



## Application Note AN003

### Laser Induced Damage Threshold Performance

Revision 1v0, 21 October 2013



## **SUMMARY**

This application note analyses the laser damage threshold performance of a UV-fused silica substrate after processing at PowerPhotonic. PowerPhotonic's unique laser micro-machining process uses a two-step process to cut and smooth the desired optical surface shape. The laser smoothing process leaves the surface atomically smooth resulting in exceptional damage threshold performance.

The measurements were done with an uncoated optic to determine the intrinsic performance of PowerPhotonic's UV-fused silica substrates. The results show that the UV-fused silica optic was able to withstand  $>5\text{GW}/\text{cm}^2$  for short pulses at 1064nm.

## **METHOD**

The laser damage threshold test was performed in general compliance with the ISO 21254 specification. The laser used in these measurements has a Gaussian profile in the focal plane.

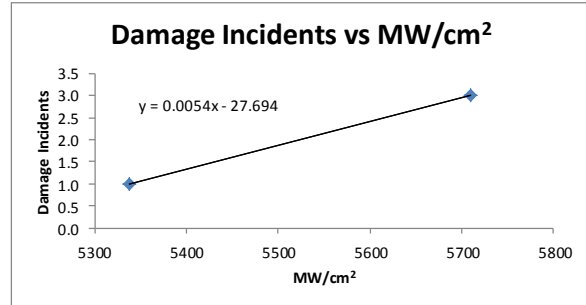
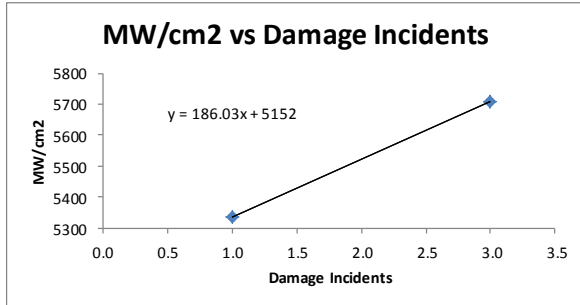
The UV-fused silica substrate sample was irradiated numerous times using a small beam over the clear aperture of the sample. 10 sites were irradiated at each fluence of irradiance level. The sample was observed using a microscope at up to 500x to determine if the laser irradiation had physically altered the substrate surface.

The sample was mounted in a configuration that allowed it to be moved from the microscope focal plane to the laser beam using a series of high accuracy motorized translation stages. The sample was observed with the microscope, moved to the beam and irradiated. The sample was then returned to the microscope and inspected.

The testing was done with a short-pulse laser, of pulsewidth 20ns and wavelength 1064nm.

The results were taken on 16<sup>th</sup> July 2013.

**LASER DAMAGE THRESHOLD RESULTS**



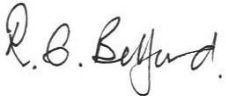
	Damage Incidents	MW/cm <sup>2</sup>	J/cm <sup>2</sup>
Row 1	0	506.2	10.12
Row 2	0	1017.7	20.35
Row 3	0	1505.1	30.10
Row 4	0	2007.3	40.15
Row 5	0	2942.6	58.85
Row 6	0	4064.7	81.29
Row 7	0	4289.4	85.79
Row 8	0	4569.3	91.39
Row 9	1	5338.0	106.76
Row 10	3	5710.1	114.20

Additional testing at higher power levels was not undertaken due to the likely damage to the test equipment.

Based on these test results, the PowerPhotonic UV-fused silica optic with no AR coating has a laser damage threshold of 5,152MW/cm<sup>2</sup> or 103.0J/cm<sup>2</sup>.

In typical applications, the laser damage threshold of the optic is very likely going to be determined by the performance of the anti-reflectance coating and not the substrate itself.

**Appendix 1: Damage Certification Summary**

<h1>BRL</h1>				
BELFORD RESEARCH LTD				
Physical Electronics- Materials and Energy				
Company Number 348121 Registered in Scotland VAT Reg. No.105 1655 47				
LIDT - Damage Certification Summary				
Customer	PowerPhonic		PO #	1751
Date:	16.07.2013	Lot #	1	Job # 13-66 PP 1
Angle:	0	Pol:	Linear	HR/AR AR
Test Type S-on-1	Pre Clean	Air	Vis Inspection: perfect	
Inspection and LIDT Results				
Lot No.	Customer Sample No.	Parameters	Laser Induced Damage Threshold	
			MW/cm <sup>2</sup>	J/cm <sup>2</sup>
1	2147 00-324	20 Hz 20 ns	5152	103.04
Details Extremely good sample.				
Microscopy:			Laser Spot Log and Size:	
Tested by:		Comments:		
				
BRL certifies that LIDT has been conducted in general accordance with ISO Standards 21254-1; 21254-2; 21254-3 and ISO-TR-21254-4 2011 All instrument calibration is traceable to NIST.				
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