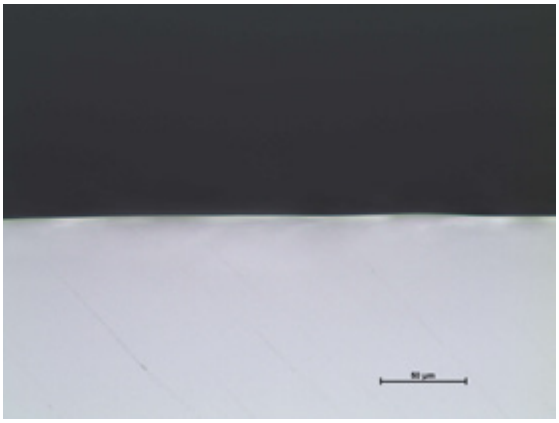
Glass Cutting and Silicon Scribing Excel with Quasar® TimeShift™ Technology

In manufacturing processes for today's consumer electronics devices, lasers have played an important role in driving up manufacturing yields and throughput while driving down costs. While today's UV Q-switched DPSS lasers have met manufacturing demands thus far, they do have limitations in achieving higher speeds. This is because the output power decreases and pulse width increases significantly with increasing pulse repetition frequency (PRF). To overcome this limitation, Spectra-Physics developed the Quasar® high power UV hybrid fiber laser. It has a unique combination of higher power at higher PRF along with TimeShift™ technology that enables advanced features such as software-adjustable pulse width, pulse splitting, and pulse shaping. Quasar provides >40 W output power at PRF of 250 kHz, while maintaining pulse width of 10 ns. With proper parameter optimization, high quality and high throughput can be achieved with this unique UV nanosecond pulsed laser source. The processing benefits of the Quasar UV laser have been demonstrated in two common microelectronic materials – silicon and glass.

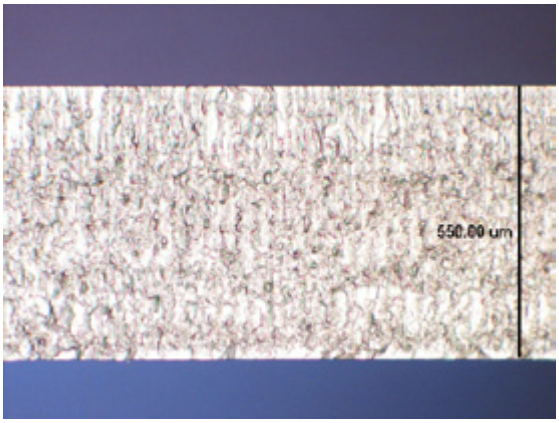
GLASS CUTTING WITH QUASAR

In Spectra-Physics' applications lab studies, Quasar's unique TimeShift technology has enabled clean quality linear cuts at high throughput on 0.55 mm thick display glass. Control of pulse temporal characteristics, made possible by the TimeShift technology, facilitates tailoring of the individual laser pulses to reduce thermal loading and hence chipping and cracking in the material. This has also resulted in good quality cuts at faster scanning speeds, improving overall processing throughput. We achieved linear cutting speed of 1 m/sec, highly desired in the manufacturing process.

Glass Cutting with Quasar



TOP VIEW
Top view of the cut edge shows a clean cut quality with minimal chipping (<10 µm).



SIDE VIEW
Side view of the cut edge shows roughness within the acceptable range of typical manufacturing requirements.

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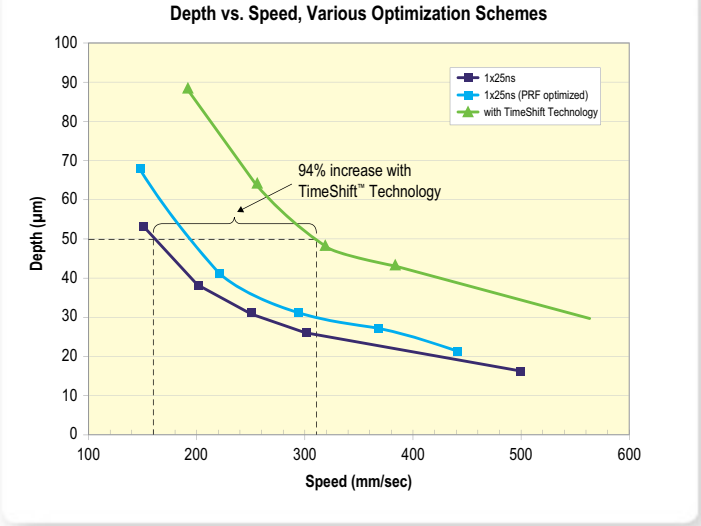
Glass Cutting and Silicon Scribing with Quasar

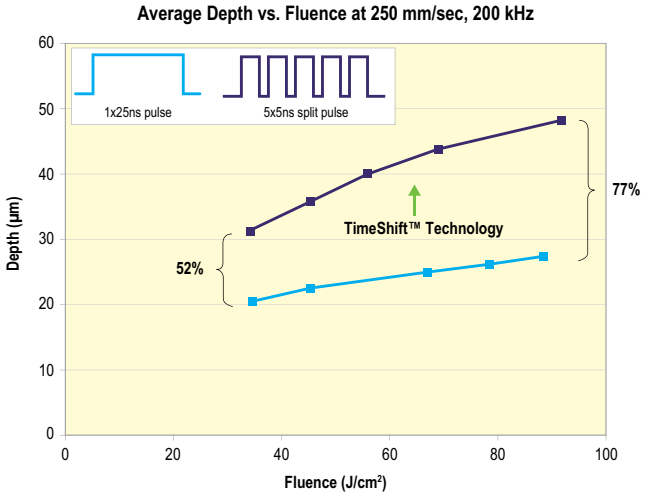
SILICON SCRIBING WITH QUASAR

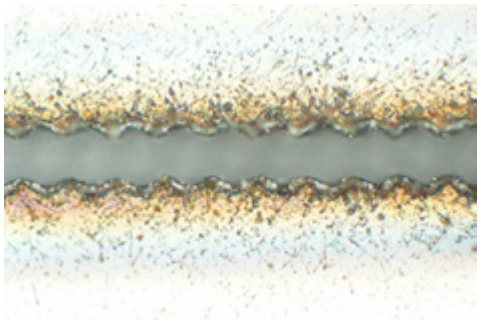
The Quasar UV laser was used to scribe ~100 µm thick polished single crystal (<100>) silicon wafers. Very high scribing speeds were achieved while avoiding thermal damage to the material. Using TimeShift technology to maintain the same 50 µm scribe depth, a single 25 ns pulse at high PRF of 300 kHz and a burst of pulses (10 sub-pulses of 5 ns, separated by 10 ns) repeated at 255 kHz frequency, increased the scribe speed as compared to a baseline single 25 ns pulse width at 200 kHz PRF process. Further additional improvement is possible by optimizing other TimeShift features such as adjustable pulse width and pulse shape.

To show the advantage of TimeShift technology's pulse splitting capability, we generated laser scribes at same scribe speed and PRF for various fluence levels. Two sets of data were collected; one with a pulse output of a single 25 ns pulse, and one with a burst of five 5 ns sub-pulses separated by 10 ns. Scribe depth data shows the clear advantage of using pulse splitting burst micromachining over single pulse machining. An increase in ablation depth between 52% and 77% was observed depending on the fluence level. We also observed improvement in quality of split pulse scribe.

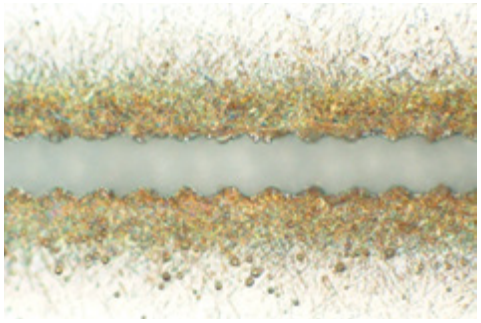


Silicon Scribing with Quasar





SPLIT PULSE SCRIBE



SINGLE PULSE SCRIBE

The visual appearance of debris and HAZ for the two cases shows that split pulse burst-mode scribe have higher quality with less loose debris on the top surface.

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