

OPTICS FOR ULTRAFAST LASERS



OPTOMAN



LADY DISPERSION

OPTOMAN

YOUR SIDEKICK FOR
LASER OPTICS DEVELOPMENT

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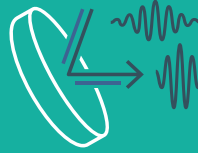
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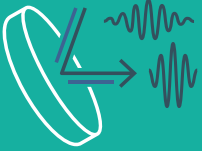
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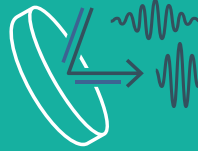
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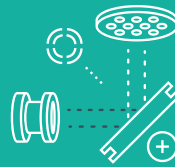
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HIGHLY CUSTOMIZED AND APPLICATION OPTIMIZED LASER OPTICS FOR DEMANDING APPLICATIONS FROM DEMANDING MARKETS



Optics for
DPSS Lasers



Optics for
Medical Laser
Systems



Optics for
Ultrafast Lasers



Optics for Defense
Applications and
LIDARs



Optics for multi
kW Laser Systems



Optics for
micromachining and
macromachining
systems



Research &
Development



Optics for Inspection
Measurement and
Diagnostics Systems



Optics for
Biomedical
Applications



ABOUT OPTOMAN

Born in 2017 in Vilnius, Lithuania, OPTOMAN is a coatings SuperHero, who designs, develops and manufactures advanced, high accuracy and repeatability thin film coatings by Ion-beam sputtering (IBS) technology. By digging deep into each application, OPTOMAN provides custom, application-optimized optics for academia and industry.

OPTOMAN as your sidekick is always willing and ready to help you with finding optimized solutions (ultra)fast and back you up in critical situations and finally get the job done as was promised.

What makes OPTOMAN different?

Imagine you're the high-tech SuperHero, say Batman, and you need high-tech gadgets. You can try and find appropriate gadgets to buy, maybe even an Iron Man suit, but you're the Batman, you're unique, you have kick-ass martial arts skills and your gadgets need to support them. That's when Batman turns to Alfred, who develops gadgets, consults you and basically shares the same KPI - protect Gotham. OPTOMAN is Alfred.

**HI, I AM OPTOMAN - YOUR
SIDEKICK FOR LASER OPTICS
DEVELOPMENT**

**92 % OF CUSTOMERS CONSIDER
OPTOMAN A STRATEGIC PARTNER**

(in OPTOMAN terms - a sidekick for
laser optics development)*

CORE COMPETENCE

- Ultrafast laser optics.
- High LIDT and enhanced lifetime.
- Durable and environmentally stable coatings.
- Extreme low-loss coatings.
- Agility, flexibility, and quick prototyping.



* Customer satisfaction survey results, 2022



CAPABILITIES

SuperHero Power Coatings

High reflectance coatings:

- $> 1 \text{ J/cm}^2$ @ 1030 nm, 500 fs, 10^5 -on-1;
- $> 11.20 \text{ J/cm}^2$ @ 355 nm, 6 ns, 10^3 -on-1;
- $> 0.484 \text{ J/cm}^2$ @ 343 nm, 300 fs, 10^7 -on-1.

Anti-reflective coatings:

- $> 40 \text{ J/cm}^2$ @ 1064 nm, 10 ns, 10^3 -on-1;
- $> 12.66 \text{ J/cm}^2$ @ 355 nm, 6 ns, 10^3 -on-1.

Polarizing coatings:

- $> 18.7 \text{ J/cm}^2$ @ 1064 nm, 10 ns, 10^3 -on-1.

Optics for Mid-IR applications

- Low absorption coatings.
- Spectral range 1 – 5 μm .
- Broadband turning/bending mirrors with $R > 99.8\%$.
- Chirped and GTI mirrors for ultrafast laser systems.
- Coatings on CaF_2 , MgF_2 , YAG, Sapphire, Silicon substrates.

Extreme low-loss coatings:

- Super Mirrors HR ($R > 99.995\%$).
- Precision Thin-film Polarizers (Tp/Ts ratio $> 10000:1$).
- $R < 0.01\%$ Anti-Reflective Coatings.
- Coating with an absorption loss of $< 1 \text{ ppm}$.

Application oriented optics for:

- Medical lasers (Er:YAG, Ho:YAG, Nd:YAG, Alexandrite...).
- Mirrors for galvo-scanners (Silicon, UVFS...).
- Membrane mirrors for deformable mirror assemblies.
- OPO, OPA, OPCPA.
- Defense & Aerospace industries.
- Mirrors for multipass cells (MPC).

Bread and butter

- Laser line and broadband mirrors (HR $> 99.99\%$).
- $R < 0.05\%$ Anti-Reflective Coatings.
- Thin Film Polarizers (Tp/Ts extinction ratio $> 1000:1$).
- Pump, dichroic Mirrors (eg. HR $> 99.9\%$ + HT $> 99\%$).
- Output couplers, plate beam splitters (eg. PR $50\% \pm 1\%$).
- Spectral range 193 nm - 5000 nm.
- Component size: from 3 mm up to 300 mm.
- Coatings can be applied on plane, spherical, cylindrical, aspherical, elliptical surfaces, prisms and other exotic configurations.
- Ultrafast (express) prototyping service available.

Some of cool stuff we do:

- Knife-edge coated optics (edge chips $< 50 \mu\text{m}$).
- 100% coated aperture components.
- Segmented/Masked coatings.
- Stress-compensated coatings (PV flatness $< \lambda/20$ @ 633 nm).
- Coatings on multi-surface prisms.
- Coatings on micro lens assemblies.
- Coatings on big size wafers (up to a diameter of 300 mm).
- Zero phase shift mirrors.
- Coatings on metal substrates.
- Optical assemblies.
- Coatings on fast axis collimators (FAC).
- Coatings on fibers and end caps.

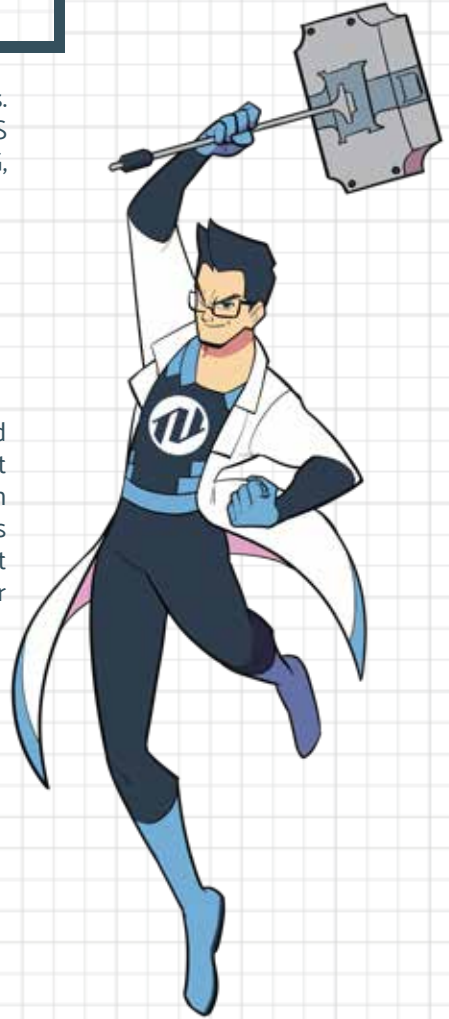


MIRRORS FOR BIG & SCARY FS, PS LASERS

High laser power levels call for high-power measures. OPTOMAN is here to save the day with high reflectivity IBS mirror coatings designed for big & scary ultrafast Yb:YAG, Yb:KYW/KGW, Yb doped fiber lasers.

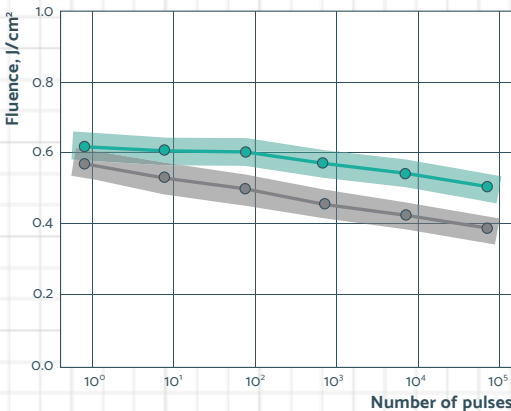
- Low GDD performance.
- Optimized for high average power ultrafast laser systems.
- Absorption within coating < 1 ppm @ 1064 nm.
- Zero-phase shift behavior.

While high laser-induced damage threshold is a buzzword when talking femtosecond & picosecond optics, it is not (only) the nominal LIDT value that matters. The separation of laser damage modes - catastrophic and color-change - is evident when measuring standard optics. The fatigue effect of color-change damage becomes even more significant for high-power mirrors after prolonged radiation (>10³ pulses).

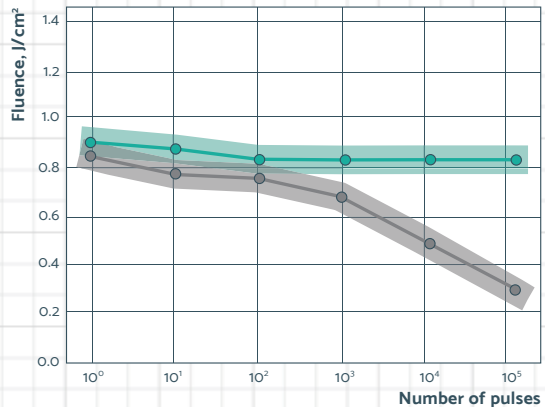


Color-change effect is an arch-enemy and a LIDT-limiting factor for ultrafast applications, and has to be eliminated in order to increase the lifetime of optics

Market-Standard Mirrors



Market-Standard High Power Mirrors



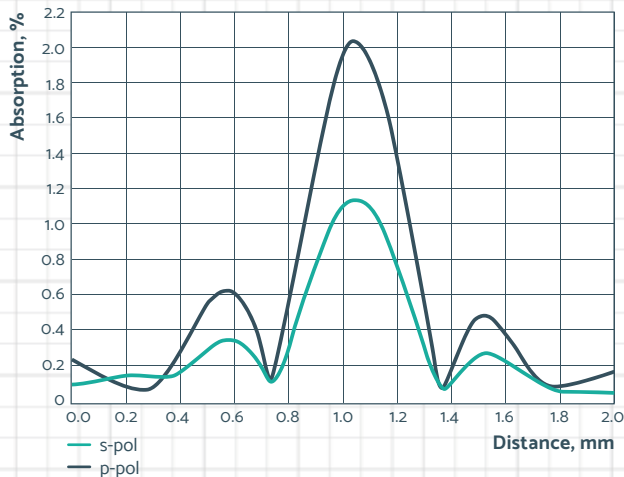
- Catastrophic
 - 95% confidence interval
 - Color change
 - 95% confidence interval
- Wavelength: 1030 nm
Pulse duration (FWHM): 491.1 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: Linear P
Beam diameter (1/e²): (177.4 ± 3.6) μm

- Catastrophic
 - 95% confidence interval
 - Color change
 - 95% confidence interval
- Wavelength: 1030 nm
Pulse duration (FWHM): 491.1 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: Linear P
Beam diameter (1/e²): (177.4 ± 3.6) μm

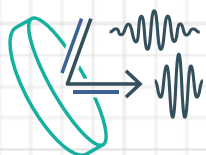
It is well known that absorption is the main cause of laser damage. Strategically working towards color-change elimination, OPTOMAN did a number of R&D runs, aiming to optimize coating design, coating parameters as well as pre- and post- coating processes. Eventually, OPTOMAN was able to reduce coating absorption down to ~1 ppm for the s-polarization component and ~2 ppm for the p-polarization component:

Absorption @ 1064 nm ~1 ppm for s-pol component and ~2 ppm for p-pol component.

Measured by PCI technology.



This achievement has paved the way to develop a product specifically optimized for ultrafast laser applications - SuperHero League Mirrors featuring no color-change damage. The LIDT of these mirrors is defined only by the catastrophic-damage values which have also been boosted and are higher than market-standard high-power mirrors.



SUPERHERO LEAGUE MIRRORS (ULLM5SHL)

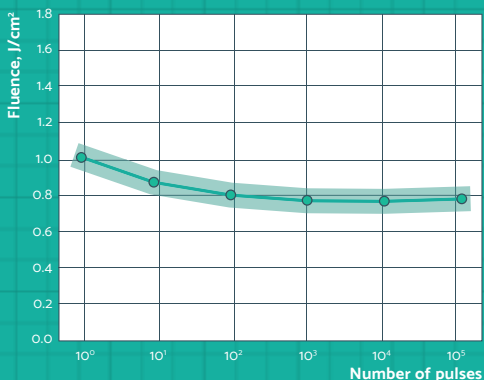


Order this product from OPTOSHOP

- Very high LIDT
- No color-change damage
- Fully characterized



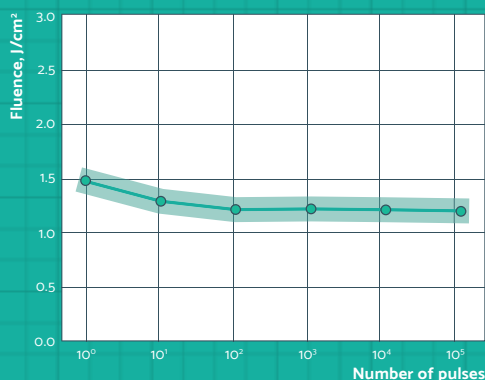
High confidence level >0.7 J/cm²



- Catastrophic
- 95% confidence interval

Wavelength: 1030 nm
Pulseduration (FWHM): 497.7 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: P
Beam diameter (1/e²): (176.8 ± 4.8) μm

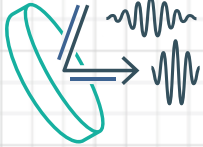
High confidence level >1 J/cm²



- Catastrophic
- 95% confidence interval

Wavelength: 1030 nm
Pulseduration (FWHM): 491.1 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: Linear S
Beam diameter (1/e²): (177.4 ± 3.6) μm

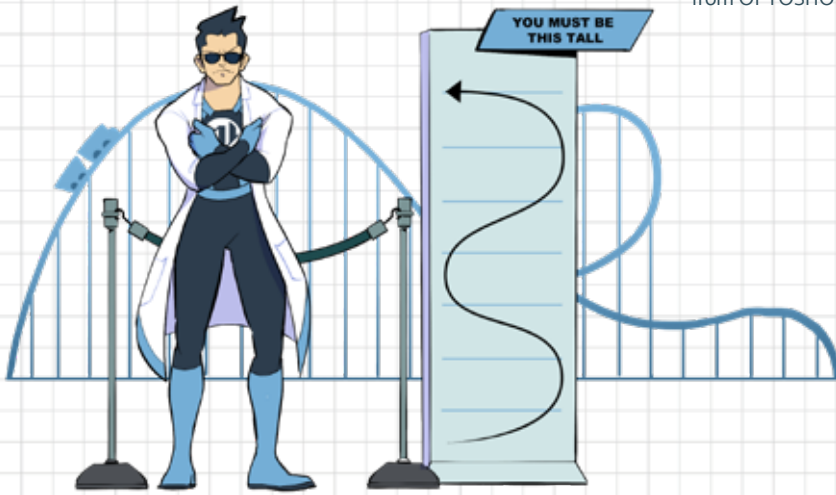
SuperHero League Mirrors are the upgraded version of
OPTOMAN bestseller – ULLM5 mirrors.



STANDARD MIRRORS (ULLM5)



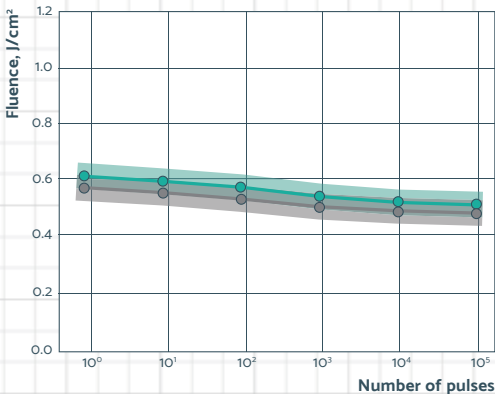
Order this product
from OPTOSHOP



- Perfect price-to-performance ratio
- Industry standard specifications
- Fully characterized

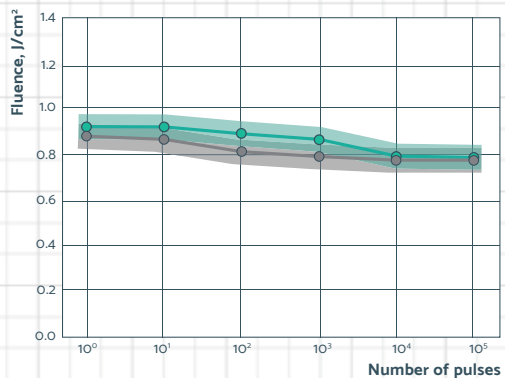
LIDT	Lifetime	Price
●●●●●○	●●●●●○	●○○○○○

High confidence level >0.4 J/cm²



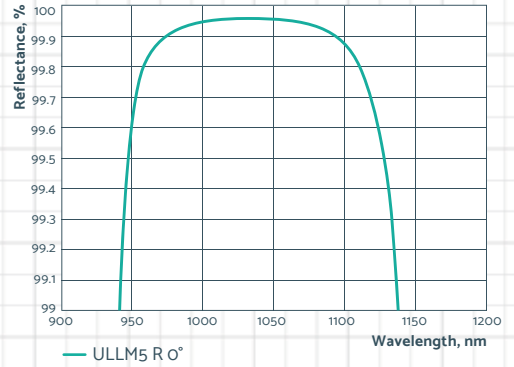
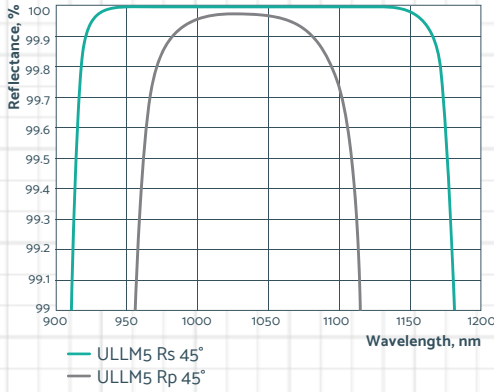
- Catastrophic
 - 95% confidence interval
 - Color change
 - 95% confidence interval
- Wavelength: 1030 nm
Pulse duration (FWHM): 491.1 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: Linear P
Beam diameter (1/e²): (177.4 ± 3.6) μm

High confidence level >0.7 J/cm²



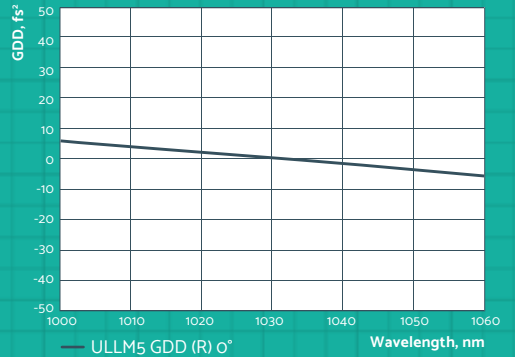
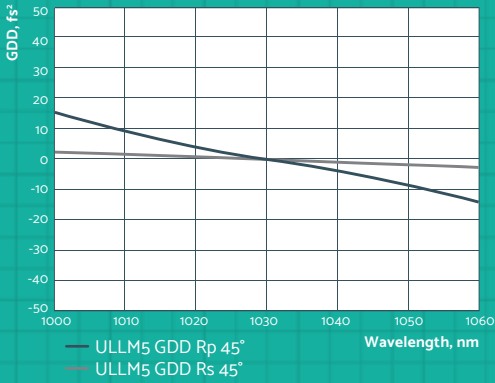
- Catastrophic
 - 95% confidence interval
 - Color change
 - 95% confidence interval
- Wavelength: 1030 nm
Pulse duration (FWHM): 491.1 fs
Repetition rate: 10 kHz
AOI: 45°
Polarization: Linear S
Beam diameter (1/e²): (177.4 ± 3.6) μm

Rs > 99.95% & Rp > 99.9% @ 1010-1050 nm



Reflected Group Delay Dispersion

IGDD Rsl < 20 fs², IGDD Rpl < 50 fs²



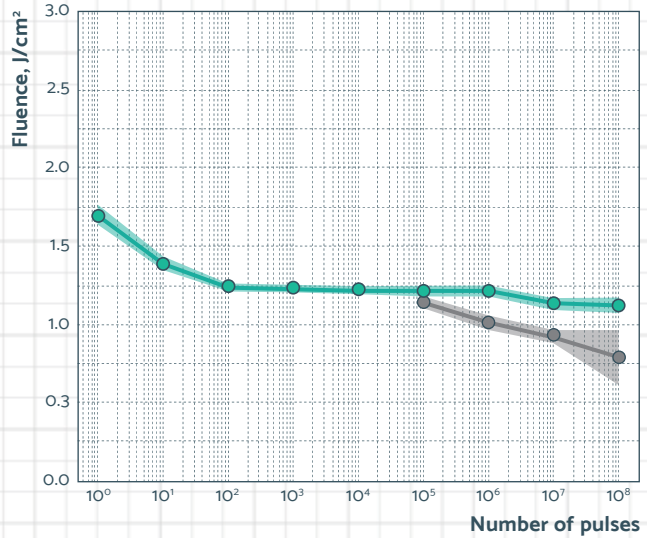
	Standard (ULLM5)	SuperHero League (ULLM5SHL)
Substrate	UVFS	
Surface Quality, S1	10-5 S-D (MIL-PRF-13830B)	
Surface Flatness, S1	<λ/10 @ 633 nm over CA	
AOI	0° or 45° or which ever °	
Coating (IBS)	HRs > 99.95% & HRp > 99.9% @ 1010 - 1050 nm (Yes, custom bandwidths available)	
Laser Induced Damage Treshold	Femtosecond: > 0.4 J/cm ² , 1030 nm, 500 fs, 10 kHz, p-pol > 0.7 J/cm ² , 1030 nm, 500 fs, 10 kHz, s-pol	Femtosecond: > 0.7 J/cm ² , 1030 nm, 500 fs, 10 kHz, p-pol > 1 J/cm ² , 1030 nm, 500 fs, 10 kHz, s-pol
	Picosecond: > 2 J/cm ² , 1030 nm, 10 ps, 10 kHz, p-pol > 3 J/cm ² , 1030 nm, 10 ps, 10 kHz, s-pol	Picosecond: > 3 J/cm ² , 1030 nm, 10ps, 10 kHz, p-pol > 5 J/cm ² , 1030 nm, 10ps, 10 kHz, s-pol

Working further towards reducing the total cost of ownership for our partners, we have invested in long-term degradation measurements, proving OPTOMAN SuperHero Power mirrors reliability and high-duty cycle.

These results aim to answer your concerns about long-term laser exposure consequences.

LIDT results

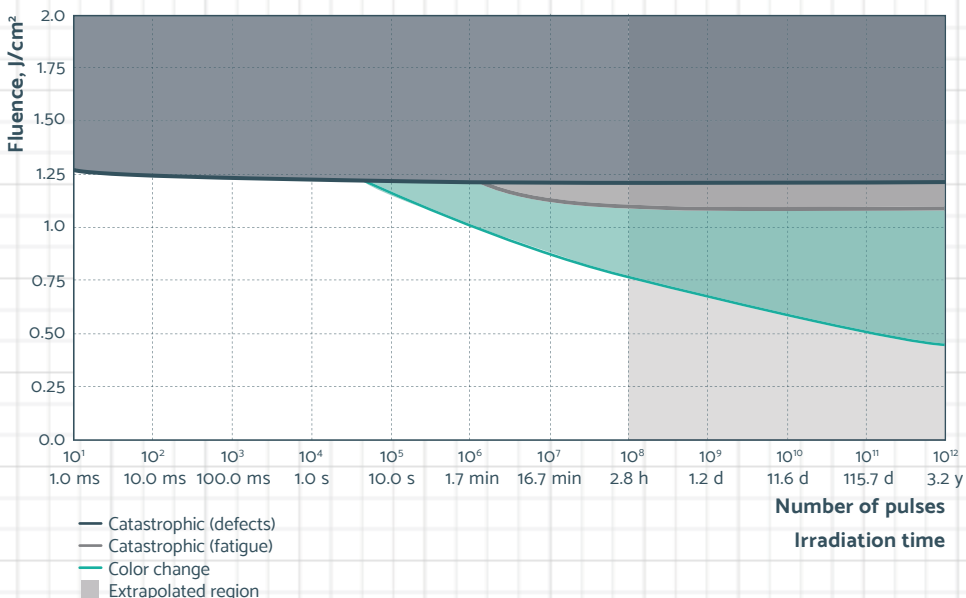
Catastrophic 1-on-1 LIDT	1,70 J/cm ²
Catastrophic 10 ⁸ -on-1 LIDT	1,119 J/cm ²
Color change 10 ⁸ -on-1 LIDT	0,78 J/cm ²
Absorption (1070 nm, Linear S)	< 1 ppm
Absorption (1070 nm, Linear P)	1,6 ppm



- Catastrophic
 - 95% confidence interval
 - Color change
 - 95% confidence interval
- Wavelength: 1030 nm
 Pulse duration (FWHM): 500.9 fs
 Repetition rate: 10 kHz
 AOI: 45°
 Polarization: Linear S
 Beam diameter (1/e²): (185.0 ± 0.9) μm

This measurement and extrapolation demonstrate the fluence levels of SuperHero Power mirrors according different irradiation time.

Basically, this measurement proves that if your laser's fluence is <0.5 J/cm², your laser featuring SuperHero Power mirrors, could run non-stop longer than it takes for a student to finish his physics bachelor's degree.

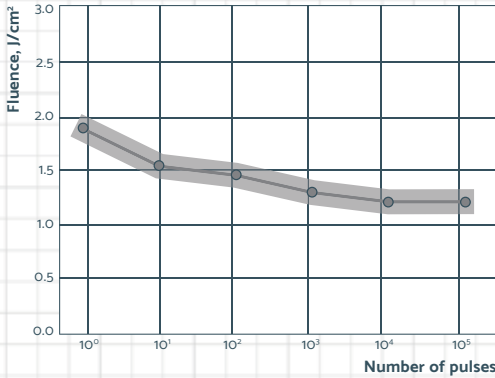


OPTOMAN DOESN'T STOP HERE...



Keep an eye out for our technological developments that are still in progress. Coatings featuring super high LIDT with no color-change degradation are under development. Preliminary R&D figures:

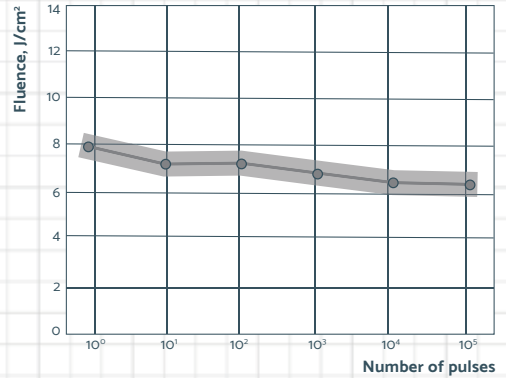
LIDT > 1.2 J/cm², 1030 nm, 500 fs, 10 kHz, s-pol



- Catastrophic
- 95% confidence interval

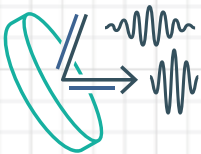
Wavelength: 1030 nm
 Pulse duration (FWHM): 500.3 fs
 Repetition rate: 10 kHz
 AOI: 45°
 Polarization: Linear S
 Beam diameter (1/e²): (176.0 ± 1.1) μm

LIDT > 6 J/cm², 1030 nm, 10 ps, 10kHz, s-pol



- Color change
- 95% confidence interval

Wavelength: 1030 nm
 Pulse duration (FWHM): 10.1 ps
 Repetition rate: 10 kHz
 AOI: 45°
 Polarization: Linear S
 Beam diameter (1/e²): (113.2 ± 0.8) μm

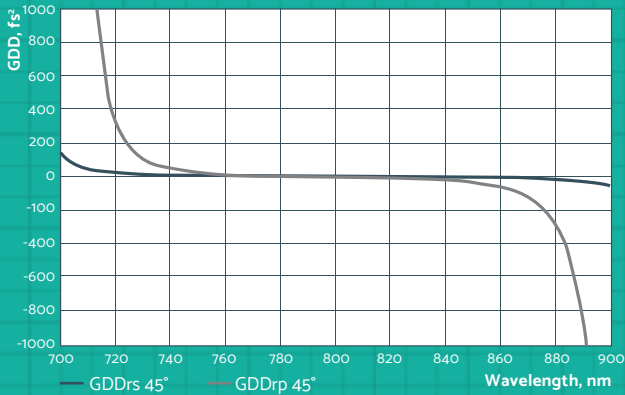
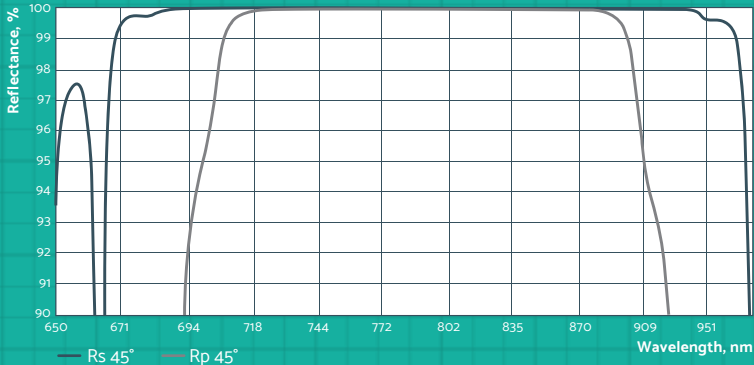


OPTICS FOR Ti:SAPPHIRE LASERS

Ti: Sapphire lasers, featuring relatively broad emission wavelengths, typically between 700 nm and 900 nm, sometimes even 650 -1100 nm, are the tough challenge for optical coatings manufacturers. Especially when you combine such a broad spectrum together with high power few tens of femtoseconds pulses. However, optical components shouldn't cause a headache for laser manufacturers. So if you're still looking for **durable, long-lasting, high LIDT** optics for your Ti:Sapphire laser, congratulations - you're at the right place!

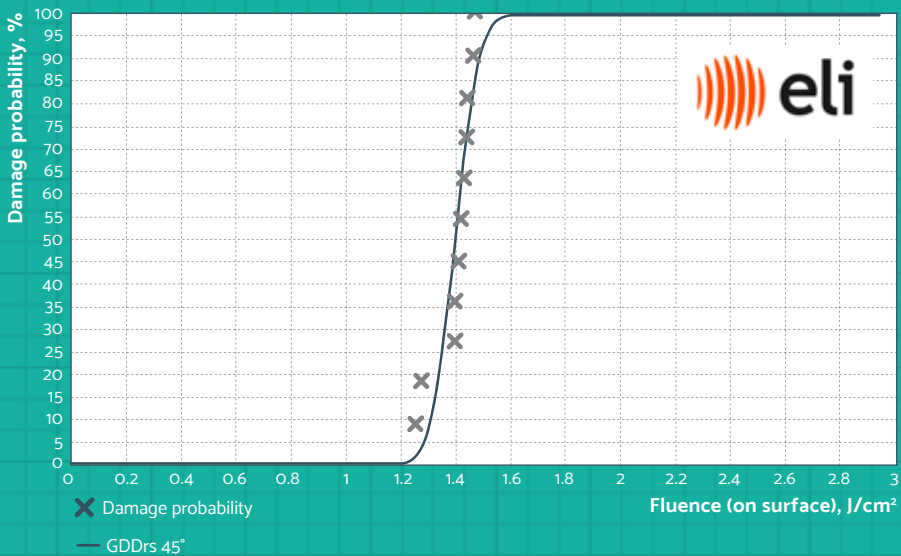
Design examples

HRs>99.9% @ 700-920 nm + HRp>99.9% @ 730-870 nm, AOI=45° (low GDD)



LIDT results

If you're into Ti:Sapphire business and are aware of the offerings in the market, you'll probably be pretty impressed with what OPTOMAN has achieved in terms of LIDT:



LASER PARAMETERS

Central Wavelength: 800 nm
Pulse duration (FWHM): (47 ± 5) fs
Repetition rate/frequency: 100 Hz
Angle of incidence: 45°

TEST PROCEDURE

Test type: S-on-1 (10k-on-1), R-on-1
Test environment: vacuum $\rightarrow 1, 5 \times 10^{-5}$ mbar

S polarization LIDT: 1.397 J/cm²

P polarization LIDT: 0.71 J/cm²

No color change



IBS COATED OPTICS FOR ULTRA VIOLE[N]T LASERS

OPTOMAN has done quite a unique thing – optimized the IBS coating process to make low absorption and high longevity dielectric optical components for ULTRA VIOLE[n]T LASERS.

Main challenges that UV optics face:

- Low transparency due to absorption
- Scattering due to even tiny imperfections
- Laser damage and long-term degradation

WHY NOT METAL OR FLUORIDE COATINGS?

Fluoride coatings:

Soft coatings



High surface roughness



Scattering and rapid coating degradation

Metal coatings:

High absorption



Heating

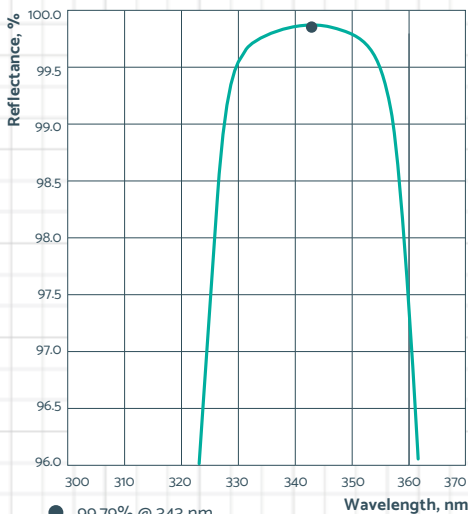


Laser damage

Design examples

HRa > 99.7% @ 343 nm, AOI = 45°.

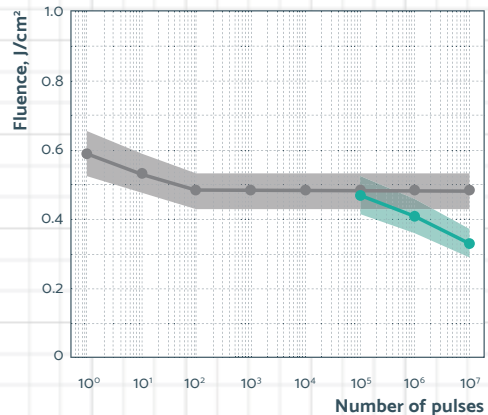
For high power femtosecond applications.



HR @ 343 nm for ultrafast laser applications:

LIDT (catastrophic): >0.484 J/cm² @ 343 nm, 300 fs, 10⁷ – on – 1

LIDT (color change): >0.332 J/cm² @ 343 nm, 300 fs, 10⁷ – on – 1



● Offline detection

■ 95% confidence interval

● Color change

■ 95% confidence interval

Wavelength: 343 nm

Pulse duration (FWHM): 300 fs

Repetition rate: 200 kHz

AOI: 45°

Polarization: Linear S

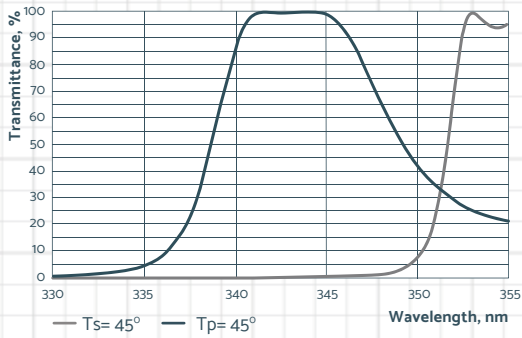
Beam diameter (1/e²): (19.5 ± 0.5) μm

Low Absorption Polarizer 343 nm

Coatings (IBS):

S1: $R_s > 99.7\%$ & $T_p > 95\%$ @ 343 nm, AOI = $45^\circ \pm 2^\circ$

Extinction ratio: $T_p/T_s > 300:1$



GTI AND CHIRPED MIRRORS

The Gires-Tournois Interferometer (GTI) mirror is a dielectric dispersive mirror with a spatial variation of the layer thickness values. Such mirrors are used for dispersion compensation in mode-locked lasers, for example.

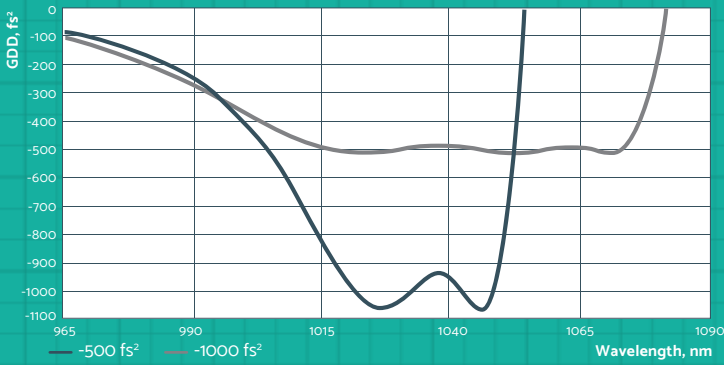
FEATURES:

- Dispersive mirrors – chirped and GTI design;
- Spectral range 250nm - 5000 nm;
- Negative GDD down to -5000 fs²;
- Positive dispersion mirrors;
- Low (flat) or predefined GDD behavior;
- LIDT >0.3 J/cm² @ 1030nm, 50 fs, 150 kHz;
- LIDT >0.25 J/cm² @ 266 nm, 180 fs, 10 kHz.



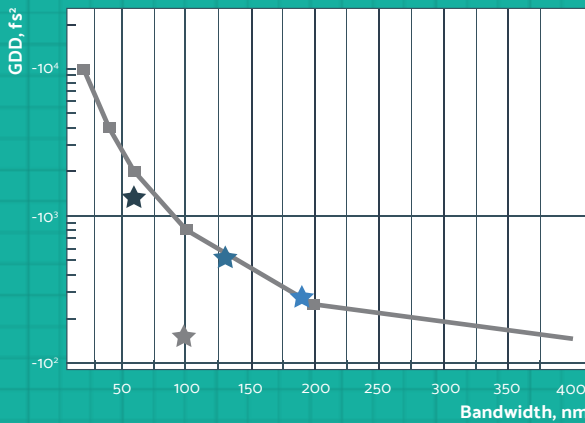
GDD VS BANDWIDTH

It is important to note that bandwidth and GDD are closely connected. A high value of negative GDD results in a very narrow bandwidth. For a better understanding, see the graph below.



GDD vs Wavelength for different chirped mirror designs. A more negative GDD value results in a narrower operational bandwidth.

Below graph indicates GDD dependence on operational bandwidth at a fixed coating thickness of 10 μm . Stars on the graph indicate experimentally produced designs,



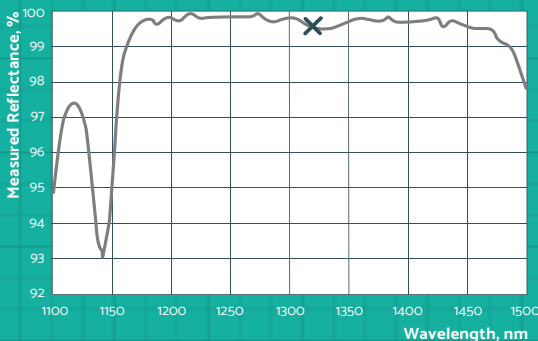
- Theoretical design:**
- 10 μm
- Produced coatings:**
- ★ 10.3 μm
- ★ 12.2 μm
- ★ 11.9 μm
- ★ 9.9 μm

Relation between dispersive mirror operational bandwidth and average achievable GDD.

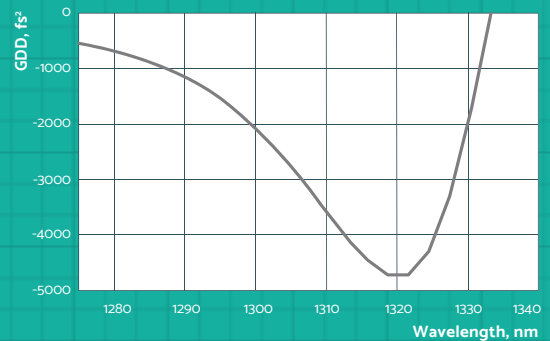
Source: PERVAK, V., et al. Empirical study of the group delay "Optics express", 2013, 21:15: 18311-18316. dispersion achievable with multilayer mirrors.

Design examples

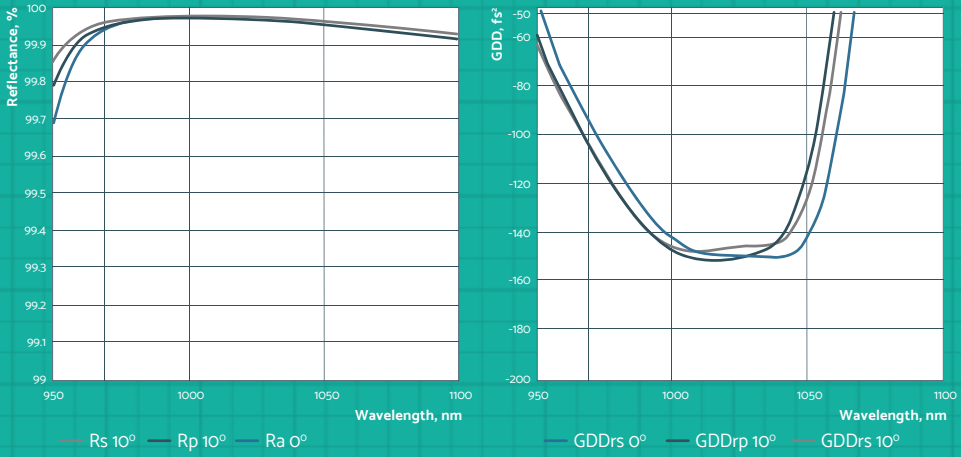
HRs > 99.5% @ 1320 nm, AOI 45°, GDD_Rs -5000 \pm 2500 fs² @ 1315-1325 nm, AOI 45°



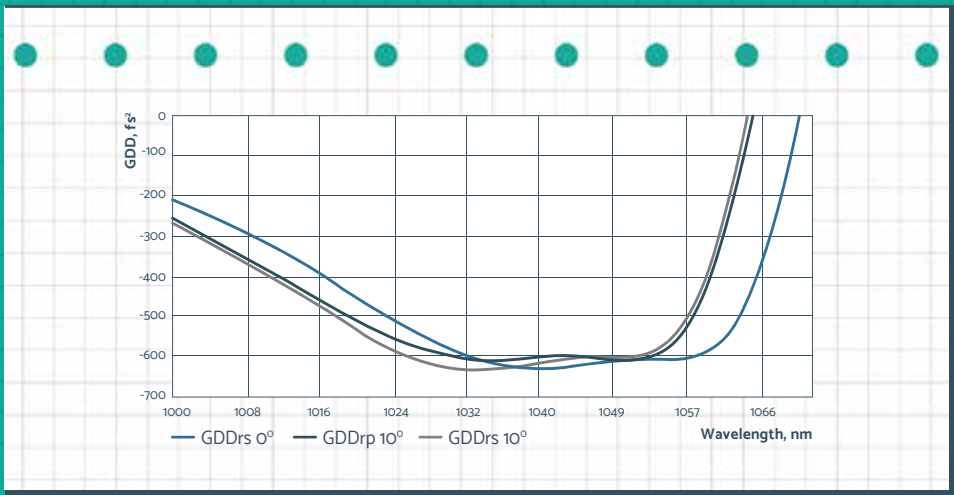
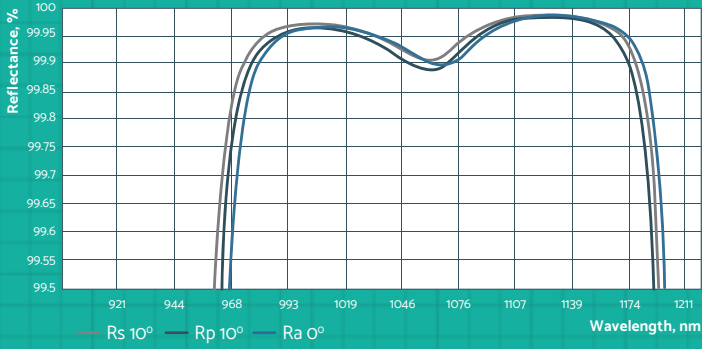
X 99.61% @ 1320 nm

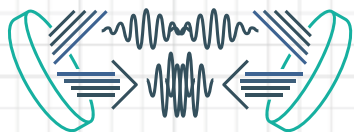


HRs, $p > 99.98\%$ (best effort 99.99%) @ 1020 - 1030 nm, AOI = 0-10° (GDDs, $p = -80 \pm 20 \text{ fs}^2$ (best effort +/-15 fs²))



Rp & Rs > 99.8% @ 1010 - 1050 nm, AOI = 0-10°
 GDD_avg = -600 fs² ± 150 fs² @ 1025 - 1055 nm, AOI = 0-10°



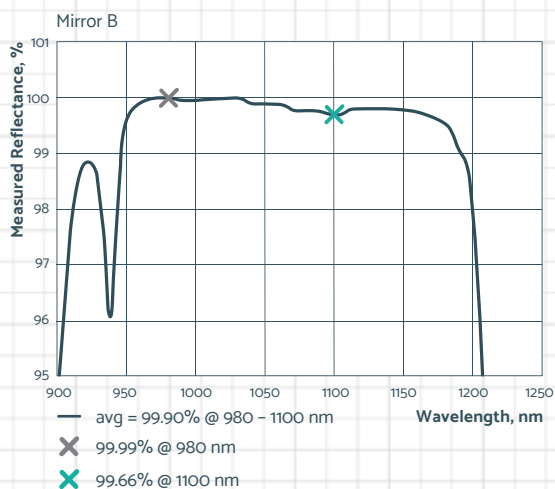
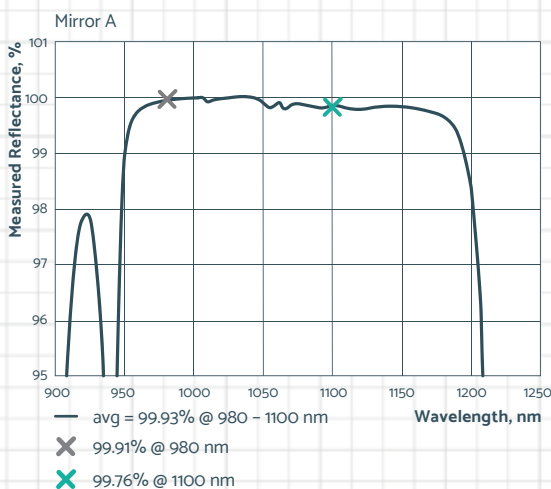


CHIRPED MIRROR PAIRS

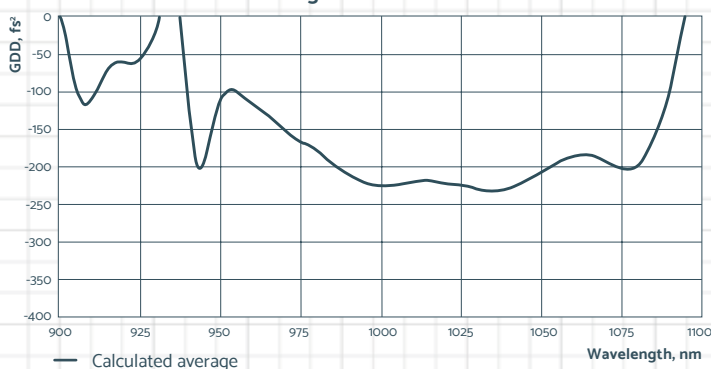
Matching chirped mirror pairs give a dispersion compensation effect for ultrafast laser pulses, for example in OPCPA systems. A pair of precisely designed optical mirrors cancel out oscillations of each other by featuring out-of-phase GDD.

Design examples

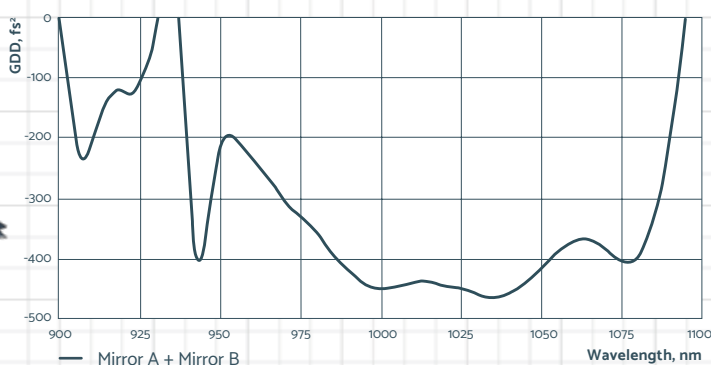
HR > 99.8% @ 980 - 1080 nm, AOI = 5° (per mirror);
 GDD = -400fs² +/- 80fs² @ 980 - 1075 nm, AOI = 5° (per pair)

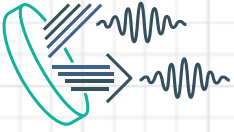


Average GDD Performance



GDD Performance





MIRRORS FOR MULTIPASS CELLS (MPC)

A dielectric fight for pulse duration downscaling and energy upscaling IN MULTIPASS CELLS (MPC)

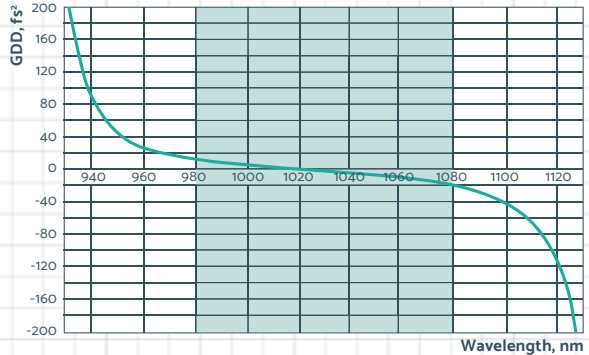
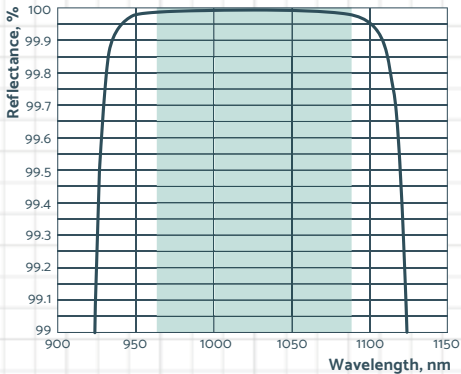
Nonlinear compression of laser pulses with tens of millijoule energy in a gas-filled multipass cell is a promising approach to realize a new generation of high average power femtosecond sources.

The whole approach relies on efficient HR mirrors, which enable to have a large number of reflections with low losses.

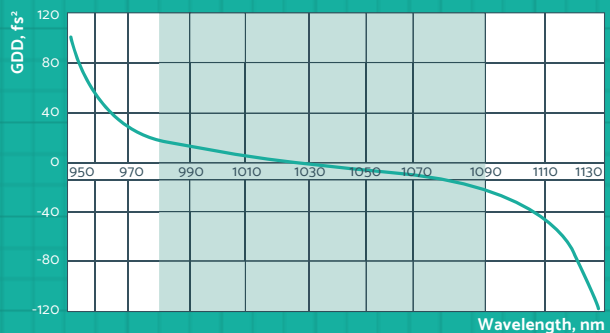
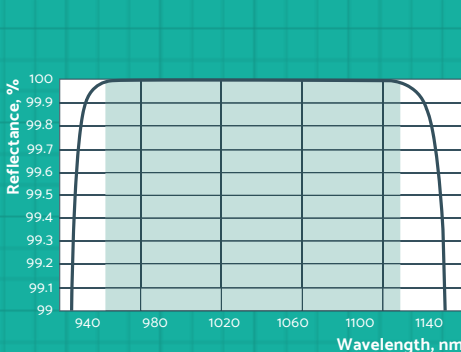
OPTOMAN developed dielectric mirrors optimized specifically for MPC application. OPTOMAN offers flat, concave, and convex broadband mirrors with high **reflectivity ($R > 99.99\%$)**, **high LIDT ($> 0.69 \text{ J/cm}^2 @ 1030 \text{ nm}, 200 \text{ fs}, 10^5 \text{ -ON-1}$)** and **low and smooth GDD**.

Design examples

HR > 99.99% @ 970-1090 nm, AOI = 0° (IGDDr1 < 20 fs² @ 980-1080 nm)

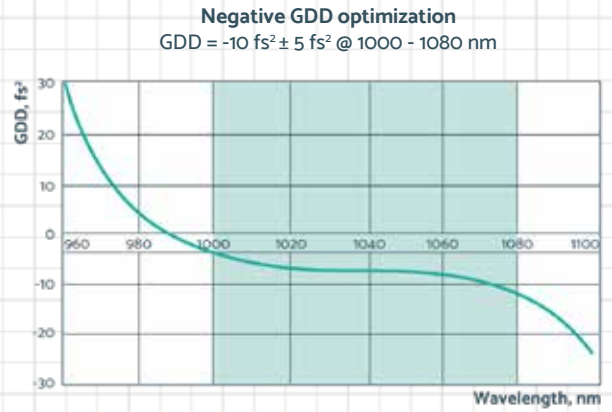


HR > 99.95% @ 950-1130 nm, AOI = 0° (IGDDr1 < 20 fs² @ 980-1090 nm)



Features

- Mirrors available in spectral range of 400-2000 nm;
- HR (in gas) > 99.99%;
- Absorption: <1 ppm @ 1030 nm.
- LIDT: >0.69 J/cm² @ 1030 nm, 200 fs, 10⁵ -on-1

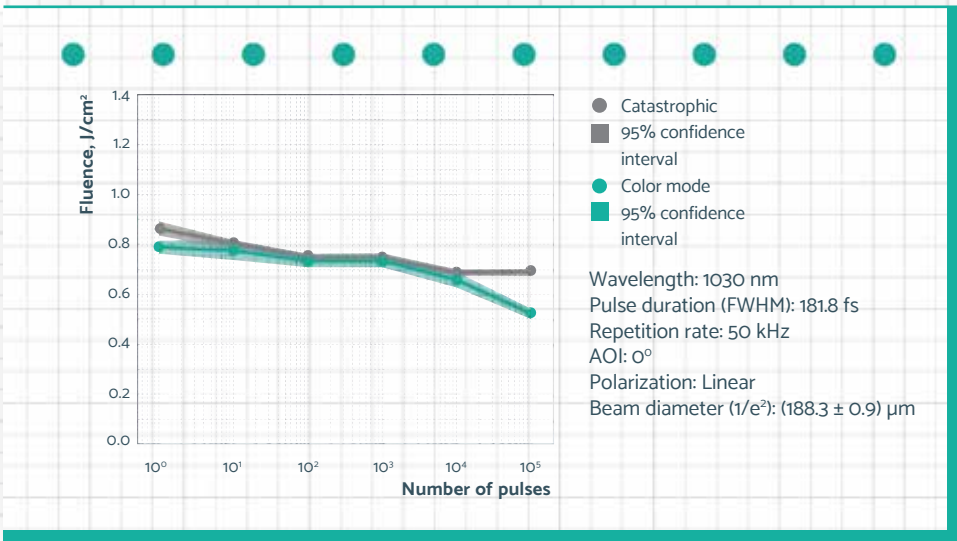


Higher LIDT or broader spectrum?

	OPTION 1 - Enhanced LIDT	OPTION 2 - Enhanced Spectral Bandwidth
Spectral bandwidth	<170 nm at R>99.9% level	<260 nm at R>99.9% level
Group delay dispersion	< ±20 fs ² < 90 nm	< ±20 fs ² < 130 nm
Reflection	R>99.98% (confident 99.95%)	R>99.98% (confident 99.95%)
Absorption	A<1.5 ppm	A<3 ppm (confident 5 ppm)
LIDT	>0.69 J/cm ² @ 1030 nm, 180 fs	>0.2 J/cm ² @ 1030 nm, 180 fs

LIDT measurement

Test mode	Threshold (Catastrophic)			Threshold (Color mode)		
1-on-1	0.865	+0.030 -0.030	J/cm ²	0.790	+0.029 -0.028	J/cm ²
10-on-1	0.799	+0.019 -0.019	J/cm ²	0.777	+0.041 -0.040	J/cm ²
10 ² -on-1	0.742	+0.019 -0.019	J/cm ²	0.735	+0.027 -0.026	J/cm ²
10 ³ -on-1	0.742	+0.019 -0.019	J/cm ²	0.735	+0.027 -0.026	J/cm ²
10 ⁴ -on-1	0.690	+0.015 -0.015	J/cm ²	0.659	+0.034 -0.033	J/cm ²
10 ⁵ -on-1	0.690	+0.015 -0.015	J/cm ²	0.523	+0.020 -0.020	J/cm ²

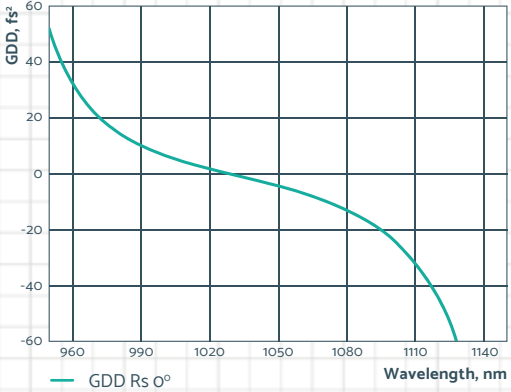
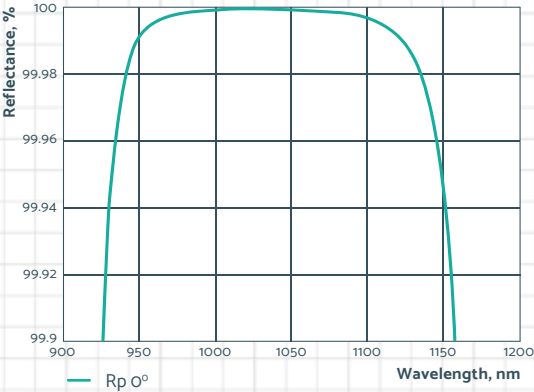


OPTOMAN STANDARD MPC MIRROR



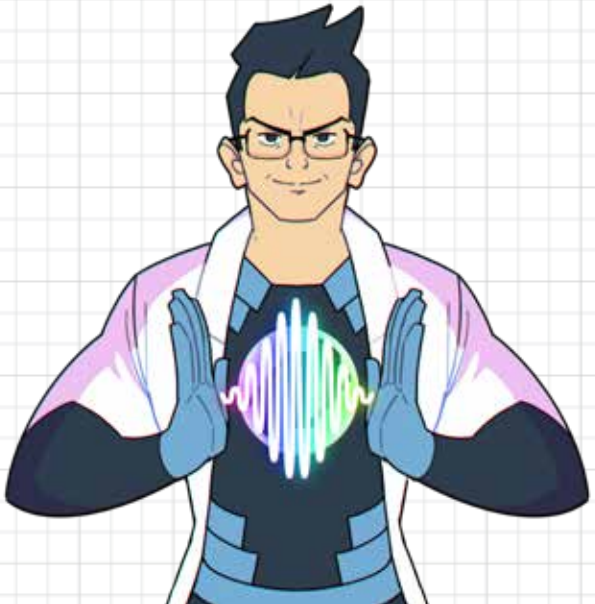
Order this product from OPTOSHOP

PCV-R300-UVFS-76.2-ET12.5-LLM196



- Material:** UVFS
- Diameter:** 76.2 mm +0/-0.2 mm
- Edge thickness:** 12.5 mm +/- 0.2 mm
- ROC S1 (concave):** 300 mm +/-0.5%
- Surface quality, S1:** 20-10 S-D MIL-PRF-13830B
- Surface irregularity, S1:** $\lambda/8$ @ 633 nm
- Surface 2:** commercial polish
- Centration:** <math><3</math> arcmin
- Protective chamfer:** 0.4-0.6 mm x 45°
- Arrow marks to S1, concave

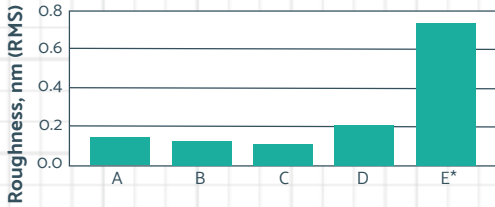
- Coatings (IBS):**
- S1 (arrow marks, CV):** HR>99.99% @ 980-1080 nm, AOI=0°
- IGDDrI <math><50</math> fs² @ 980-1080 nm
- S2:** uncoated





EXTREME LOW-LOSS COATINGS

Absorption and scattering are the main limiting factors when trying to manufacture perfect coatings. But what if absorption loss and surface roughness were limited down to <2 ppm and <2 Å respectively? Pretty close to perfect, right? This has been an object of OPTOMAN R&D activities for the past few years. That is why OPTOMAN can manufacture Super Mirrors, 10000:1 contrast Thin Film Polarizers, $R<0.01\%$ AR Coatings, and many more extremely good stuff.

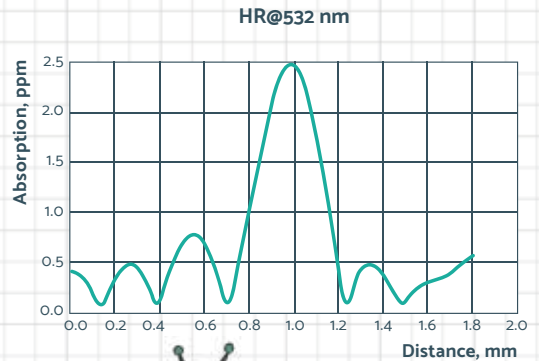
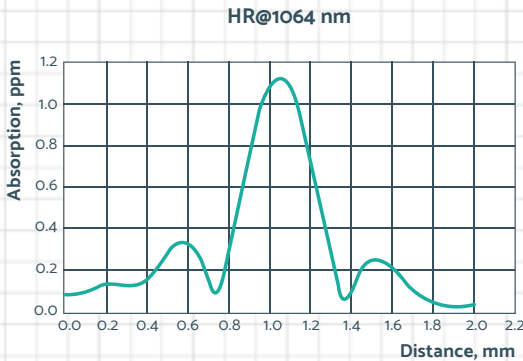


Roughness measurement results of super polished (A, B, C, D) and standard commercial grade substrates.

E* Standard commercial substrate.

Roughness plays a critical role in managing total integrated scatter to be as low as possible. The big goal is to stay below 2 Å RMS value, which is possible with fancy super-polished substrates.

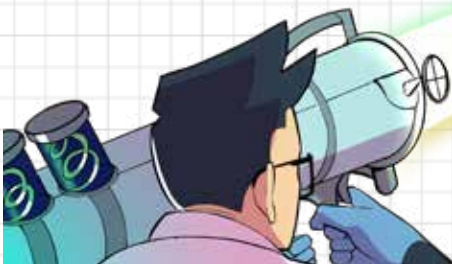
Light absorption is another loss driver and is responsible for unwanted thermal effects in high power laser systems. Keeping absorption rates below 2 ppm, reflectance value above 99.998% is achievable as well as component heating effect is negligible if existing at all.



Longitudinal photothermal absorption measured of HR@1064 nm and HR@532 nm coatings.



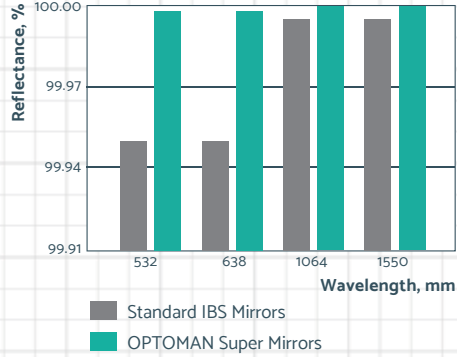
DR. ABSORPTION



SUPER MIRRORS

Dielectric mirrors with extremely low losses become Super Mirrors. Their superpower of high reflectance comes from the OPTOMAN's continuous effort to add more and more nines after the point when talking about reflectance values.

Standard IBS coated mirrors and super mirrors



CRD measurement results:

HR>99.998% @ 532 nm, AOI=0° Total loss=40 ppm	HRs>99.99857% & HRp>99.99816% @ 1064 nm, AOI=45°
HR>99.9983% @ 638 nm, AOI=0° Total loss=17 ppm	Total loss = 14.3 ppm (S-pol) and 18.4 ppm (P-pol)
	HR>99.9997% @ 1064 nm, AOI=0° Total loss = 3 ppm

Disclaimer: Reflectance values for Super Mirrors illustrate the very best achieved values and current max level of capabilities.

LOW LOSS ULTRAFAST MIRRORS

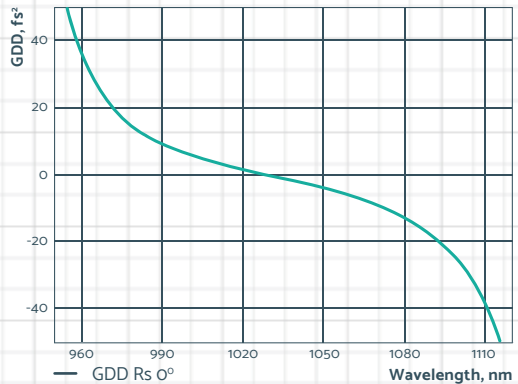
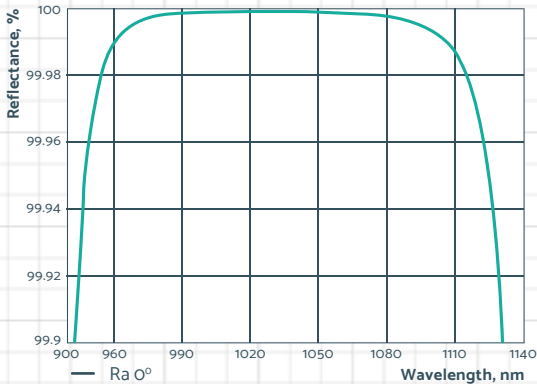
LOW ABSORPTION AND HIGH EFFICIENCY



Order this product from OPTOSHOP

Design examples

Coating code: LLM134
Coatings (IBS)
HR>99.995% @ 1030 nm, AOI=0°



MEASURING CAPABILITIES FOR LASER OPTICS

As with great laser power comes great responsibility for coaters, OPTOMAN acts responsibly during the whole supply chain process, including post-coating quality checks. OPTOMAN is carefully inspecting the quality of the optics produced, so the customer could enjoy seamless usage of optical components, without investing his time and effort to ensure that optics are compliant to the specifications.

Measuring capabilities:

Cosmetic surface quality inspection	MIL-PRF-13830B, ISO 10110, or customer-specific conditions
Spectral measurements	Tsp, Rsp @ 220 nm - 5000 nm, from 0° to 75° AOI
LIDT & Lifetime testing	ISO 21254 (CW, ns, ps, fs)
Environmental testing	MIL-C-484197
GD, GDD, TOD measurements	700-1600nm Rsp AOI=0° and 45°
Absorption measurements (Photothermal technology)	355 nm, 405 nm, 532 nm, 690 nm, 785 nm, 830 nm, 1064 nm, 1342 nm
Cavity ring-down measurements	532 nm, 638 nm, 1064 nm, AOI=0° and 45° (S-pol, P-pol)
Surface form errors	Down to $\lambda/20$ @ 633 nm. Measured aperture up to 4"
Product design verification	First article inspection (FAI)

WHERE DOES OPTOMAN WORK?

OPTOMAN spends a significant amount of time in manufacturing facilities, therefore he wants to show you how does his 217 m² ISO7 certified workplace look like and what are the key processes that allow him to offer you top-notch optical components.

Preparation of substrates

Firstly, thorough preparation of substrates is needed in order to make quality optical coatings as you don't want to start the coating process on unclean substrates:

OPTOMAN uses a 7-stage fully automated cleaning process, which makes the preparation of substrates efficient and effective.



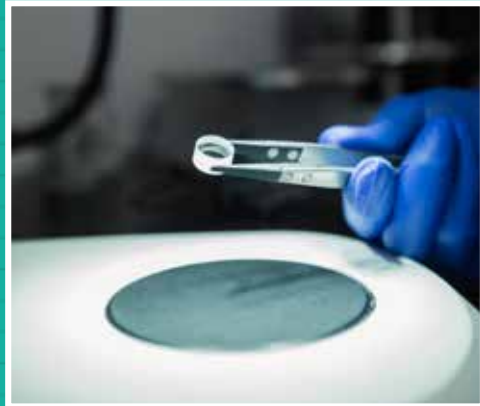
Coating deposition

As with great laser power comes great responsibility for coaters, OPTOMAN uses only the most advanced thin film deposition technology – Ion Beam Sputtering (IBS), which allows him to exploit his superpowers. IBS has the same meaning to OPTOMAN as Mjöltnir hammer has to Thor. So yes, it's pretty important and OPTOMAN does not shy investments to have the best IBS machines in order to provide the best optics. The area where IBS machines are is extra clean, meeting the requirements of ISO 5.



Quality inspection and metrology

OPTOMAN doesn't call optical components high quality by default. Measurements and inspections are needed to define the quality. OPTOMAN is equipped to do it.



Final optical component

Ta-da! OPTOMAN optics are ready to fulfill their purpose – become friends with your laser beam.



R&D ACTIVITIES

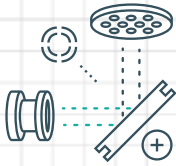
- OPTOMAN heavily invests in R&D activities.
- OPTOMAN cooperate with leading research institutions for extensive characterization and proof of concepts.

Ongoing R&D projects:

- INTENSITY – Development of low total loss coatings for VIS-NIR range.
- UNIPULSE – Development of high LIDT coatings for ps-fs applications for VIS-NIR range.
- INOSTART – Development of MID-IR (1–5 μm) coatings based on oxide / semiconductor materials.
- Neo2Fast – Development of broadband mirrors with High LIDT performance for multi-pass cells sub-10 fs applications.

**"INTELLIGENCE IS
A PRIVILEGE, AND IT
NEEDS TO BE USED FOR
THE GREATER GOOD
OF LASER PEOPLE."**

Dr. Otto Octavius



ABOUT ION-BEAM SPUTTERING TECHNOLOGY

Why IBS?

Ion Beam Sputtering (IBS) is a technique when the layer of a desired material is formed by molecules extracted from the target material by a highly energetic and precisely controlled ion beam.

As with great laser power comes great responsibility for coaters, OPTOMAN is equipped by IBS machines in order to meet the most demanding requirements from most demanding industrial and scientific applications.

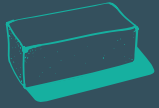
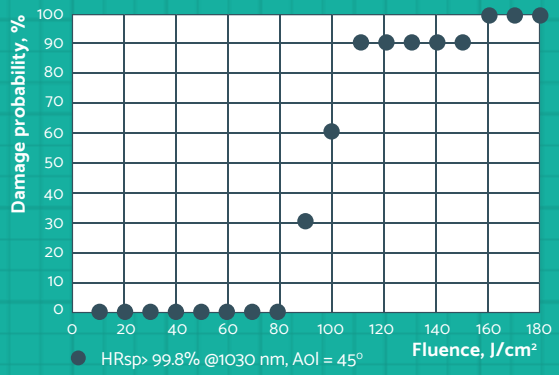


Inherently stable sputtering process

A very stable ion beam combined with high vacuum ($\sim 1 \times 10^{-4}$ mbar during the deposition) and ultra-high purity metal targets (>99.99%) result in a super stable deposition process. It enables a fully automatic deposition and the ability to precisely control refractive indices and thicknesses of each deposited layer.

High resistance to laser irradiation

By choosing proper deposition parameters and ensuring cleanliness in every step of the manufacturing chain, OPTOMAN is able to produce coatings with very low defect densities. That is the reason why IBS coatings exhibit excellent resistance to laser irradiation!



IBS
Near Bulk
Density



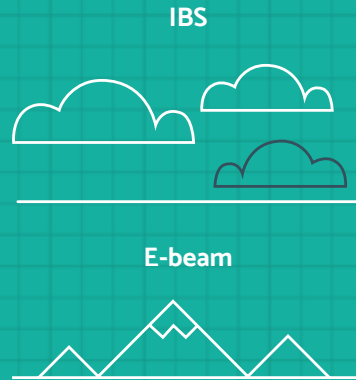
E-beam
Porous
Structure

Bulk-like packing density

Due to the bulk-like layer's density, IBS coatings are completely immune to mechanical wear as well as changes in ambient temperature and humidity and ensure smooth operation of your laser under any circumstances. Moreover, OPTOMAN coatings may be used in harsh environments and even in outer space with no change in performance!

Scattering? What's that?!

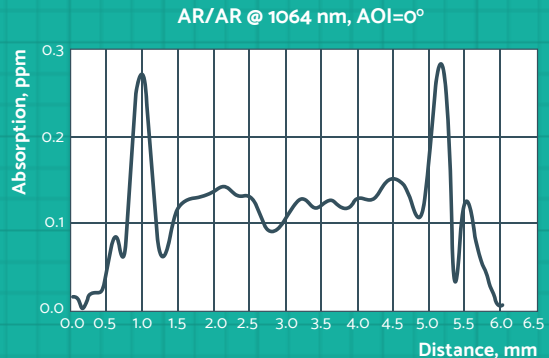
Due to the near-bulk IBS coating density, the surface roughness of the coated component is mainly determined by the initial substrate roughness. Combine this with the completely amorphous coating layers and you will end up with almost scatter-free optics!



Forget short duty cycle issues!

It is well known that absorption losses are the main cause of thermal effects and a short duty cycle. A high and stable vacuum, extremely pure target materials, near bulk coating density, spatially separated sputtering and material condensation processes allow to form almost contamination-free layers with the absorption losses below 2ppm.

If you use high repetition rate fs, or a CW system and longevity is your concern, give OPTOMAN coatings a try and you will be surprised!

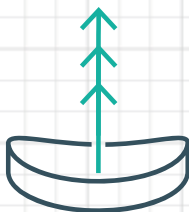


SUSTAINABLE PRODUCT LIFECYCLE

OPTOMAN acts responsibly during the whole product lifecycle.



It starts from the thorough selection and assessment of suppliers according to OPTOMAN values.



OPTOMAN has optimized production processes to ensure a high yield of production and clean optics.



OPTOMAN also reuses optical components not compliant to specifications by repolishing them to limit waste.

LOOKING FOR STANDARDIZED SOLUTIONS?

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LASER OPTICS**

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