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LOW OPTICAL ABSORPTION MEASUREMENT REPORT

SAMPLE: PO6676-R

Request from		Testing institute	
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Contact person	Ugnius Gimževskis	Tester	Edvinas Zacharovas
Inquiry ID	3307	Sale order	SO4330
Purchase order	PO7330	Test ID	E1DZWK
		Test date	2023-12-01

Specimen

Name	PO6676-R
Type	HR Dielectric Coating (HRa>99.8% @ 1060-1100 nm, AOI=44-46° 20%<Ra_avg<40% @ 450-620 nm, AOI=44-46° 15%<Ra_avg<35% @ 625-660 nm, AOI=44-46° Ts,p>85% @)
Dimensions	Ø25.4 x 6.4 mm
Packaging	Plastic box
Storage before test	Normal laboratory conditions
Dust blow-off	Canned air
Cleaning	None

Measurement

Method	Photothermal common-path interferometry (PCI)
Protocols	Longitudinal scan (L-scan), Time scan, Transverse scan (T-scan).

SUMMARY OF MEASUREMENT RESULTS

Wavelength	AOI	Polarization	Location	Sample absorption *
1070.0 nm	(45.0 ± 1.0) deg	Linear P	Front surface (S1)	$0.61^{+0.76}_{-0.54}$ ppm

* Sample absorption is evaluated from Transverse scan protocol.

TEST EQUIPMENT

Definitions and test description

Photothermal common-path interferometry (PCI) for low absorption measurements is based on spatially resolved pump-probe techinque: low power probe beam senses the heating effect of an absorbed pump beam [1]. Several different scanning protocols are performed to measure the absorption of the sample.

Irradiation sources	Pump laser	Probe laser
Manufacturer	IPG Photonics	Lumentum
Model	YLR-10-LP	1122P
Type	Continuous wave Ytterbium fiber	Continuous wave HeNe
Central wavelength	1070 nm	632.8 nm
Angle of incidence	(45.0 ± 1.0) deg	(52.0 ± 1.0) deg
Polarization state	Linear P	Linear S
Spatial beam profile in target plane	TEM00	TEM00
Beam diameter in target plane (1/e2)	(59.6 ± 5) µm	(210 ± 5) µm
Average power	(4.1329 ± 0.0019) W	(2.00 ± 0.05) mW

Measurement setup calibration	Surface
Calibration sample	UVFS Reference Surface Sample
Absorption	19.4 %
Correction fator	1.0
Responsivity	$63.6^{+1.5}_{-1.6}$ 1/W

Power meter	
Manufacturer	Ophir
Model	12A-P
Calibration due date	2024-04

Test environment	
Environment	Air
Cleanroom class (ISO 14644-1)	ISO7
Pressure	1 bar
Temperature	23 C
Humidity	42 %

[1] A. Alexandrovski, M. Fejer, A. Markosian, and Roger Route "Photothermal common-path interferometry (PCI): new developments", Proc. SPIE 7193, Solid State Lasers XVIII: Technology and Devices, 71930D (28 February 2009)

LONGITUDINAL SCAN (L-SCAN) RESULTS

Scan parameters

Scanning axis	Longitudinal (from S1 to S2)
Scanning distance	4.5 mm
Scanning step	20 µm
Pump laser power	(4.1329 ± 0.0019) W
Number of scans	1

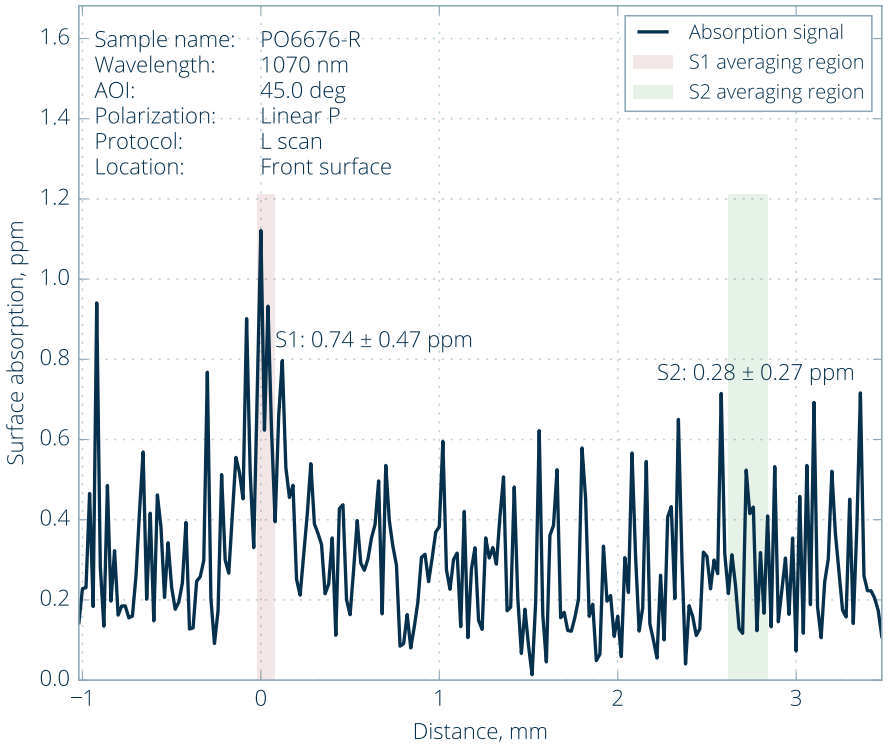


Figure 1. Longitudinal scan.

The central peaks, found at S1 and/or S2 positions, indicate the points where the pump and probe beams traverse the entrance (S1) and exit (S2) surfaces. The peak value of the signal corresponds to the surface absorptance, however, the secondary peaks (sidelobes) surrounding central peak should be regarded as part of the surface response function and lack any physical significance.

It's important to emphasize that the recorded scan distance between S1 and S2 is affected by refraction index of optical medium and therefore deviating from the actual physical thickness of the sample. The reported values are calibrated using a surface etalon sample. In cases where optical elements exhibit substantial bulk absorption, he longitudinal scan signal includes a central baseline that should be subtracted when estimating surface absorptance. The bulk absorptance portion of the signal necessitates a separate calibration process and should be interpreted separately.

Absorption values in L-scan figure are displayed only for comparison purpose, because absorption might change during the L-scan procedure. Temporal absorption changes can be seen in Time-scan results.

TIME SCAN RESULTS

FRONT SURFACE (S1)

Scan parameters

Scanning axis	Time
Scanning duration	686 s
Scanning step	1 s
Pump laser power	(4.1329 ± 0.0019) W
Number of scans	1

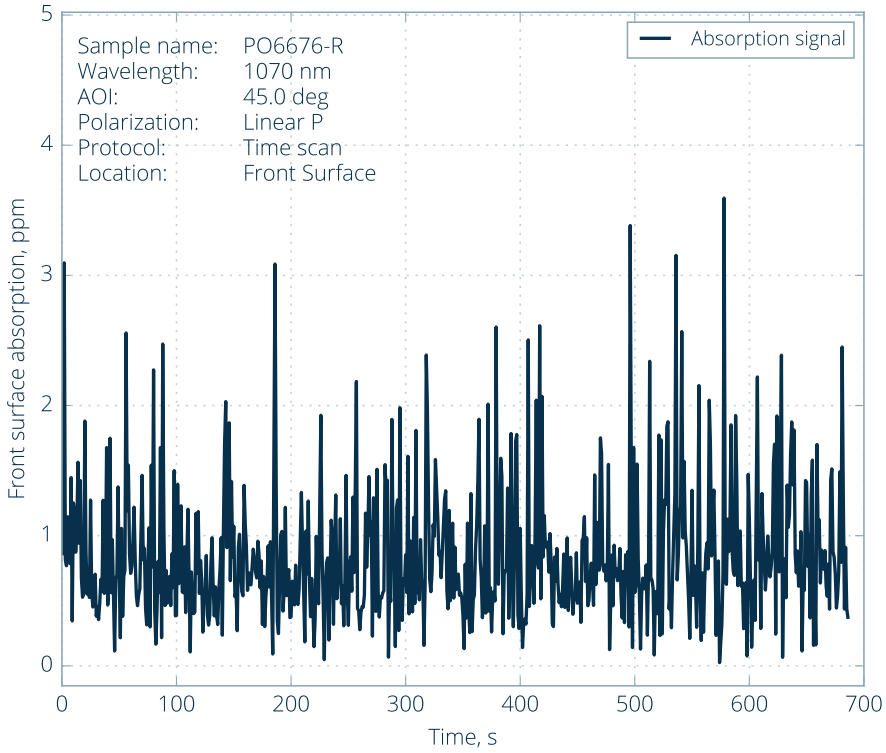


Figure 2. Time scan on front surface (S1) .

TRANSVERSE SCAN (T-SCAN) RESULTS

FRONT SURFACE (S1)

Definitions and protocol description

Sample absorption is defined as median absorption value of T-scan measurement. Uncertainty is evaluated as minimum and maximum absorption values of T-scan measurement without outliers, i.e. within range [Q1 - 1.5 · IQR, Q3 + 1.5 · IQR], where Q1 - first quartile, Q3 - third quartile, IQR - interquartile range.

Scan parameters

Scanning axis	Transverse (vertical)
Scanning distance	3.0 mm
Scanning step	35 µm
Pump laser power	(4.1329 ± 0.0019) W
Number of scans	1

Scan results

Sample absorption	$0.61^{+0.76}_{-0.54}$ ppm

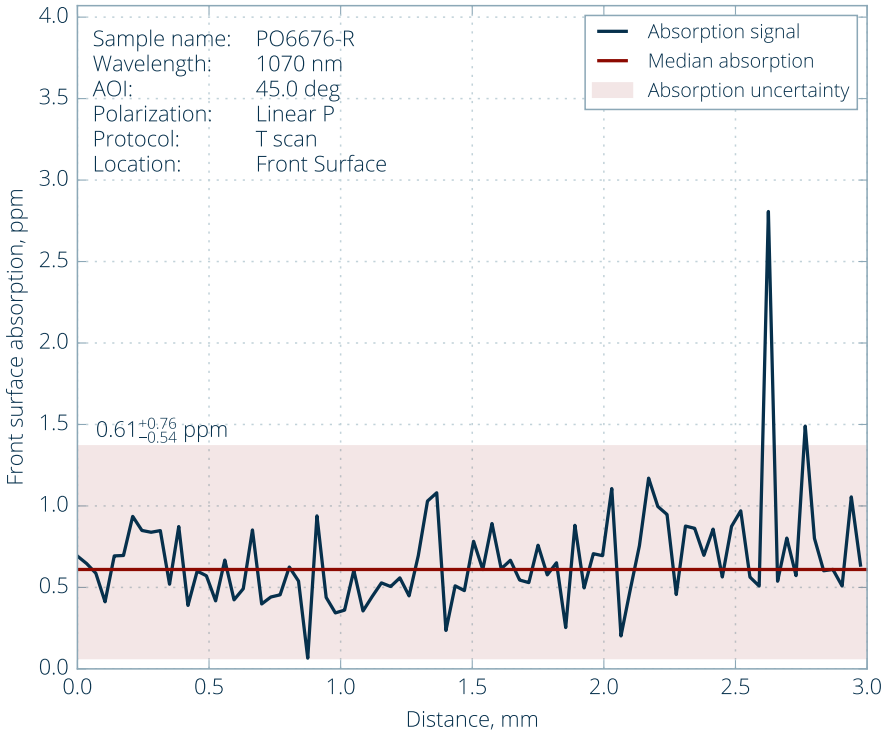


Figure 3. Transverse scan on front surface (S1) .

TESTING LOCATION

FRONT SURFACE (S1)

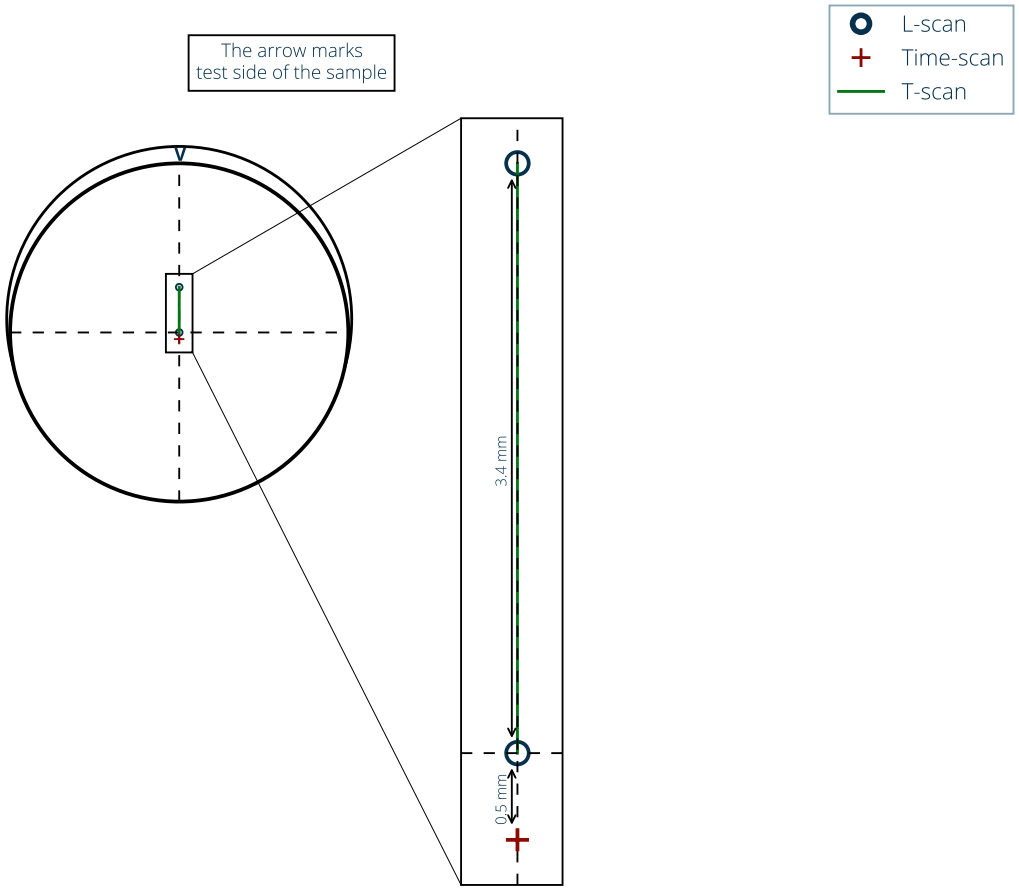


Figure 4. Measured sites on the sample.

TECHNICAL NOTES

TECHNICAL NOTE 1: High uncertainty is determined by sample high reflectivity

Test sample has high reflectivity that affects the PCI results. PCI technique is based on pump and probe beams transmitted through the sample. Since only small amount of laser energy is transmitted through the sample, PCI signal to noise ratio is low. Therefore, absorption values are reported with high uncertainty.