ORTUS®

Vacuum Coating Systems with Electron-Beam Evaporation Technology

Content

About I-Photonics

I-Photonics long year experience in working on Ion Beam technology and Thin Film physics and the related R&D works on thin film coatings and coating hardware developments testimony the importance of defining and improving continuously coating processes and provided over the years a consistent process portfolio which defines I-Photonics as an attractive and competitive solution provider.

Following the global market demands we developed Magnetron Sputtering Technology (MS, RMS, PARMS), Diamond Like Carbon Technology for IR optics (DLC by PECVD), E-Beam Evaporation (IBAD), Ion Beam Sputtering (IBS, RF IBS) for precision optics.

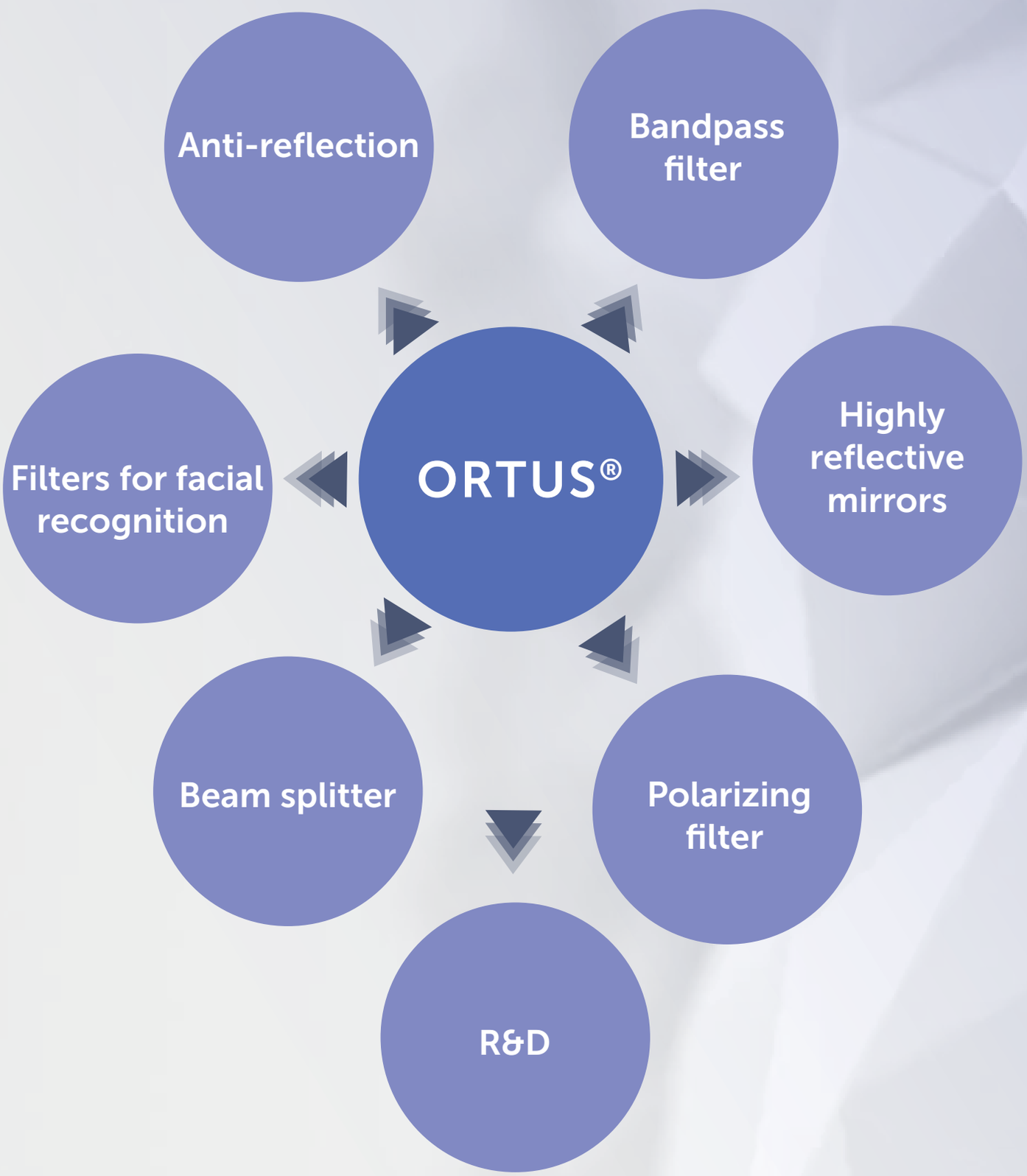
Being focused on optical coatings we developed automatic optical process control systems OCP BroadBand an OCP SingleWave that allow to make high precision multilayer optical coating for UV, VIS, NIR, Mid IR ranges with high yield.

Ongoing updates on behalf of the requirements for coatings from the customer demanded from us incessant R&D, which lead to a constant improvement of our equipment and defined the role of the entire company not only as a developer of equipment, but more as a developer of coating solution provider.

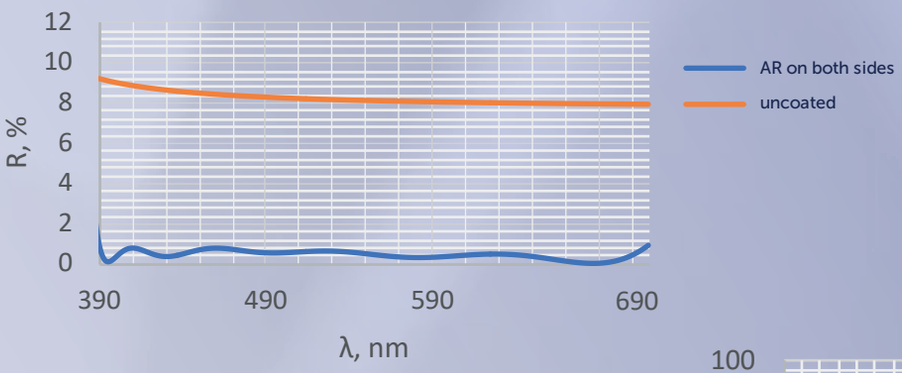
The accumulated experience in processes and methods of thin films coatings helps I-Photonics to be specialized in coating services as well. It also positioned I-Photonics as company which provides technological support for each customer and shares the knowledge in thin films.

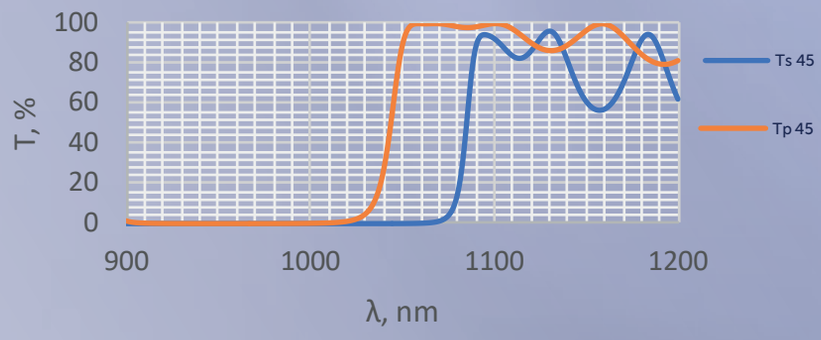
With each customer our aim is to possibly establish long-term cooperation based on our experience and continuous improvements as a solution provider.

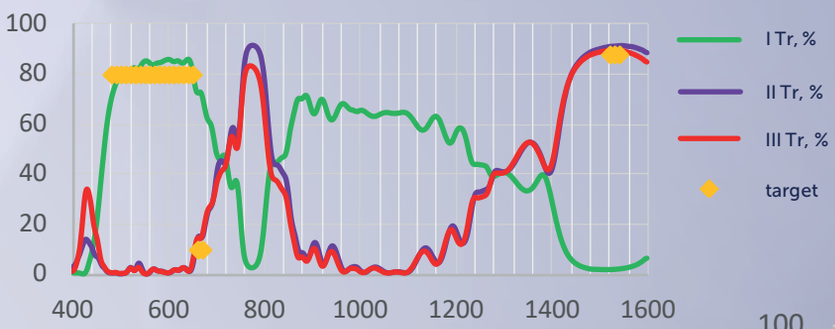
Coating types

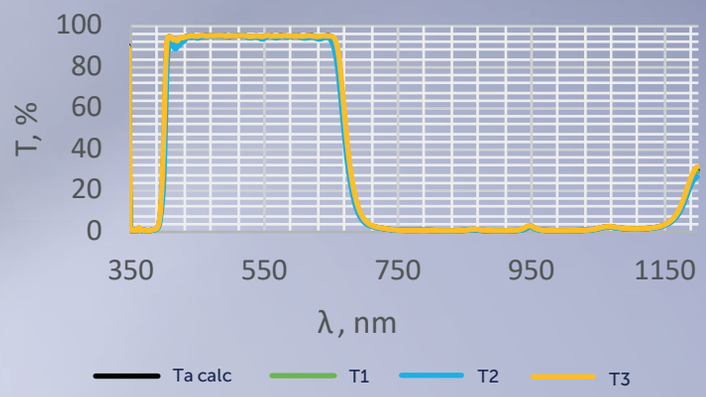


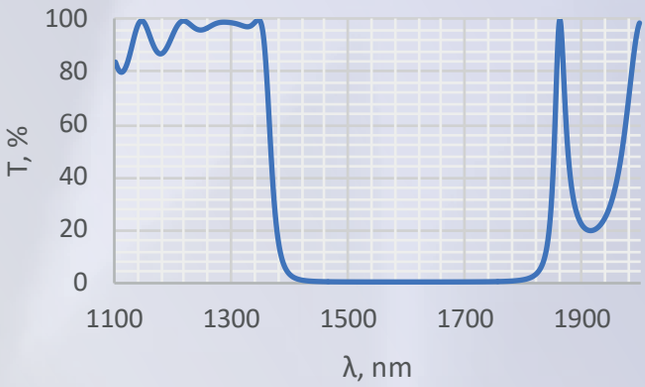
Coating types

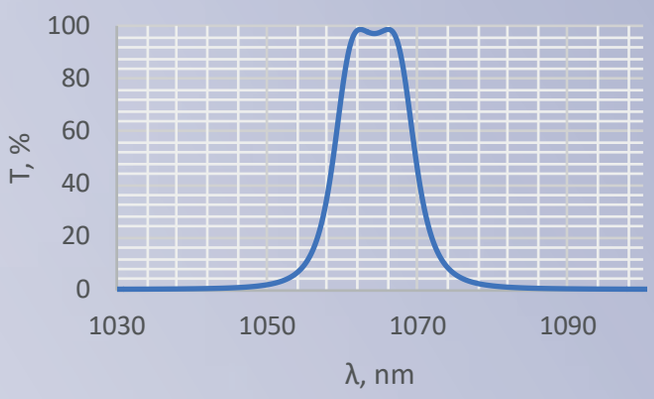












ORTUS®

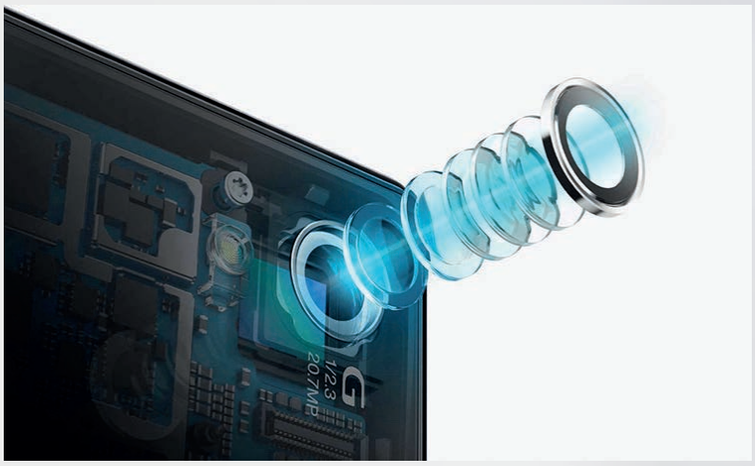
Vacuum systems with electron-beam evaporation technology

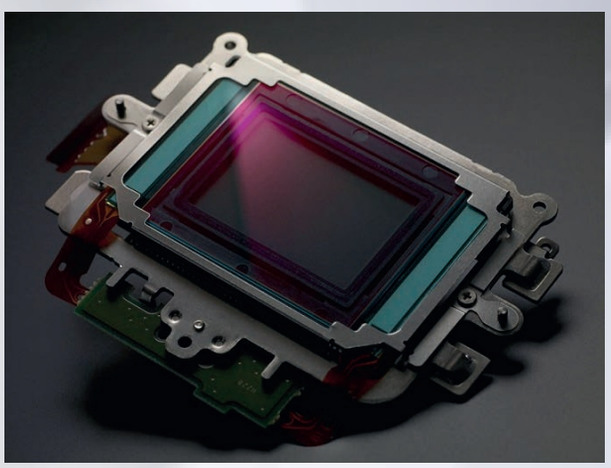
Coatings Applications:

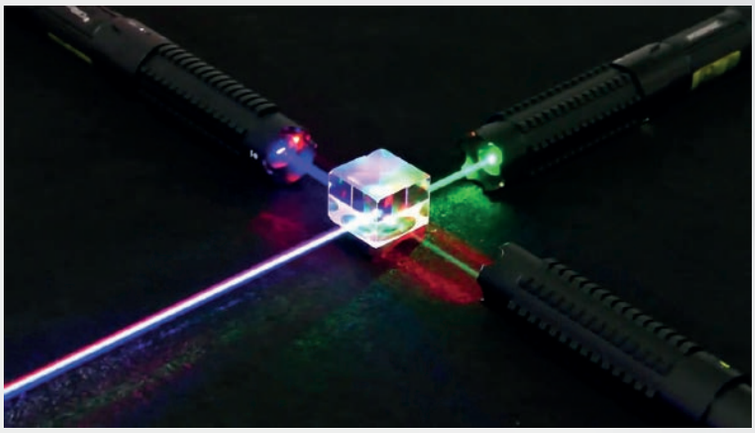
- Visible and infrared optics
- Lasers
- Customized application

To be used in:

- Sensors
- Optical systems for objectives
- Microscopes
- Telescopes
- Laser optics
- R&D



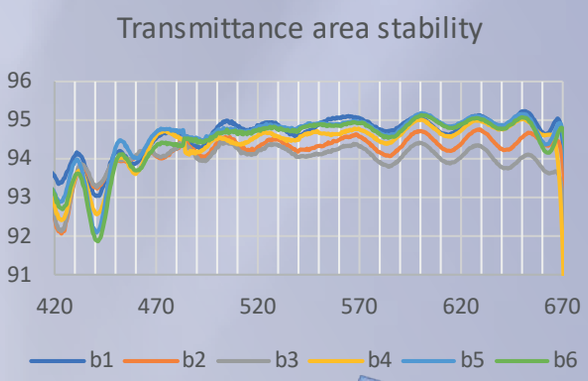


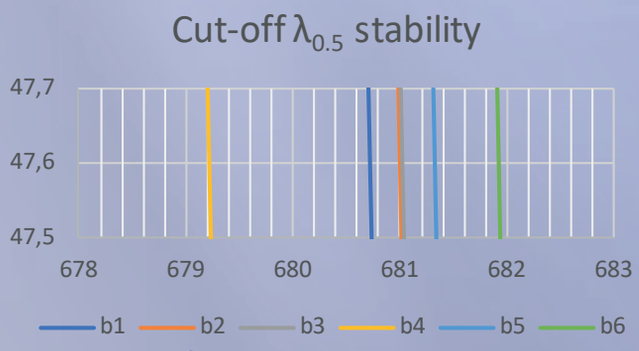


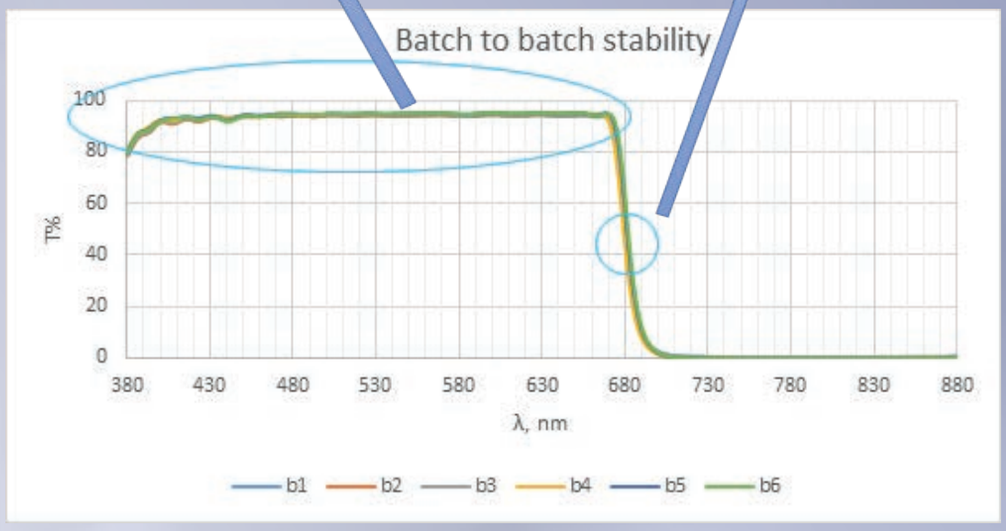
Coatings for laser systems

SWP 680 process stability

Batch to batch stability







Coating	
Tav 420-670 nm	≥94%
Tabs 420-670 nm	≥91.5%
Slope = (λ 90% - λ 10%)	Less then 20 nm
Blocking range	700-900 nm, OD 2.5
Cut off $\lambda_{0.5}$	680±2 nm
Batch to batch stability	±0,3%
Surface quality	60-40
Substrate	BK7, Ø50.8x1 mm

Environmental test	
Passed test	**Test condition**
Humidity	24 Hrs. exposure at RH 80% and 90°C

Coatings for laser systems

SWP 680 process stability

Enviromental stability

Coating	
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Tabs 420-670 nm	≥91.5%
Slope = (λ 90% - λ 10%)	Less then 20 nm
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Environmental test	
Passed test	**Test condition**
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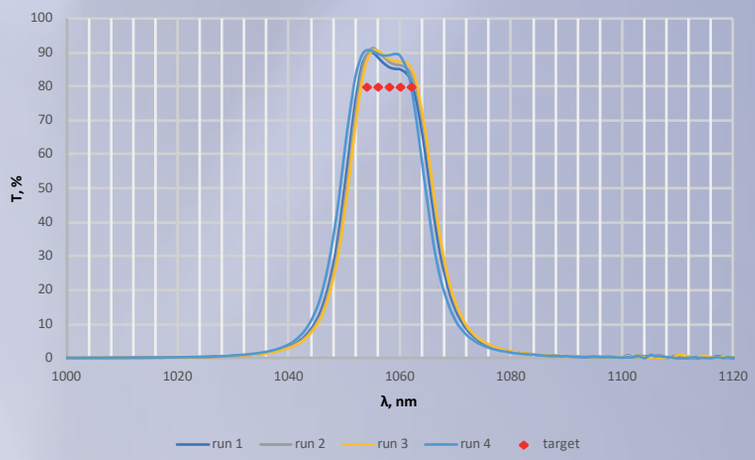
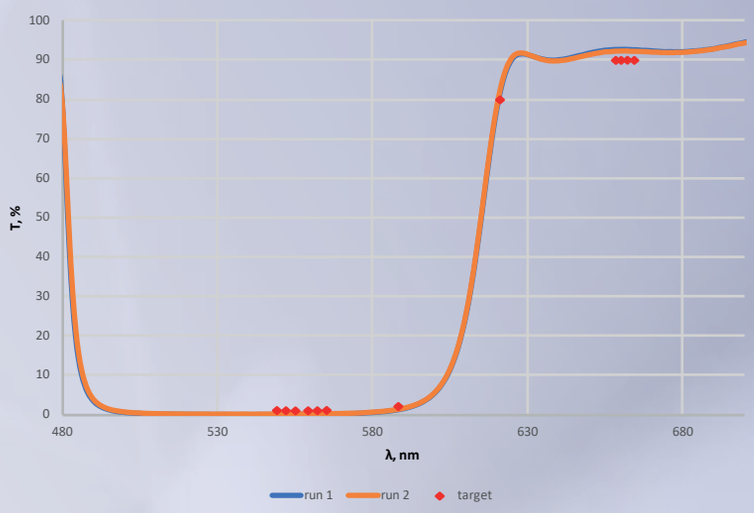
Coatings for laser systems

Bandpass filter 1064 nm



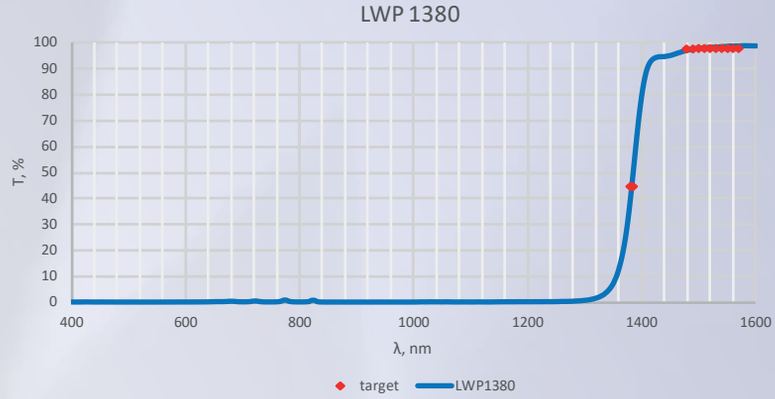
Coating	
λCWL	1064 nm
FWHM	≤ 15 nm
Tr max (without back side AR)	>89%
Blocking range	400-1200 nm, OD<3
Surface quality	40-20
Durability	MIL-C-48497A
Substrate	BK7
Dimensions	Ø 2 inch

HR532+HT658



Coating	
Wavelength range	500-660 nm
Tr λ 621 nm	> 70%
Tr λ 658 nm (without back side AR)	>90%
Blocking range	500-566 nm, OD<3
Surface quality	40-20
Durability	MIL-C-48497A
Substrate	BK7
Dimensions	Ø 2 inch

LWP 1380 (for range finders)

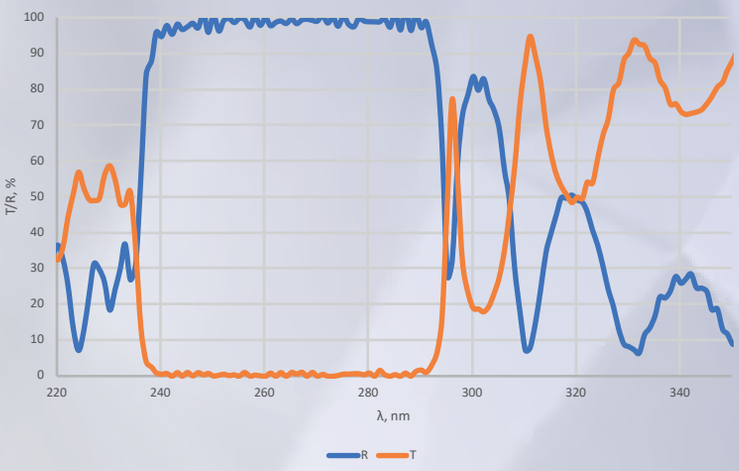


Coating	
λcwl	1380 ± 20 nm
Slope = (λ (80% of Tpeak)- λcwl)/ λcwl	≤ 2%
Blocking range	400-1300, OD<3
Tr av, % λ= 1480-1540 nm	>98%
Surface quality	40-20
Durability	MIL-C-48497A
Substrate	BK7
Dimensions	Ø 10 mm

Coatings for laser systems

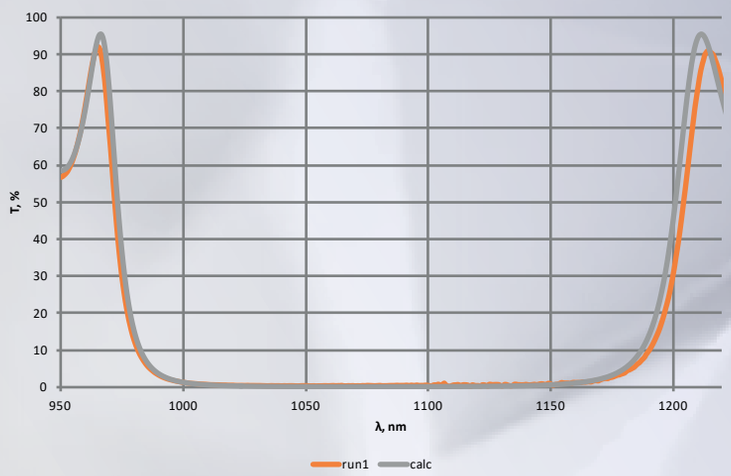
HR 266 nm

Coating	
λCWL	266 nm
R λcwl	R>99.88%
Angle	α=0°
Surface quality	20-10
Durability	MIL-C-48497A
Substrate	Fused silica
Dimensions	Ø 2 inch



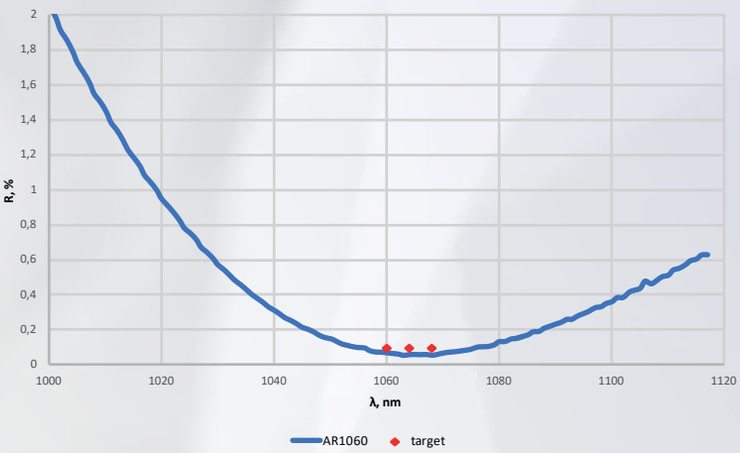
HR 1064

Coating	
λCWL	1064 nm
T, R λcwl	T<0.15%, R>99.8%
Angle	α=0°
Surface quality	20-10
Durability	MIL-C-48497A
Substrate	Fused silica
Dimensions	Ø 2 inch



AR 1064

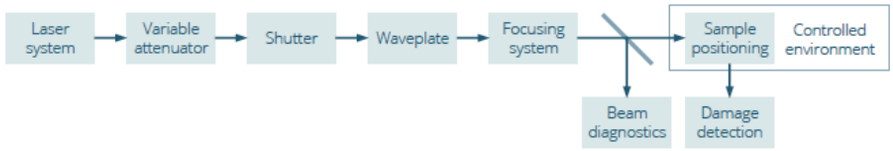
Coating	
λCWL	1064 nm
R λcwl	R<0.08%
Angle	α=0°
Surface quality	10-5
Durability	MIL-C-48497A
Substrate	Fused silica
Dimensions	Ø 2 inch



Coatings for laser systems

LIDT HR 1064

Test setup

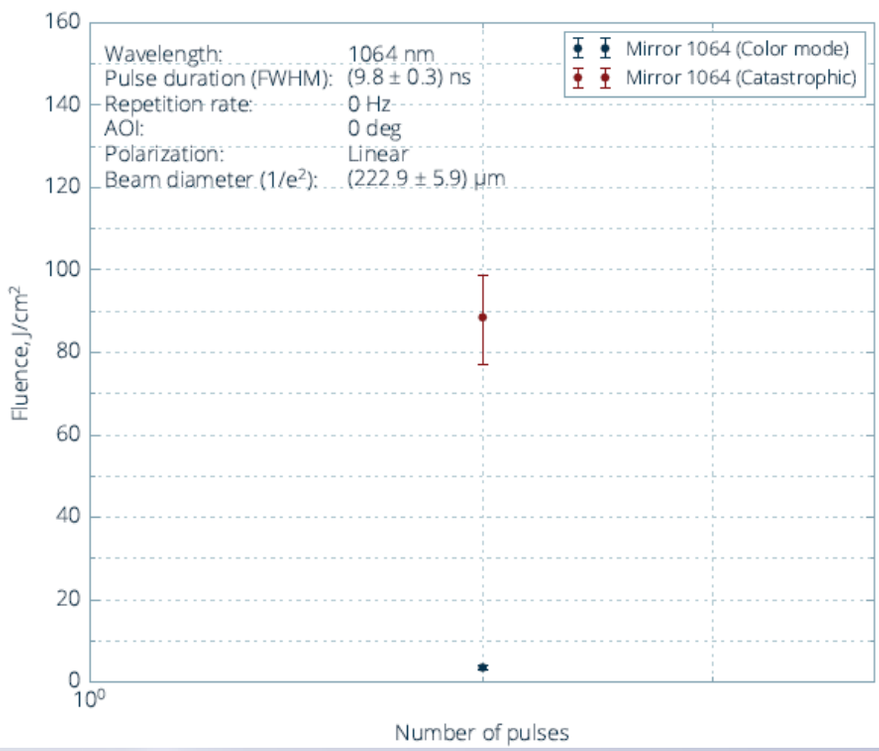


Laser and its parameters

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	0 Hz
Spatial beam profile in target plane	Near Gaussian
Beam diameter in target plane ($1/e^2$)	(222.9 ± 5.9) µm
Longitudinal pulse profile	Single longitudinal mode
Pulse duration (FWHM)	(9.8 ± 0.3) ns
Pulse to pulse energy stability	1.8 %

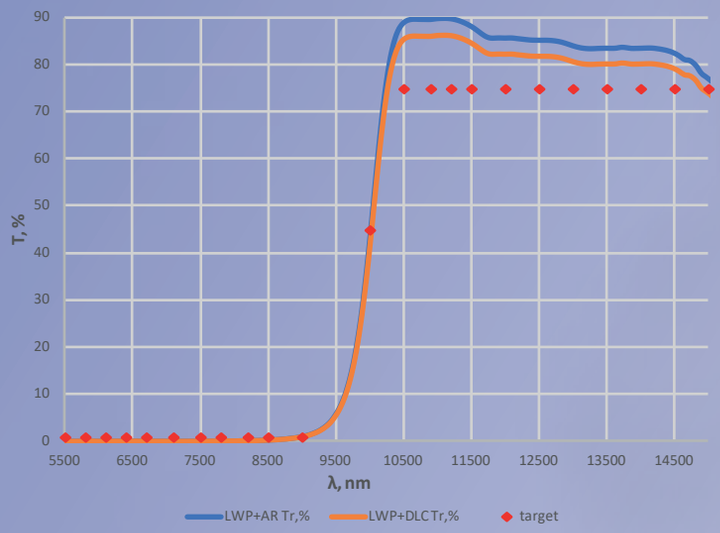
Table 1: Estimated LIDTs for sample Mirror 1064.

Test mode	Threshold (Color mode)	Threshold (Catastrophic)
2-on-1	$3.54\ ^{+0.40}_{-0.43}$ J/cm²	$88.5\ ^{+10.0}_{-11.4}$ J/cm²



Infrared coatings

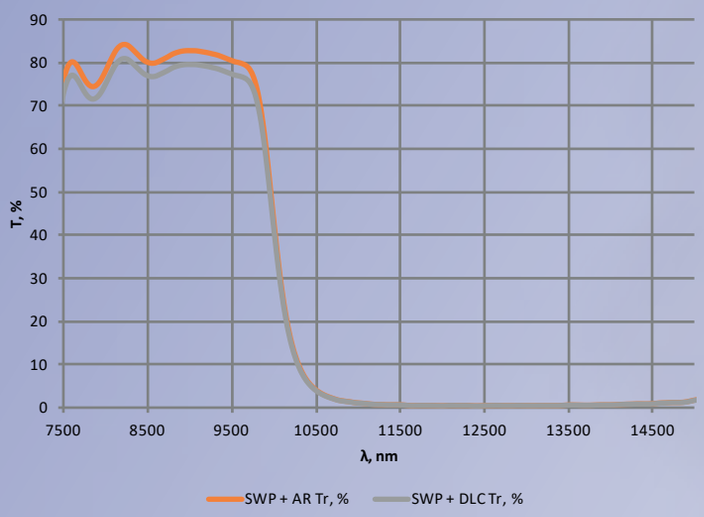
Ge long wave pass filter 10 um



Substrate		Coating	
Material	Ge	λ_{CWL}	10 µm ± 50 nm
Dimensions	Ø1-2 inch	Slope = (λ (80% of Tpeak)- λCWL)/ λCWL	≤ 2%
Thickness	1-2 mm	Blocking 5.5 - 9 µm	less than 1% (or OD>2)
		Min Tr% 10.5 µm to 15 µm	>75%
		Options:	2nd side BBAR or DLC coated

Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Severe abrasion	20 strokes eraser with a force of 2 to 2.5 pounds
Moderate abrasion	50 strokes cheesecloth with a force of 1 pound
Temperature influence	2 Hrs. at –60°C 2 Hrs. at +70°C
Adhesion	Cellophane tape applied to the coated surface and removed quickly
Salt spray (fog)	24 Hrs. salt spray
Salt solubility	24 Hrs. immersion in salt water (44.7 gr per liter)
Aging effect	Wavelength shift after about 6 months

Ge short wave pass filter 10 um



Substrate		Coating	
Material	Ge	λ_{CWL}	10 µm ± 50 nm
Dimensions	Ø1-2 inch	Slope = (λ (80% of Tpeak)- λCWL)/ λCWL	≤ 2%.
Thickness	1-2 mm	Blocking 10.7 - 15 µm	less than 1% (or OD>2)
		Min Tr% 7.5 – 9.7 µm	>70%
		Options:	2nd side BBAR or DLC coated

Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Severe abrasion	20 strokes eraser with a force of 2 to 2.5 pounds
Moderate abrasion	50 strokes cheesecloth with a force of 1 pound
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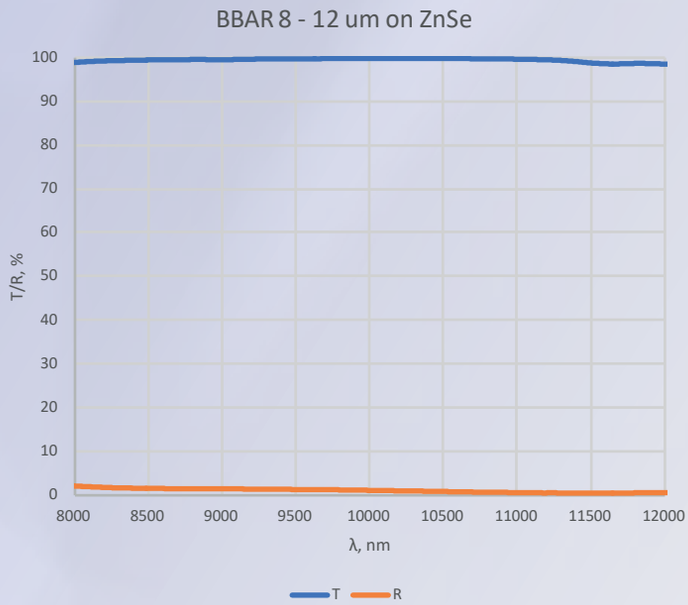
Aging effect	Wavelength shift after about 6 months

Infrared coatings

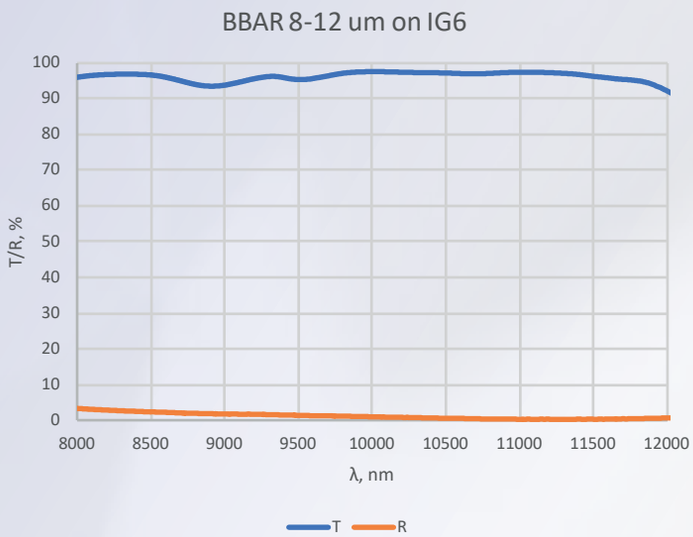
Broad band anti-reflection coating 8 – 12 um on ZnSe



Substrate		Coating	
Material	ZnSe	2 sides	
Dimensions	Ø1-2 inch	λ=8-12 mkm	Tav=99.57% Rav=1.10%
Thickness	3±0,02 mm	Angle	α=0˚

Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Moderate abrasion	50 strokes cheese cloth at 1 pound force
Temperature influence	2 Hrs. at –60 °C 2 Hrs. at +70 °C
Adhesion	Cellophane tape applied to the coated surface and removed quickly

Broad band anti-reflection coating 8 – 12 um on IG6

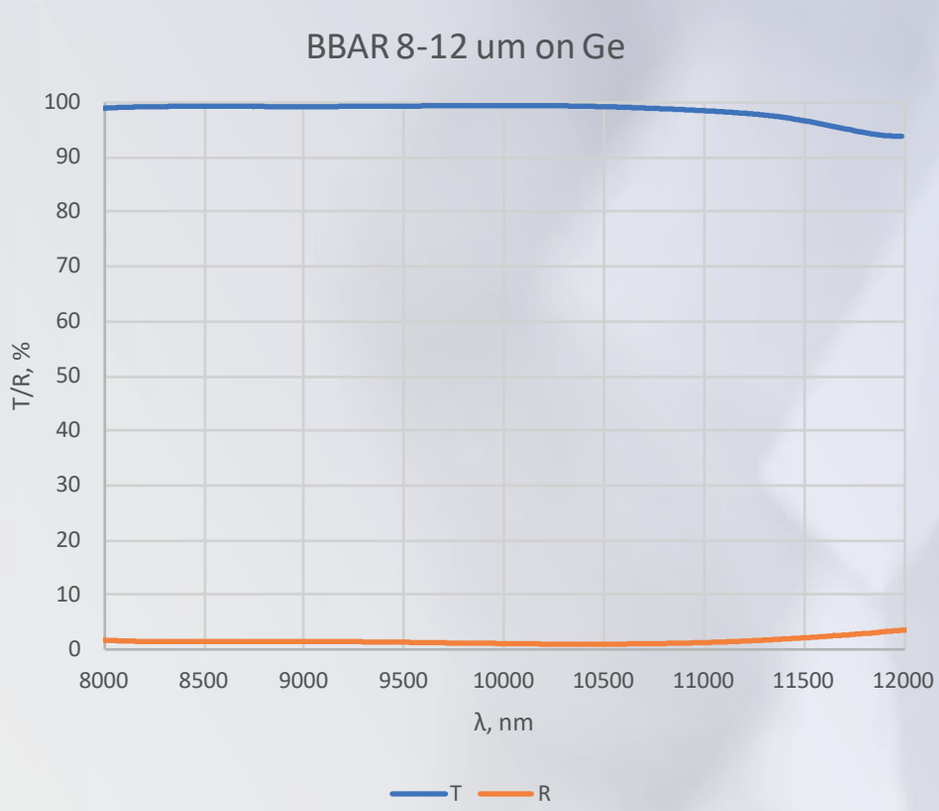


Substrate		Coating	
Material	IG6	2 sides	
Dimensions	Ø1-2 inch	λ=8-12 mkm	Tav=96.01% Rav=1.41%
Thickness	3±0.02 mm	Angle	α=0˚

Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Moderate abrasion	50 strokes cheese cloth at 1 pound force
Temperature influence	2 Hrs. at –60°C 2 Hrs. at +70°C
Adhesion	Cellophane tape applied to the coated surface and removed quickly

Infrared coatings

Broad band anti-reflection coating 8 – 12 um on Ge

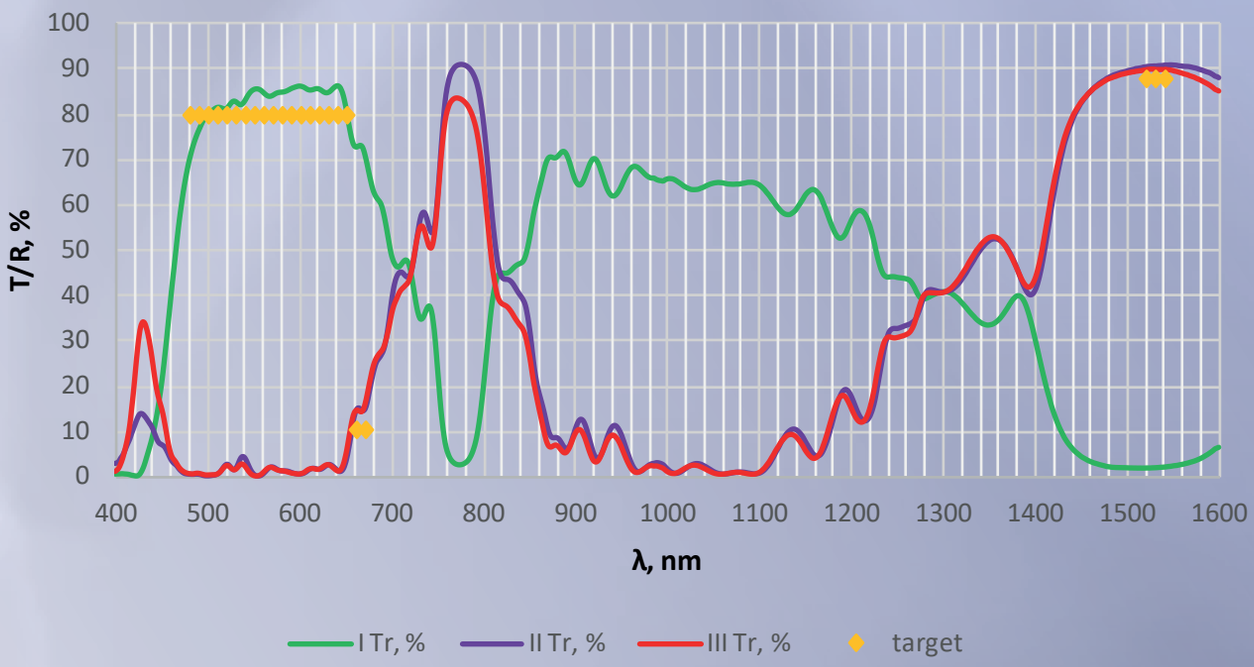


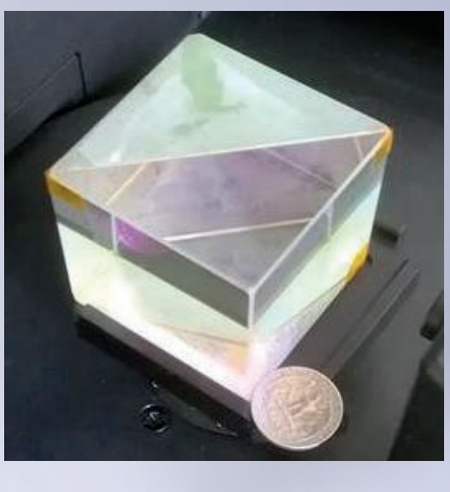
Substrate		Coating	
Material	Ge	2 sides	
Dimensions	Ø1-2 inch	λ=8-12 mkm	Tav=98.81% Rav=1.41%
Thickness	1±0,02 mm	Angle	α=0°

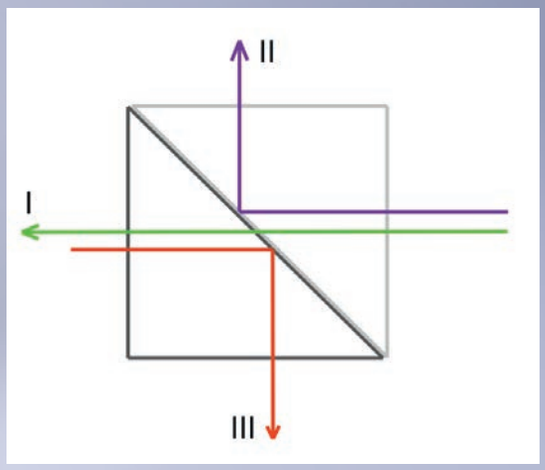
Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Moderate abrasion	50 strokes cheese cloth at 1 pound force
Temperature influence	2 Hrs. at –60°C 2 Hrs. at +70°C
Adhesion	Cellophane tape applied to the coated surface and removed quickly

Customized applications

Coatings on prisms





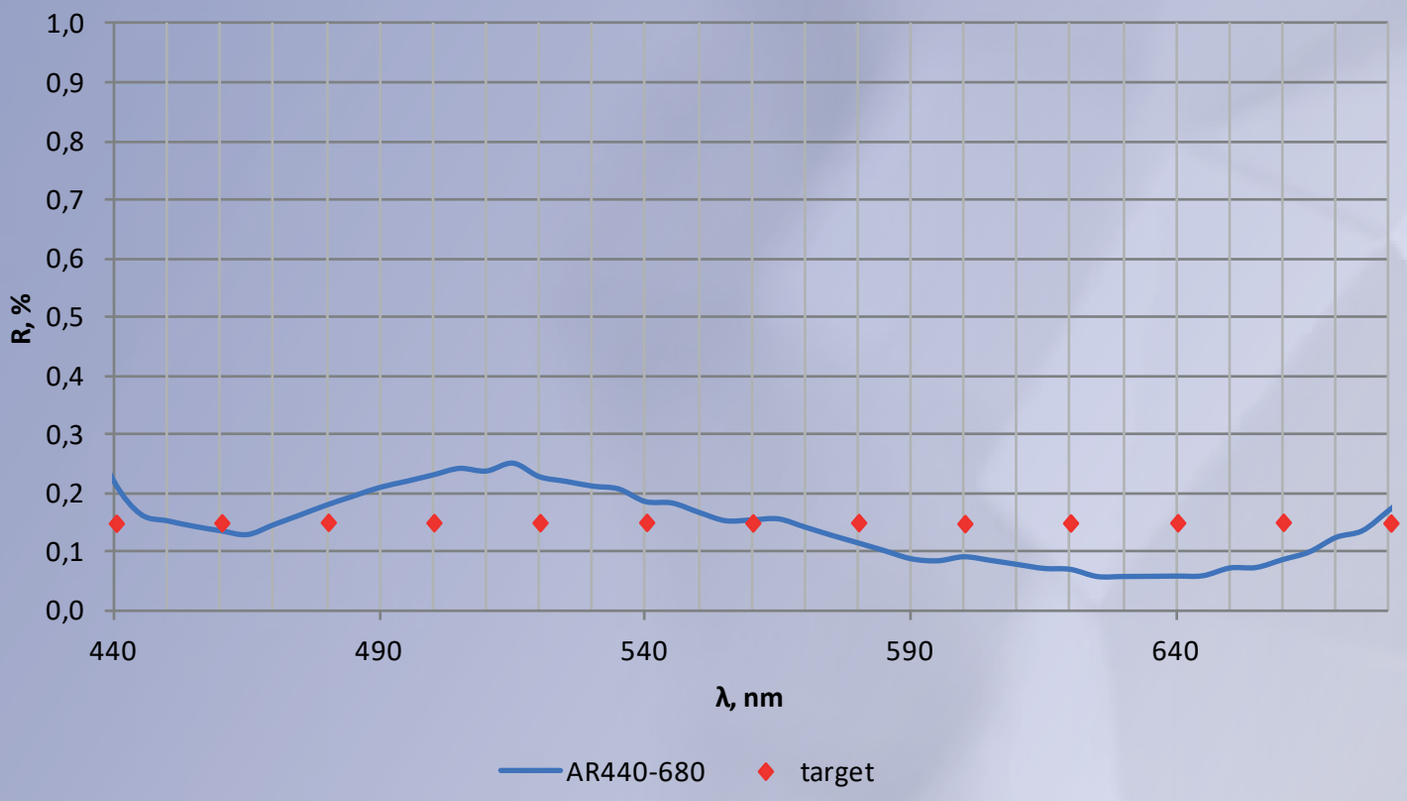


Passed test	Test condition
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Severe abrasion	20 strokes eraser with a force of 2 to 2.5 pounds
Moderate abrasion	50 strokes cheesecloth with a force of 1 pound
Temperature influence	2 Hrs. at –60°C 2 Hrs. at +70°C
Adhesion	Cellophane tape applied to the coated surface and removed quickly
Salt spray (fog)	24 Hrs. salt spray
Salt solubility	24 Hrs. immersion in salt water (44.7 gr per liter)
Aging effect	Wavelength shift after about 6 months

Direct I	Ta λav > 80%, λ =480-660 nm
Direct II	Ta λmin > 90%, λ =1520-1560 nm
Direct III	Ta λ av > 10%, λ =641-670 nm

Customized applications

Broad band anti-reflection coating 440 – 680 nm



Range	440-680 nm
Ra av, %	≤ 0.15 %
Ra max	≤ 0.25 %
Substrates	PK52A, BK7, SF2, SF6, etc.

Passed test	**Test condition**
Humidity	24 Hrs. exposure at RH 95% to 100% at 50°C
Severe abrasion	20 strokes eraser with a force of 2 to 2.5 pounds
Moderate abrasion	50 strokes cheesecloth with a force of 1 pound
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Aging effect	Wavelength shift after about 6 months

I-Photonics ORTUS® systems

ORTUS® 700

ORTUS® 900

ORTUS® 1100

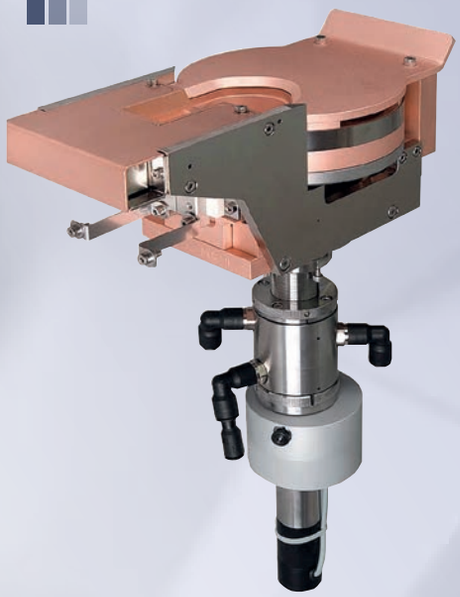
ORTUS® 1500

System	Dome diameter	Planetary, diameter and qty.
Ortus 700	620 mm	270 mm, 3 pcs.
Ortus 900	800 mm	327 mm, 4 pcs.
Ortus 1100	995 mm	387 mm, 4 pcs.
Ortus 1500	1390 mm	590 mm, 4pcs.

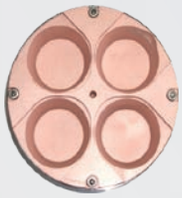
Sizes can be customized

Electron-beam evaporation system

- Integrated design - 32mm bore installation
- 3 different sizes EV M-6, EV M-8, EV M-10
- Operating power: 6KW - 12KW
- No water leakage in vacuum chamber (static seal)
- Noise immune optical positioning
- Customized crucibles, 1 ... 12 pockets

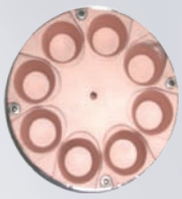


Crucibles

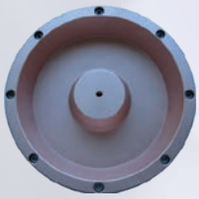


4 x 35cc

6 x 40cc
- High power
- Cooling
- 10KW AL

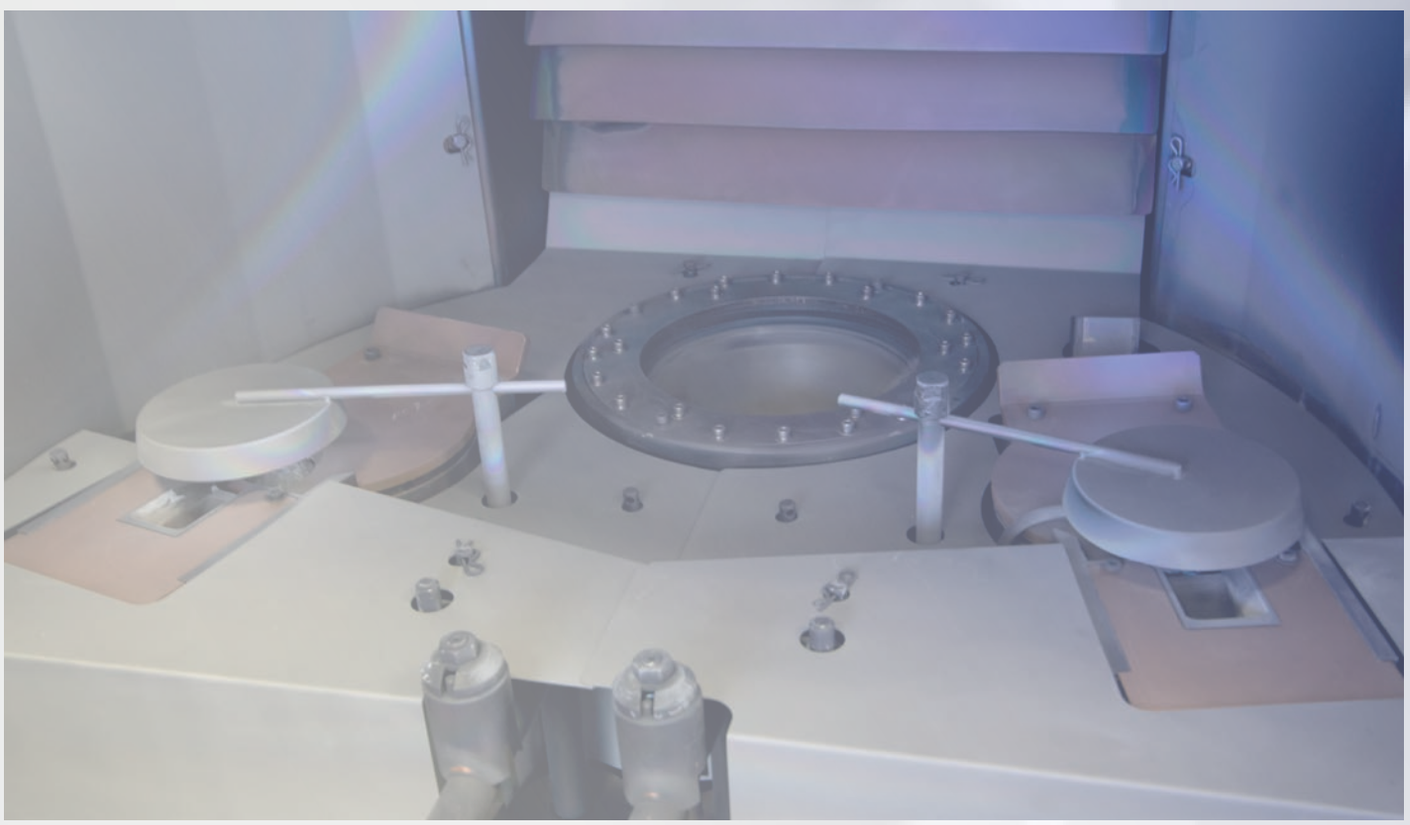


8 x 12cc



1 x 450cc

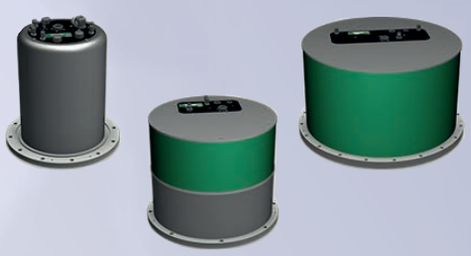
1 x 650cc



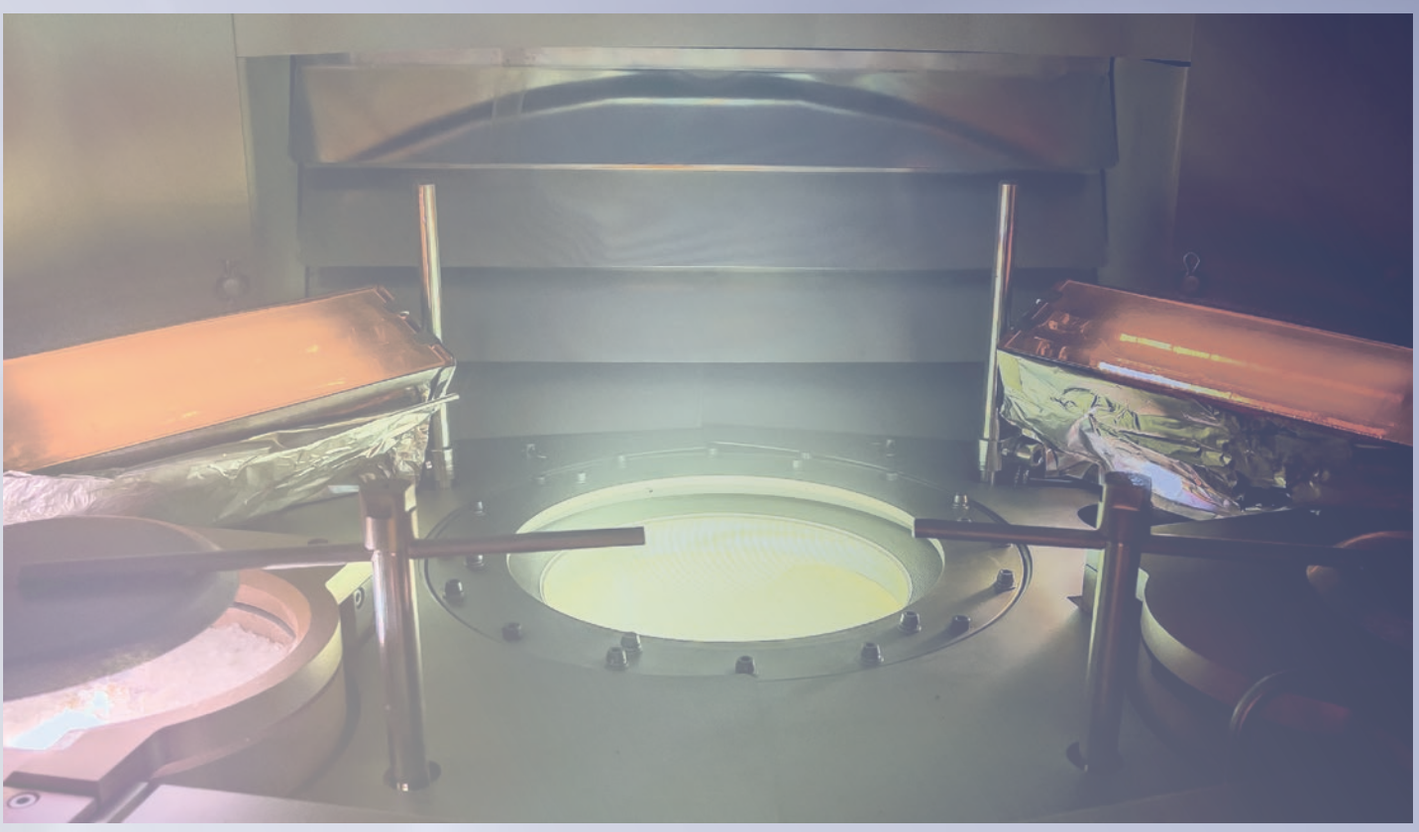
Cleaning and assistance system

The COPRA RF-ICP Plasma Beam Source

The COPRA RF-ICP Plasma Beam Technology based on its inductively coupled 13,56 MHz excitation. The sources are working gas independent, reliable and maintenance poor. The Standard COPRA delivers a high ion current (ICD) at constantly low ion energies (IE) which can be easily controlled and adjusted if needed. The customizable design of these COPRA Round Plasma Sources facilitate particle poor thermal stable and stress less etching and deposition. The COPRA Round Plasma Sources (DN-Series) are key components in the precision optics productions and are easily scalable to serve customized dimensional needs.



Ion source:	Copra DN251	Copra DN401
Power	3 kW	5 kW
Ion energy	30-350 eV	30-350 eV
Ion current density	up to 2.5 mA/cm^2	up to 2.5 mA/cm^2
Gas working pressure	1x10^{-4} ... 2x10^{-2} mbar	1x10^{-4} ... 2x10^{-2} mbar
Compensator	No need	No need



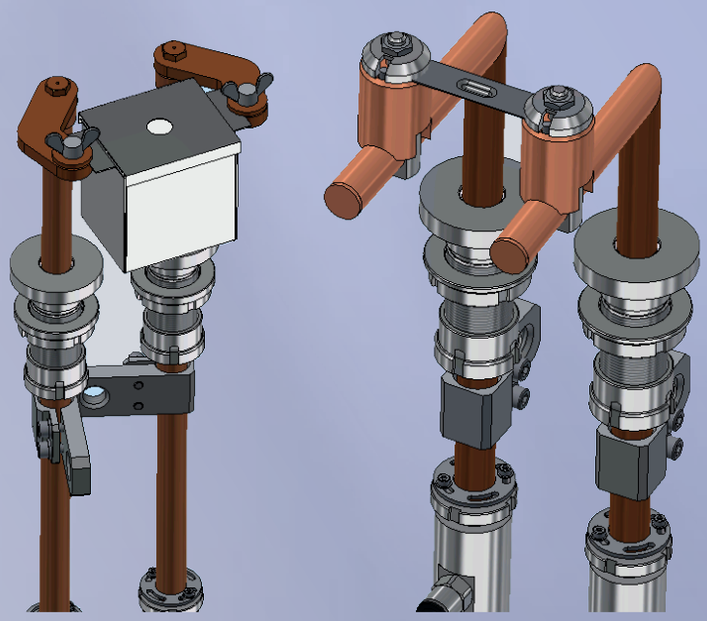
OCP optical monitoring system

OCP SingleWave

Spectral subrange, nm	220-380	380-1100	1100-1650	1650-2500
Spectral resolution, nm	0.8	0.8	1.6	3.2
Wavelength accuracy, nm	±0.2	±0.2	±0.4	±0.8
Wavelength repeatability, nm	±0.1	±0.1	±0.2	±0.4
Monitor types	Intermittent (direct): transmission continuous (indirect by test glass): transmission, reflection, backside reflection			
Baseline stability, %	±0.1%/h	±0.1%/h	±0.25%/h	±0.75%/h
Dark noise, %	±0.01@550nm	±0.01@550nm	±0.1@1550nm	±1@2100nm
Stray light, %	0.3@250nm	0.05@550nm	0.1@1550nm	0.1@2100nm
Built-in PC	Yes			
Light source	Deuterium lamp	Halogen lamp (DC-controlled power supply)		
Detector	Si	Si	IGA	IGA
Software for thin film design	OptiLayer, IzoSpectra, FilmStar, MS Excel, Essential Macleod			
Data transfer	OPC UA, Modbus TCP/IP Other by request			
Test glass changer	8 positions test glass changer integrated with 4 position cooled quartz crystal changer			

Resistive evaporation system

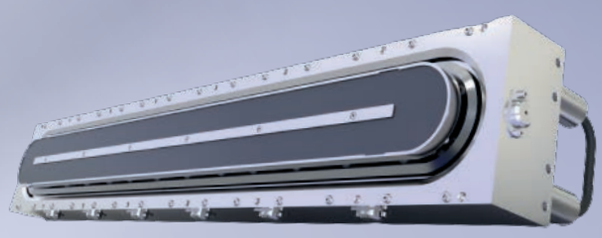
P, kW	U, V	I, A
3	5	600
3	10	300



Other options for cleaning and assistance

I-Photonics EHS-50 End-Hall Ion Source

Power	1.2 kW
Ion energy	40-180 eV
Gas working pressure	9×10^{-5} to 1.5×10^{-3} mbar



I-Photonics Linear sources with anode layer accelerator

Ion energy	40-2000 eV
Ion current density	up to 4.2 mA/cm^2 (slit length)
Gas working pressure	1.5×10^{-4} to 1×10^{-2} mbar
Compensator	Filament / magnetron

Substrate holders

Types of substrate holders:

- Planetary
- Dome
- Customized

Planetary holders

Planetary, ø/pcs	Ortus 700 – 270mm/3pcs. Ortus 900 – 327mm/4pcs. Ortus 1100 – 387mm/4pcs. Ortus 1500 – 590mm/4pcs. Can be customized
Substrates	Lens: 1", 2", 70.76 (3"), 60mm, 80mm, 100mm, 124mm, 200mm Prisms and special substrate: according to customer request
Coatings uniformity on the whole planetary holder	<+/- 1.5%

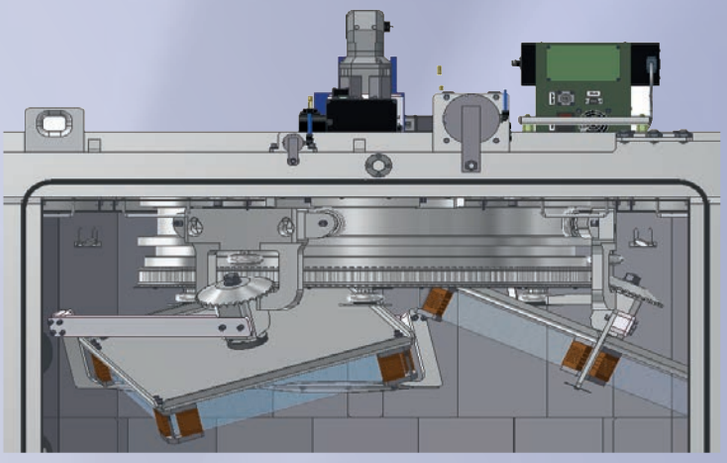
Dome holders

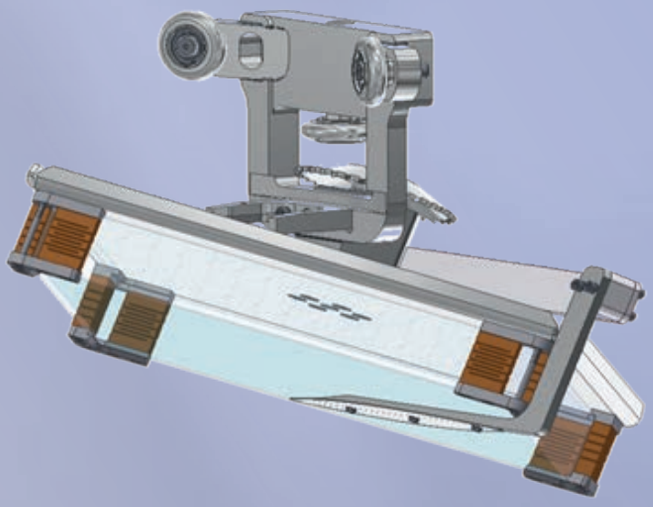
Dome, ø	Ortus 700 – 620 mm. Ortus 900 – 800 mm. Ortus 1100 – 995 mm. Ortus 1500 – 1390 mm. Can be customized
Substrates	Lens: 1", 2", 70.76 (3"), 60 mm, 80 mm, 100 mm, 124 mm, 200 mm Prisms and special substrate: according to customer request
Coatings uniformity on the whole planetary holder	<+/- 2%

Customized holders

Coater	Ortus 1100
Substrate	ZnS, semisphere Ø151.6 mm, radius of curvature 77 mm, 4 pcs.
Coating	BBAR 8-12 µm, double side
Coating uniformity, %	<+/- 2%

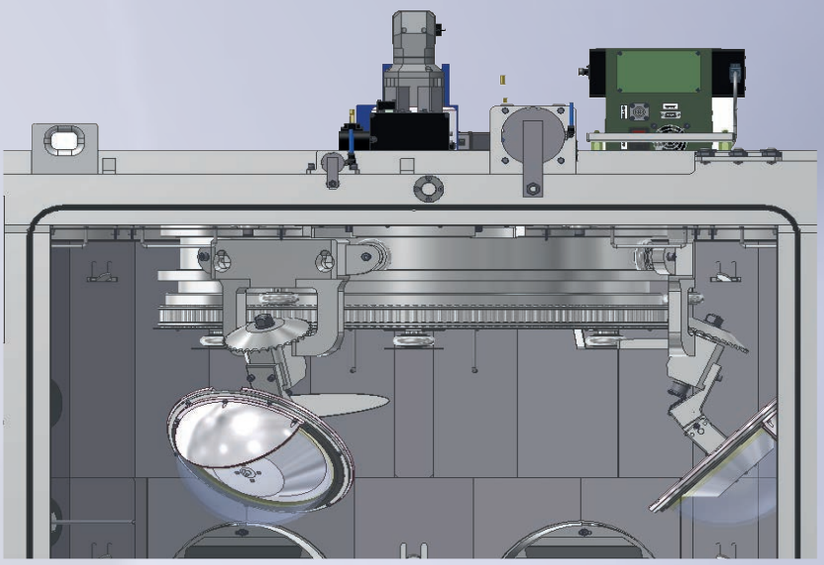
Customized holders

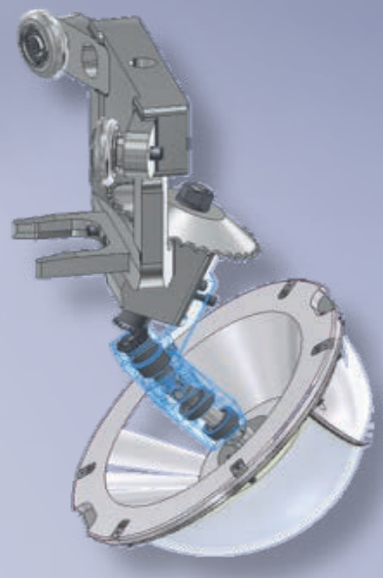




Coater	Ortus 1500
Substrate	K108, 420x420x60 mm, 3 pcs.
Coating	MgF_2, SiOX, ZnS, Ta_2O_5 etc.
Coating uniformity, %	<+/- 3%

Customized holders





Coater	Ortus 1500
Substrate	ZnS, semisphere Ø250 mm, radius of curvature 125 mm, 3 pcs.
Coating	BBAR 8-12 µm, double side
Coating uniformity, %	<+/- 10%

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