LIDARIS
LIDT Service

# LASER-INDUCED DAMAGE THRESHOLD (LIDT) MEASUREMENT REPORT

## S-ON-1 (ISO 21254-2) TEST PROCEDURE

### SAMPLE: SAMPLE

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## 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 | 01/01/2021 |
| Sale order | SO0001 |
| Test ID | - |

## Specimen

| | |
|---|---|
| Name | Sample |
| Type | AR Coating (1064nm) |
| Dimensions | Ø25.4 x 3.0 mm |
| Packaging | Plastic box |

# TEST EQUIPMENT

## Test setup

Laser system → Variable attenuator → Shutter → Waveplate → Focusing system → Sample positioning / Controlled environment

Beam diagnostics

Damage detection
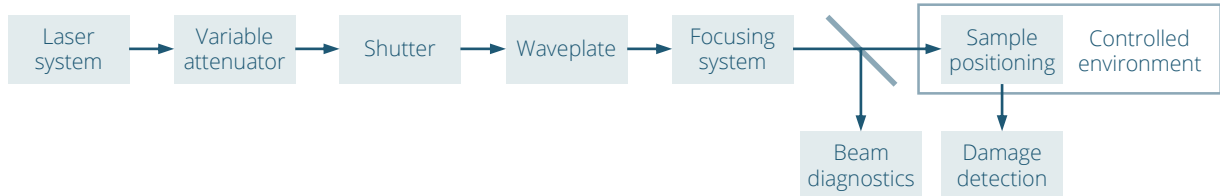
## Laser and its parameters

| | |
|---|---|
| Type | Q-switched, seeded Nd:YAG |
| Manufacturer | InnoLas Laser |
| Model | SpitLight Hybrid |
| Central wavelength | 1064.0 nm |
| Angle of incidence | 0.0 deg |
| Polarization state | Linear |
| Pulse repetition frequency | 20 Hz |
| Spatial beam profile in target plane | TEM00 |
| Beam diameter in target plane ($1/e^2$) | $(245.8 \pm 2.5)$ µm |
| Longitudinal pulse profile | Single longitudinal mode |
| Pulse duration (FWHM) | $(9.9 \pm 0.5)$ ns |
| Pulse to pulse energy stability (SD) | 1.4 % |

## Energy/power meter

| | |
|---|---|
| Manufacturer | Ophir |
| Model | PE50-DIF-C |
| Calibration due date | 2020-07-01 |



(a) Beam profile

(b) Pulse profile
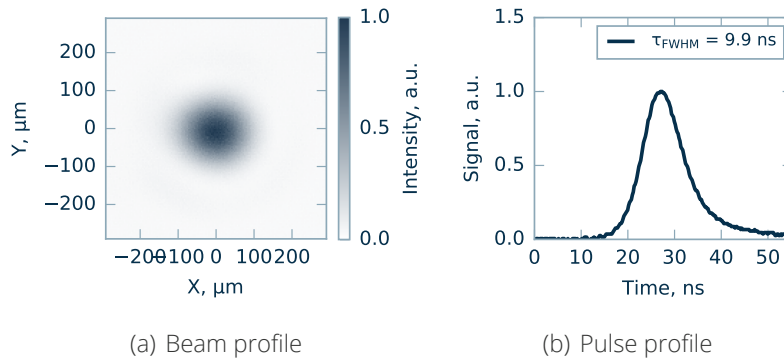
Figure 1. Laser parameters used for measurements.

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# 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. Laser-induced damage threshold (LIDT) is defined as the highest quantity of laser radiation incident upon the optical component for which the extrapolated probability of damage is zero. [1]

LID of the sample is investigated by performing a standardized S-on-1 test procedure.[2] LIDT value is determined by fitting experimental damage probability data with a model derived for a Poisson damage process assuming degenerate defect ensemble. [3]

## Test sites

| | |
|---|---|
| Number of sites | 420 |
| Arrangement of sites | Hexagonal |
| Minimum distance between sites | 900 µm |
| Maximum pulses per site | 1000 |

## Analysis information

| | |
|---|---|
| Online detection | Scattered light diode |
| Offline detection | Nomarski microscope |
| Software version | 75dc5d14 |

## Test environment

| | |
|---|---|
| Environment | Air |
| Cleanroom class (ISO 14644-1) | ISO7 |
| Pressure | 1 bar |
| Temperature | 25.4 - 26.0 C |
| Humidity | 28.4 - 31.8 % |

## Sample preparation

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

[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)
[2]ISO 21254-2:2011: Lasers and laser-related equipment - Test methods for laser-induced damage threshold - Part 2: Threshold determination, International Organization for Standardization, Geneva, Switzerland (2011)
[3]J. Porteus and S. Seitel, Absolute onset of optical surface damage using distributed defect ensembles, Applied Optics, 23(21), 3796–3805 (1984)

# LIDT TEST RESULTS

## LIDT VALUE

| $10^3$-on-1 | $10.91 ^{+0.77}_{-1.15}$ J/cm$^2$ |
|---|---|

## CHARACTERISTIC DAMAGE CURVE

Table 1: Estimated LIDTs from fiting model for sample Sample.

| Test mode | Threshold (Offline detection - microscopy) | Threshold (Online detection - scattering) |
|---|---|---|
| 1-on-1 | $21.73 ^{+1.65}_{-2.73}$ J/cm$^2$ | $22.46 ^{+1.02}_{-3.07}$ J/cm$^2$ |
| 10-on-1 | - | $14.67 ^{+1.11}_{-1.62}$ J/cm$^2$ |
| $10^2$-on-1 | - | $11.51 ^{+0.36}_{-1.27}$ J/cm$^2$ |
| $10^3$-on-1 | $10.91 ^{+0.77}_{-1.15}$ J/cm$^2$ | $11.51 ^{+0.36}_{-1.33}$ J/cm$^2$ |

Sample name: Sample
Wavelength: 1064 nm
Pulse duration (FWHM): (9.9 ± 0.5) ns
Repetition rate: 100 Hz
AOI: 0.0 deg
Polarization: Linear
Beam diameter (1/e$^2$): (245.8 ± 2.5) µm
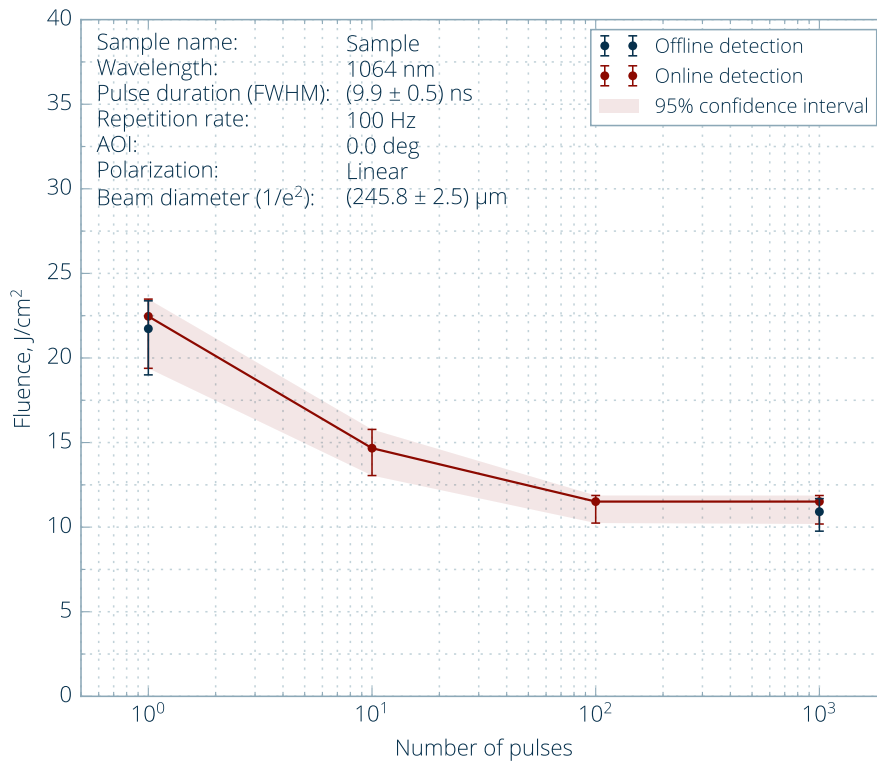
Figure 2. Characteristic damage curve.

# DAMAGE PROBABILITY
## (OFFLINE DETECTION)
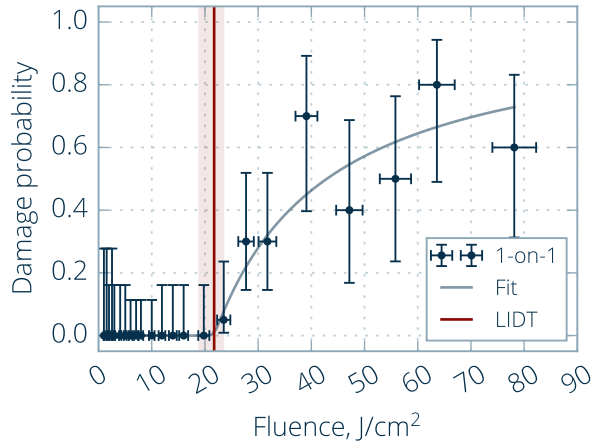


(a) 1-on-1
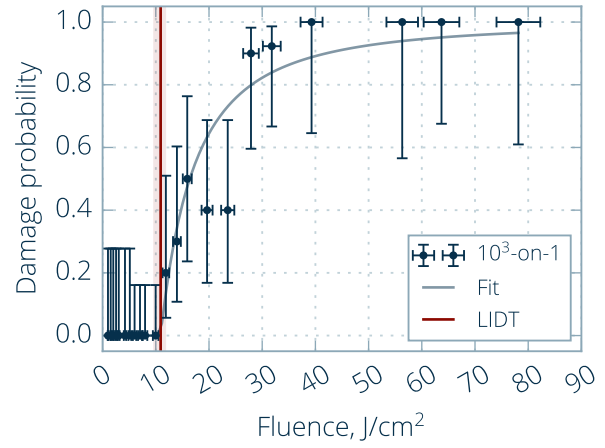
(b) $10^3$-on-1

Figure 3. Damage probability plots.
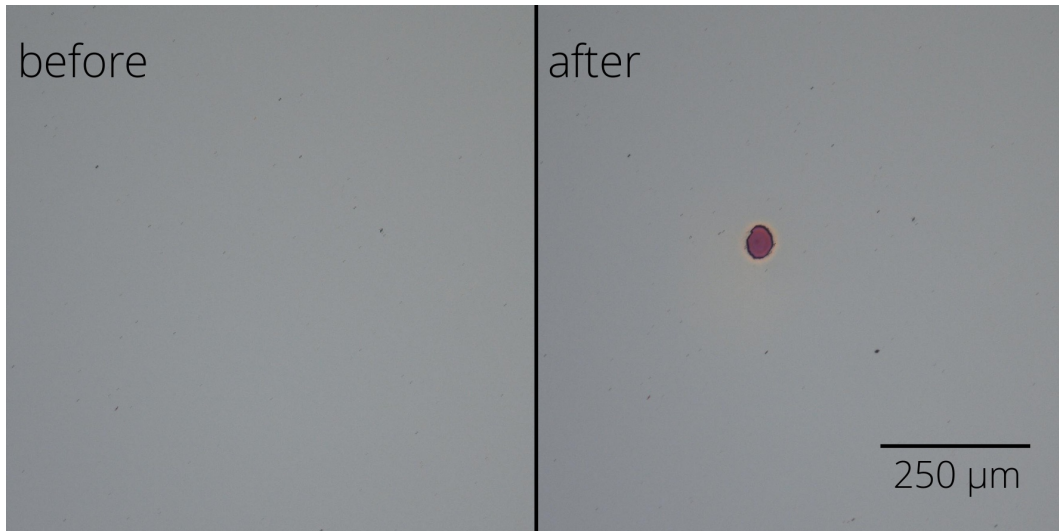
# TYPICAL DAMAGE MORPHOLOGY
## (OFFLINE DETECTION)



before    after

250 µm

Figure 4. Typical damage morphology: fluence 11.9 J/cm$^2$, damage after 640 pulse(s).
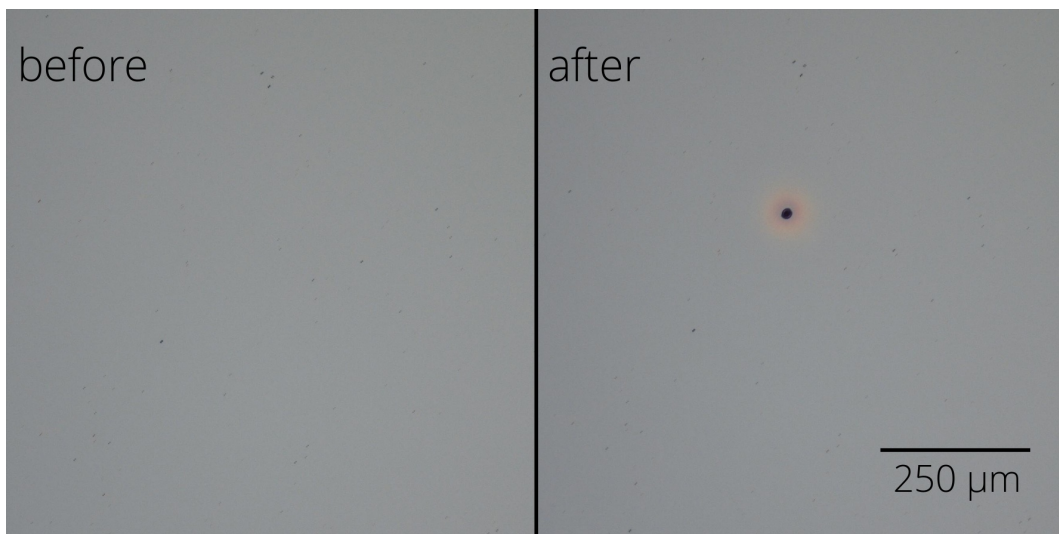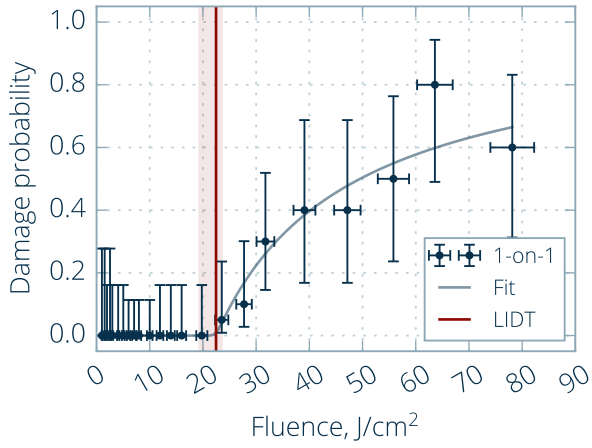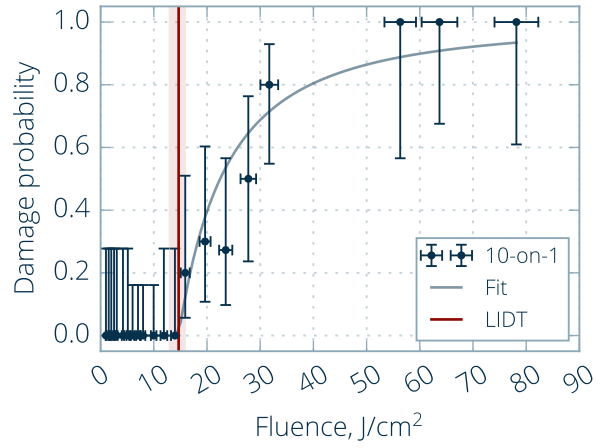


before    after

250 µm

Figure 5. Typical damage morphology: fluence 23.6 J/cm$^2$, damage after 88 pulse(s).

# DAMAGE PROBABILITY
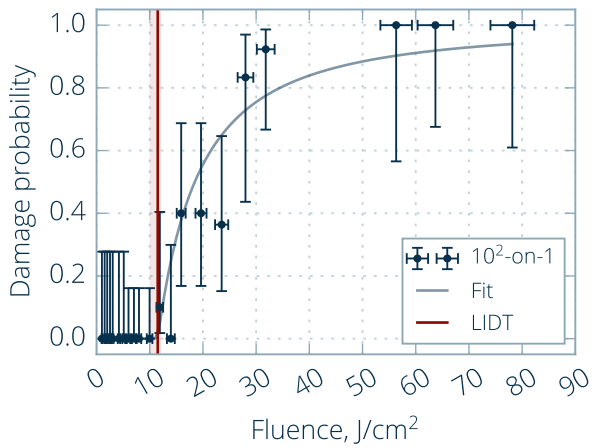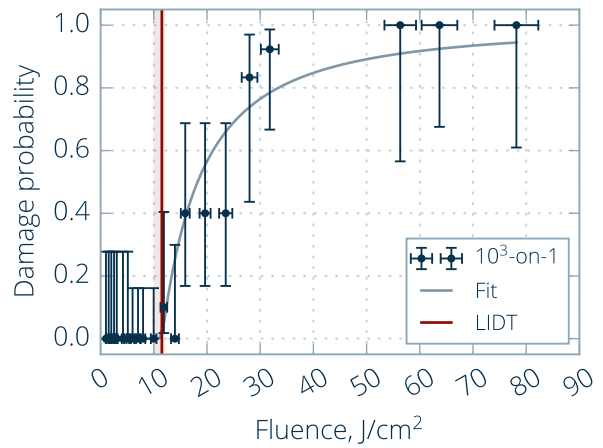# (ONLINE DETECTION)



(a) 1-on-1

(b) 10-on-1

(c) $10^2$-on-1

(d) $10^3$-on-1

Figure 6. Damage probability plots.