LIDARIS
LIDT Service

LASER-INDUCED DAMAGE THRESHOLD (LIDT) MEASUREMENT REPORT

LIDARIS' RASTER SCAN TEST PROCEDURE

SAMPLE: SAMPLE

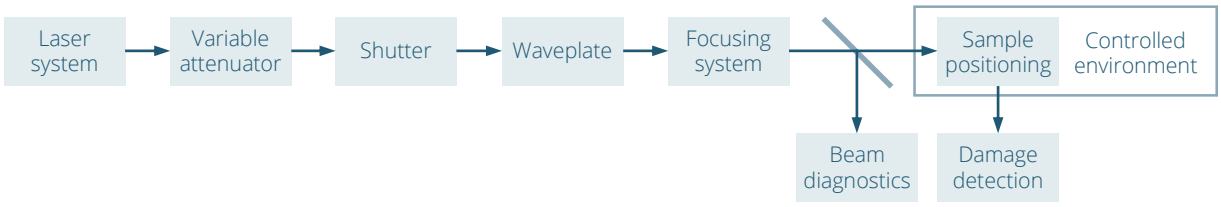
Request from	
Address	Company Address Line 1 Address Line 2 Country
Contact person	Name Surname
Inquiry ID	Inquiry ID: 0001
Purchase order	-

Testing institute	
Address	UAB Lidaris Saulėtekio al. 10 10223 Vilnius Lithuania
Tester	Name Surname
Test date	01/01/2025
Sale order	SO0001
Test ID	-

Specimen	
Name	Sample
Type	AR Coating
Dimensions	Ø25.4 x 6.4 mm
Packaging	Plastic box

TEST EQUIPMENT

Test setup

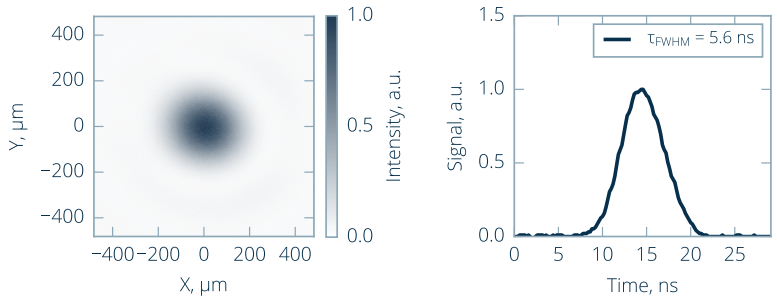


Laser and its parameters

Type	Q-switched, seeded Nd:YAG
Manufacturer	InnoLas Laser II
Model	SpitLight Hybrid
Central wavelength	532.0 nm
Angle of incidence	0.0 deg
Polarization state	Linear
Pulse repetition frequency	100 Hz
Spatial beam profile in target plane	TEM00
Beam diameter in target plane ($1/e^2$)	(401.9 ± 3.2) µm
Longitudinal pulse profile	Single longitudinal mode
Pulse duration (FWHM)	(5.6 ± 0.3) ns
Pulse to pulse energy stability (SD)	0.9 %

Energy/power meter

Manufacturer	Ophir
Model	PE50-DIF-C
Calibration due date	2027-12-31



(a) Beam profile (b) Pulse profile

Figure 1. Laser parameters used for measurements.

TEST SPECIFICATION

Definitions and test description

Laser-induced damage (LID) is defined as any permanent laser radiation induced change in the characteristics of the surface/bulk of the specimen which can be observed by an inspection technique and at a sensitivity related to the intended operation of the product concerned. [1]
LIDARIS' RASTER SCAN test procedure involves exposure of pre-defined surface region with spatially overlapping test sites so that 90% of onset peak fluence coverage is guaranteed.
For every new scan, the fluence is ramped up until damage criteria or maximum available peak fluence of the test system is reached.
Laser-induced damage threshold (LIDT) is defined as the average fluence of lowest observed damaged level and first undamaged level below.

Test specification

Area tested per scan level ($1/e^2$ beam intens. level)	1.01 cm^2
Area tested per scan level relative to clear aperture	19.94 %
Scan speed in x-direction	8.00 mm/s
Beam overlap in y-direction (90% intensity level)	80 %
First fluence level	0.580 J/cm^2
Fluence level step	20 % increase for every subsequent level
Fluence levels	25

Analysis information

Online detection	Scattered light diode
Offline detection	Nomarski microscope
Software version	0f7970e5

Test environment

Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	21.6 - 21.8 C
Humidity	24.1 - 25.2 %

Sample preparation

Storage before test	Normal laboratory conditions
Dust blow-off	None
Cleaning	None

[1] ISO 21254-1:2011: Lasers and laser-related equipment - Test methods for laser-induced damage threshold - Part 1: Definitions and general principles, International Organization for Standardization, Geneva, Switzerland (2011)

LIDT TEST RESULTS

LIDT VALUE

Lidaris' Raster Scan	$6.83\ ^{+0.83}_{-0.80}$ J/cm^2

Table 1: Evaluated Lidaris' Raster scan LIDT for sample Sample.

Analysed Threshold type	Threshold
Damage initiation	$6.83\ ^{+0.83}_{-0.80}$ J/cm^2
Catastrophic failure	$29.35\ ^{+3.56}_{-3.46}$ J/cm^2

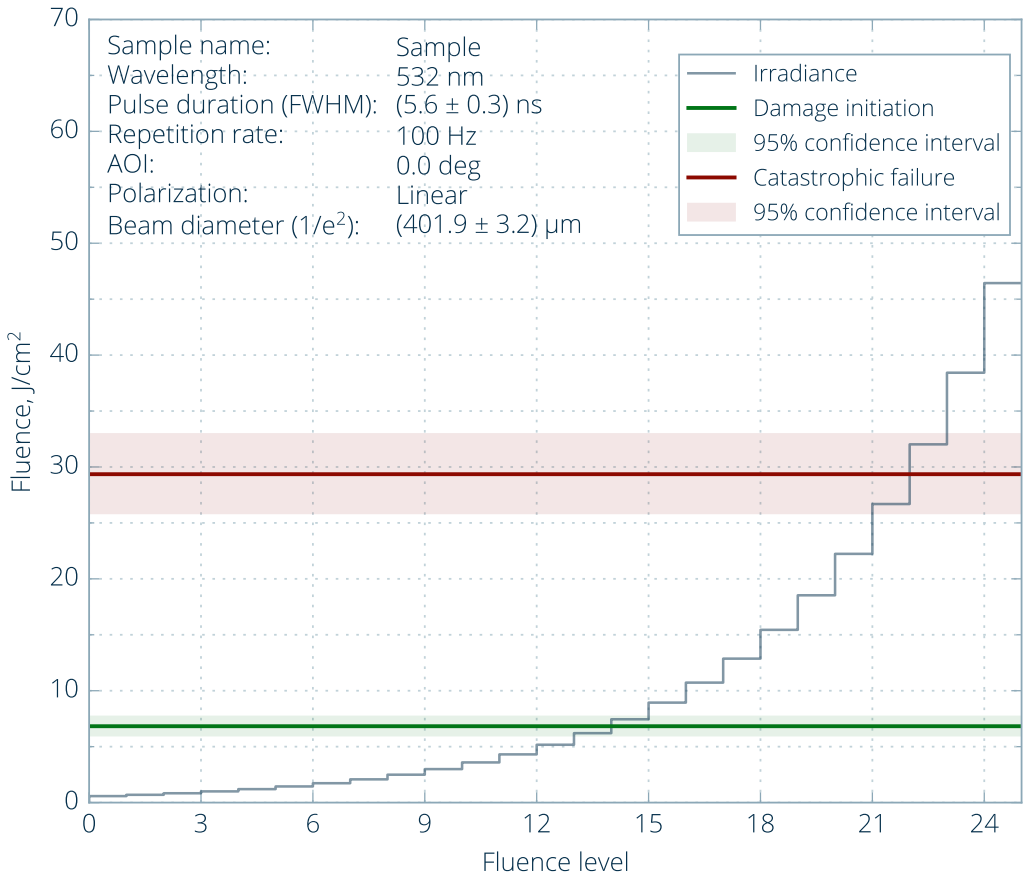


Figure 2. Raster scan test results.

NEW OBJECTS DISTRIBUTION

Microscopic images are taken before the test and after each new scan. All images are analyzed for new objects (defects). A figure of new object distribution displays the cumulative distribution of objects exceeding defined object size for each new scan level. New objects are defined as objects, that can be distinguished from surrounding area while applying various image analysis methods.

Due to variability in sample initial preparation condition (cleaning) and complexity in image analysis tools, there exists some "noise level" that can be seen at low fluence levels. At higher fluence levels, where counts of new objects increase exponentially, the majority of new objects can be attributed to laser-induced damages of ablation products. The cumulative sum of all found objects is calculated for each fluence level. The apparent area of the object is approximated with the circle and turned into the effective diameter. The size of the object is calculated as the diameter of that circle, independently of the shape of the object.

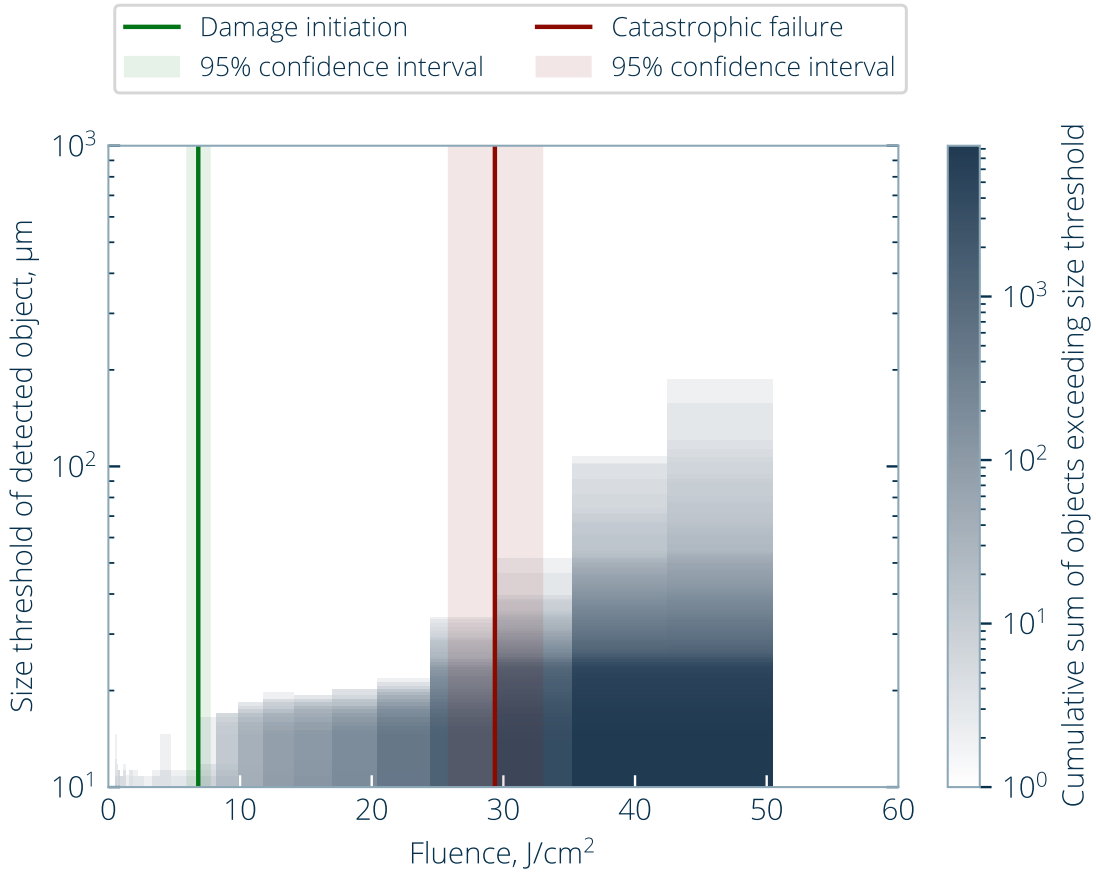


Figure 3. New objects distribution.

FLUENCE LEVELS

Table 2: Lidaris' Raster scan fluence levels for sample Sample.

Level	Fluence, J/cm^2	Status [2]
1	0.580	Passed
2	0.696	Passed
3	0.835	Passed
4	1.00	Passed
5	1.20	Passed
6	1.44	Passed
7	1.73	Passed
8	2.08	Passed
9	2.49	Passed
10	2.99	Passed
11	3.59	Passed
12	4.31	Passed
13	5.17	Passed
14	6.21	Passed
15	7.45	Damage initiation
16	8.94	Damage initiation
17	10.7	Damage initiation
18	12.9	Damage initiation
19	15.4	Damage initiation
20	18.5	Damage initiation
21	22.2	Damage initiation
22	26.7	Damage initiation
23	32.0	Catastrophic failure
24	38.4	Catastrophic failure
25	46.4	Catastrophic failure

[2] Read Technical Note 1

SCANNED SAMPLE AREA

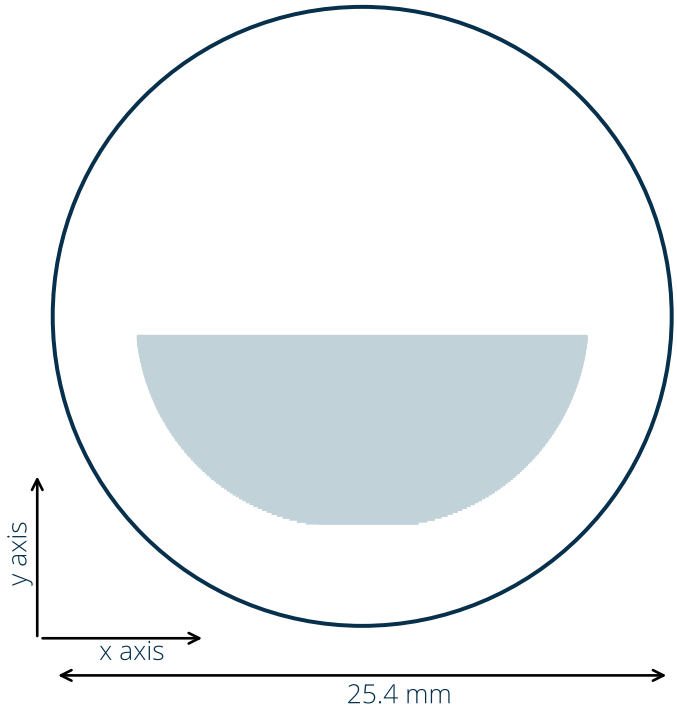


Figure 4. Scanned sample area.

TYPICAL DAMAGE MORPHOLOGY (INITIATION)

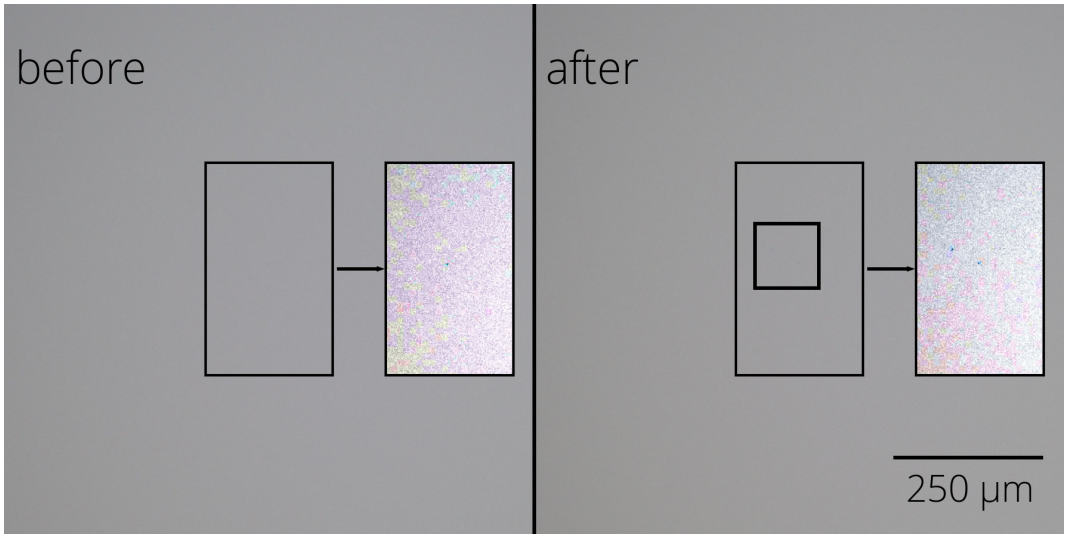


Figure 5. Typical damage morphology: fluence 7.448 J/cm^2. High contrast image.

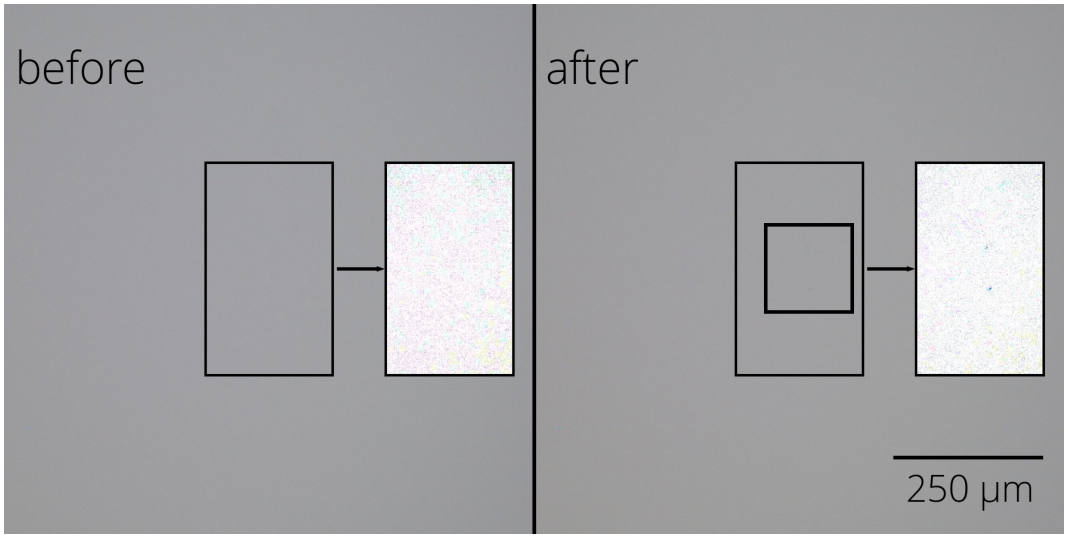


Figure 6. Typical damage morphology: fluence 10.724 J/cm^2. High contrast image.

TYPICAL DAMAGE MORPHOLOGY (CATASTROPHIC)

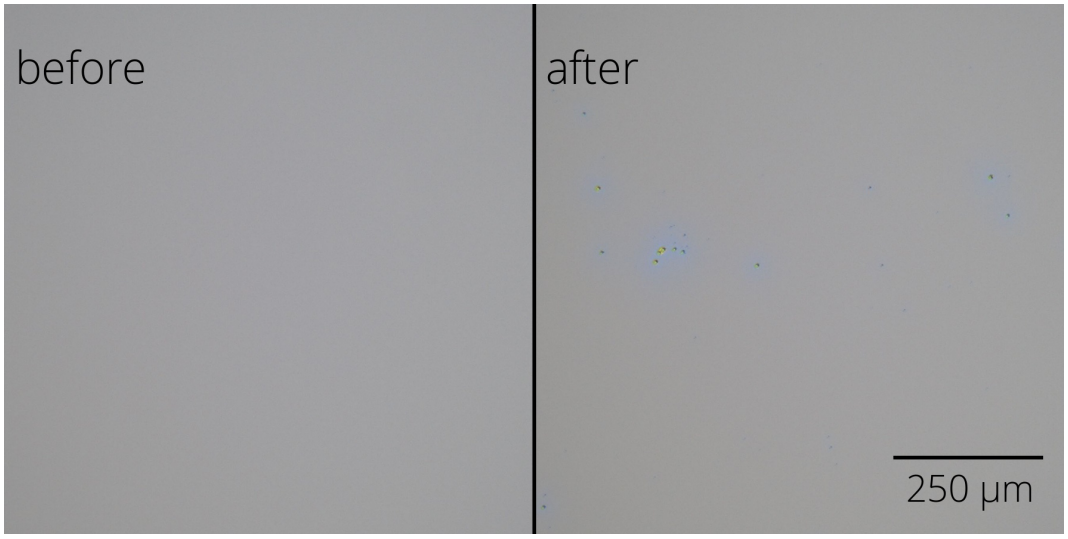


Figure 7. Typical damage morphology: fluence 32.022 J/cm^2.

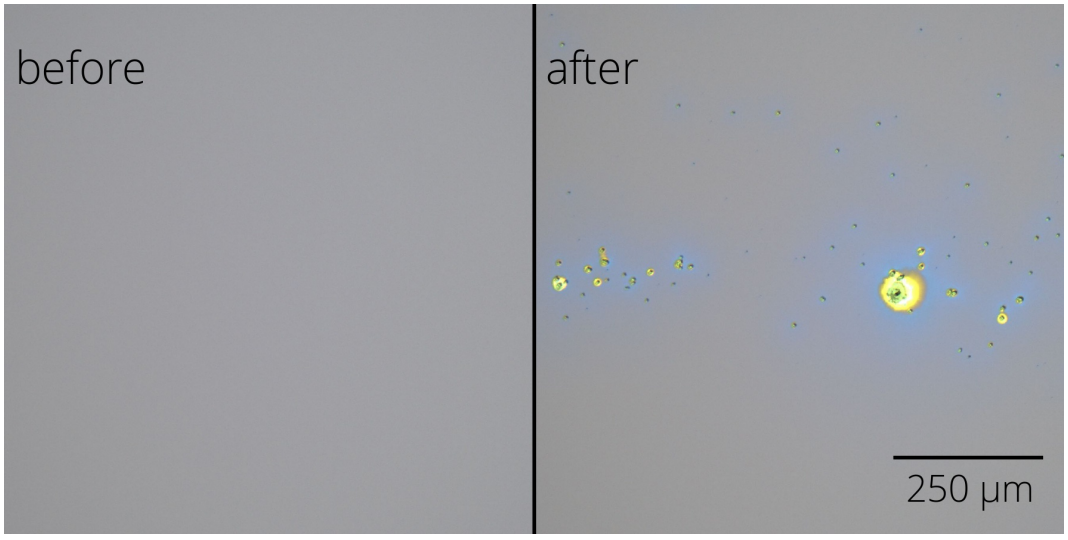


Figure 8. Typical damage morphology: fluence 46.436 J/cm^2.

TECHNICAL NOTES

TECHNICAL NOTE 1: Lidaris' Raster scan statuses

Performing Lidaris' Raster scan test scanned area is imaged with Nomarski microscope (10x) after each fluence level. Using additional image analysis tools each fluence level is labeled with one of the following statuses:

Passed – no apparent change in morphology was observed.

Laser cleaning – dust or other artificial object was cleaned with laser radiation and, as a result, sample surface might be affected by plasma scalding. It is assumed that sample survived specific fluence radiation.

Damage initiation – minor damages (small pin-points, smooth color changes, etc.) occurred. In general, they might not affect spatial properties of laser beam that irradiates the optical element but these damages can grow into further upon laser exposure.

Catastrophic failure – clearly observed damage that is bigger than 100 µm or the damage that experienced exponential or asymmetric growth after scanning the surface with higher fluences.