar Navigator	
2 W				HIPPO
3 W		Explorer XP Navigator		
4 W				
5 W	Navigator		HIPPO	
6 W		Navigator		
7 W				
8 W				
9 W				
10 W			Pulseo	
11 W		Mosaic, HIPPO		
12 W				
15 W		HIPPO		
17 W	HIPPO			
20 W			Pulseo	
27 W	HIPPO			
34 W		Pulseo		

Spectra-Physics® Lasers Sales
1-800-775-5273 sales@spectra-physics.com
www.newport.com/spectra-physics