

SPECIAL COATINGS AND OPTICS



OPT MAN

YOUR SIDEKICK FOR
LASER OPTICS DEVELOPMENT

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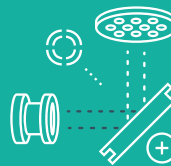
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HIGHLY CUSTOMIZED AND APPLICATION OPTIMIZED LASER OPTICS FOR DEMANDING APPLICATIONS FROM DEMANDING MARKETS



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:

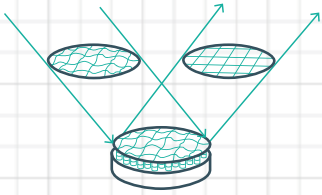
- Medical lasers (Er:YAG, Ho:YAG, Nd:YAG, Alexandrite...).
- Mirrors for galvo-scanners (Silicon, UVFS...).
- Membrane mirrors for deformable mirror assemblies.
- OPO, OPA, OPCPA.
- Defense & Aerospace industries.
- Mirrors for multipass cells (MPC).

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 200 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.



MEMBRANE MIRRORS

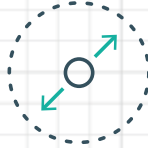
Let's say an ugly laser beam wavefront is making your images worse: the object in a picture looks distorted and it's due to not-good-enough quality mirrors. The distortion sounds good in rock music with all those guitars, but definitely not in optics.

In deformable mirrors, the distortion then needs to be compensated using a dynamic range of piezo elements. But not anymore! **You can save precious energy using IBS-coated membrane mirrors!**

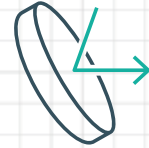
OPTOMAN can help to correct the distorted wavefront with IBS dielectric coatings. The main exceptionality of this product is that OPTOMAN is able to control surface flatness and can make coatings on very thin substrates.



Surface Flatness $\lambda/10$ per each $\varnothing 12.7$ mm region



High reflectance $>99.95\%$

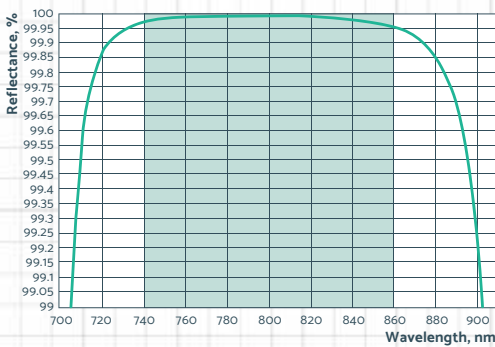


Substrate diameter up to $\varnothing 400$ mm

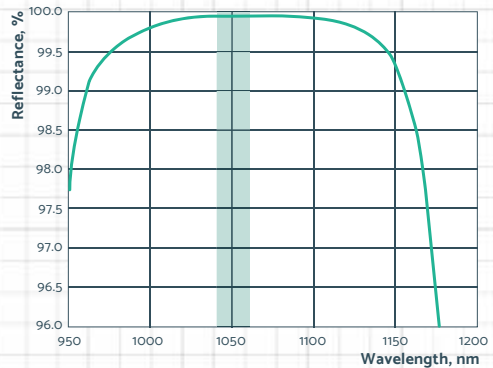
Design examples



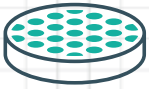
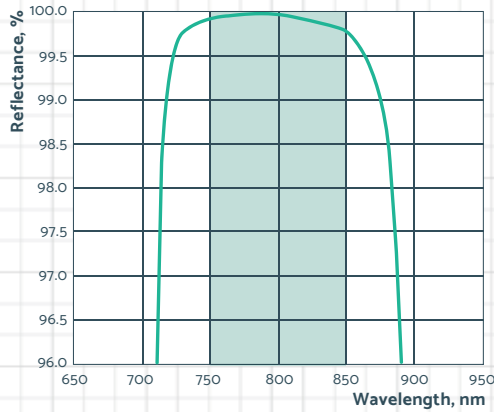
HR Membrane Mirror $\varnothing 200$ mm x 4.0 mm
 HRa $>99\%$ @ 740-860 nm, AOI= 10°
 GDD <20 fs 2



HR Membrane Mirror $\varnothing 150$ mm x 1.8 mm
 HRa $>99.9\%$ @ 1043-1053 nm, AOI= $0-10^\circ$



HR Membrane Mirror Ø200 mm x 2.5 mm
HR>99.5% @ 750-850 nm, AOI=0-10°



LOW ABSORPTION COATINGS ON MICRO-OPTICS, FIBERS AND END CAPS

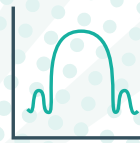
Small items like micro-optics that are a few micrometers in size are difficult to handle throughout the whole coating process, but OPTOMAN has made investments in equipment enabling repeatable process and the experienced and precise OPTOMAN squad has proven that no optics are too small for them to handle.

Now micro-optical systems as well as fibers and end caps can benefit from low absorption IBS coatings, which push the overall efficiency to new levels.



Absorption loss <1 ppm per coated surface @ 1064 nm

Absorption is the main damage and fatigue driver. With absorption being at low level, AR coated Micro-optics feature enhanced duty cycle.



Reflectance per surface down to $R < 0.01\%$

Sputtered anti-reflective coatings feature performance close to theoretical.



High Laser-Induced Damage Threshold

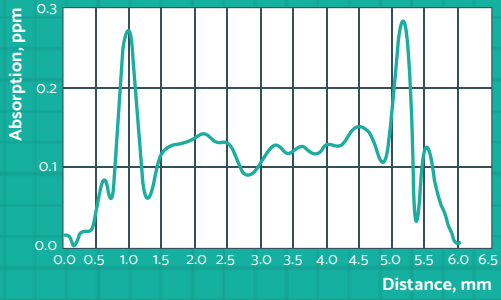
OPTOMAN transmissive coatings can be optimized for high LIDT and feature values of $>40 \text{ J/cm}^2$ @ 1064 nm, 10 ns, 10 Hz, 10^3 -on- 1.



Temperature and humidity independent performance

Durable, non-porous and near bulk IBS coatings increases the longevity and reliability of the system, eventually resulting in a lower total cost of ownership.

Low loss configuration allows transmittance higher than 99.98% of AR/AR coated components and absorption going as low as 0.3 ppm @ 1064 nm, for example.

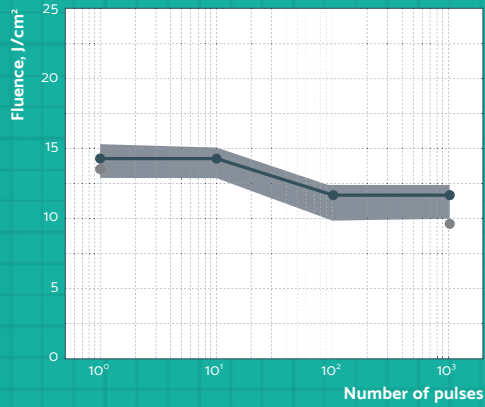


Absorption measurement @ 1064 nm. Low absorption is responsible for thermal shift-free performance and negligible fatigue of coated surfaces.

Low absorption IBS coatings on fast axis collimators (FAC) minimize the unwanted effects originating from the heat generated by the laser diode.

Laser induced damage threshold

AR/AR @ 532 nm, AOI = 0°



- Offline detection
 - Online detection
 - 95% confidence interval
- Wavelength: 532 nm
Pulseduration (FWHM): (5.3 ± 0.3) ns
Repetition rate: 100 Hz
AOI: 0°
Polarization: Linear
Beam diameter (1/e²): (216.7 ± 2.6) μm

Hey, laser beam, go through, and don't leave any photons behind!



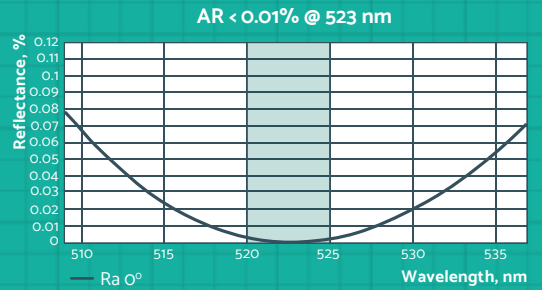
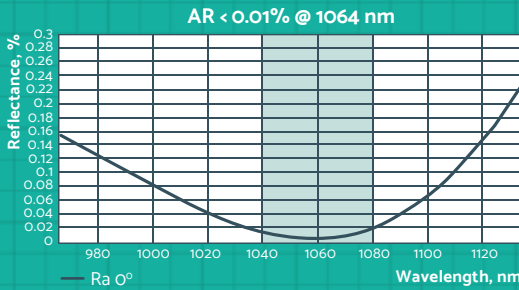
DR. ABSORPTION

OPTOMAN is flexible like your fiber and can adapt according to fiber length and bend radius.

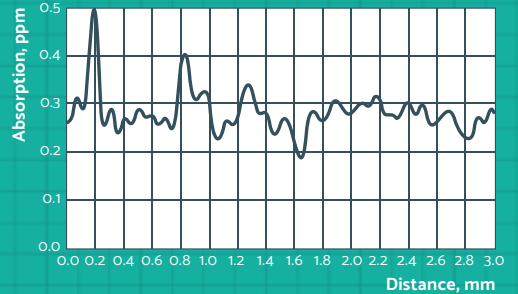
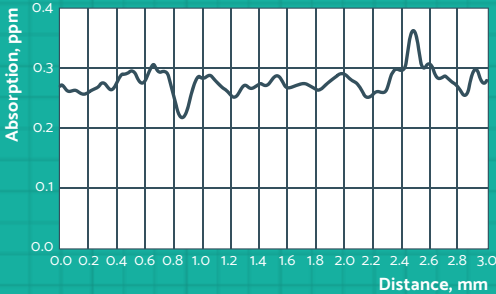
IBS is a “cold” coating deposition process in which the internal temperature does not exceed 150° C. Most anti-reflective coating processes stay below 100° C, which is useful for temperature-sensitive FC/PC connectors.



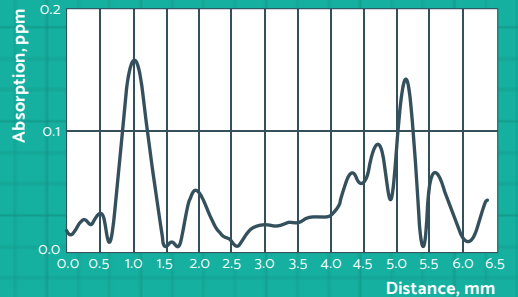
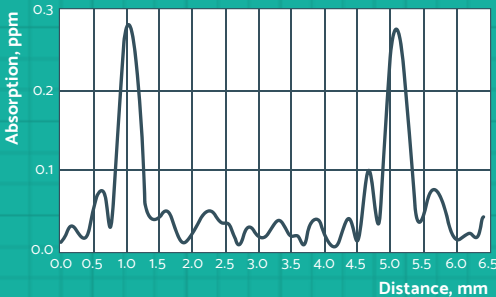
Design examples



AR<0.1% @ 1030 nm - 1090 nm & R<4% @ 500 nm - 700 nm, AOI=0°




Measured absorption at 1064 nm at AOI=0°. Transverse scan (scan across).



Measured absorption at 1064 nm at AOI=0°. Longitudinal scan (scan through).

● ● ● ● ● ● ● ● ● ●

 Note that OPTOMAN is not limited to AR coatings on micro-optics and fibers.



COATINGS ON METAL SUBSTRATES

Inspired by optical challenges in beamshaping industry, OPTOMAN has developed the capability to produce dielectric coatings on metal substrates with good adhesion.

Why this dielectric - metal union is a good idea?

Many diamond-turned metals have very high infrared reflectivity and corresponding low absorption. But, with the restriction of the optical constants of the metal material, the reflectivity couldn't be large enough. So the reflectivity of the metal surface must be improved by depositing multi-layer dielectric films. Dielectric coatings can reduce absorption, increase the laser damage threshold, and improve surface durability. Metal reflectors with high reflectivity resulting from high quality dielectric coatings and good thermal conductivity could improve the resistance to laser irradiation in high-power laser systems.

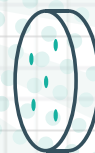


IBS coatings are available on Nickel, Aluminum, Copper, Stainless steel and other metal substrates;

Dielectric coatings of OPTOMAN get along with metal substrates - good adhesion was one of the main product development elements.



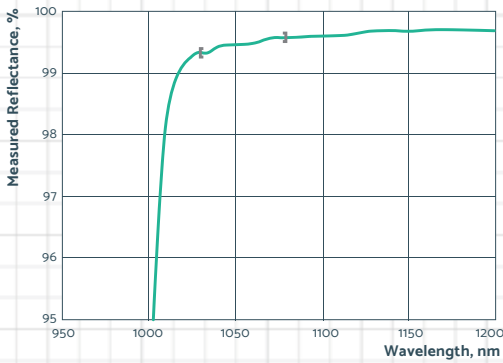
High reflectance of >99% for diamond turned components in wide-angle range.



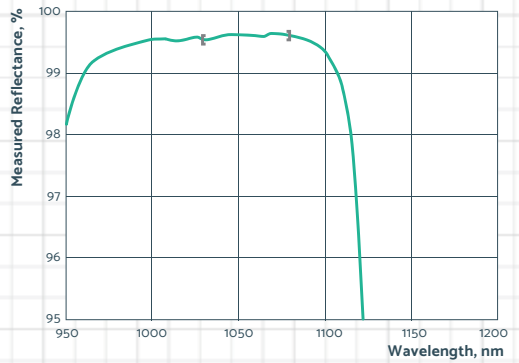
Coated elements have an excellent surface quality of 10/5.

Design examples

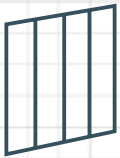
IBS coating on diamond turned Aluminum substrate:
 HRa>99.9% @ 1030-1080 nm, AOI=22.5-50°



avg = 99.46% @ 1030 - 1080 nm, AOI = 22.5°



avg = 99.60% @ 1030 - 1080 nm, AOI = 50°



SEGMENTED COATINGS

Have an application that could use different types of coatings on the same substrate? You're at the right place! OPTOMAN can make HR, AR, PR, or Polarizing coatings sandwich and do it according to your taste. The same optical substrate can be segmented and placed at different coating processes.



High yield of production



Wedge on back surface eliminates unwanted internal fringes



Back surface wedged or AR coated to eliminate ghosting



Each segment can have any type of coating (HR, AR, PR, Polarizing)

Design examples

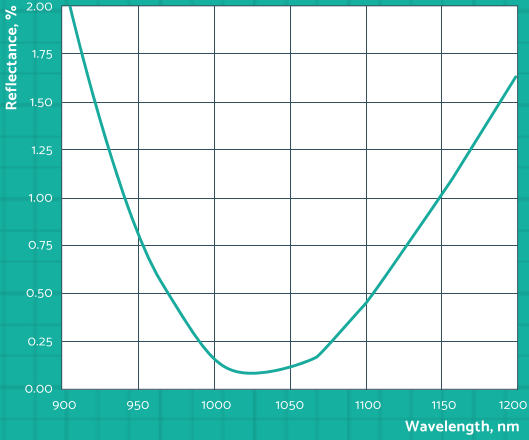
Segment 1: $AR < 0.25\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$

Segment 2: $PR = 50\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 10 \text{ fs}^2$

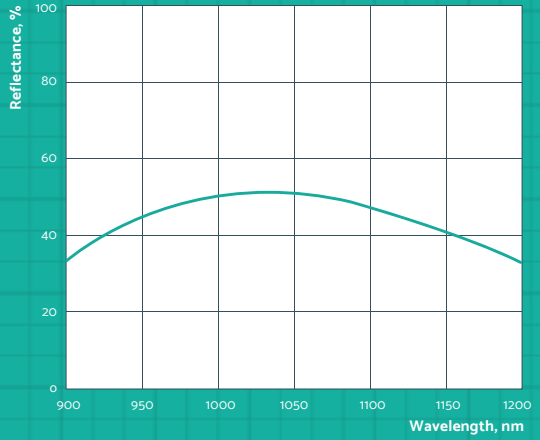
Segment 3: $PR = 72\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 20 \text{ fs}^2$

Segment 4: $PR = 83\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 20 \text{ fs}^2$

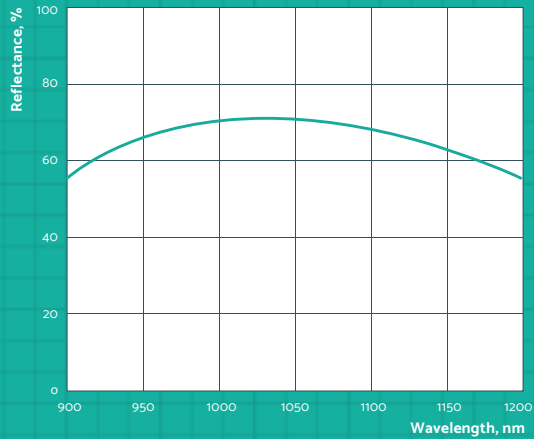
Segment 1: $AR < 0.25\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$



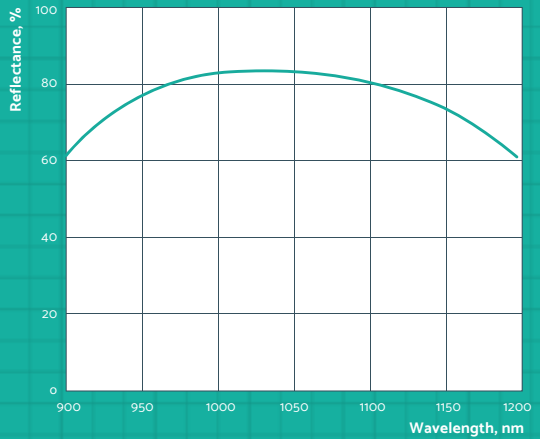
Segment 2: $PR = 50\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 10 \text{ fs}^2$



Segment 3: $PR = 72\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 20 \text{ fs}^2$



Segment 4: $PR = 83\% \pm 2\%$ @ 1010 - 1060 nm, $AOI = 0^\circ$, GDD R, $T = 0 \text{ fs}^2 \pm 20 \text{ fs}^2$



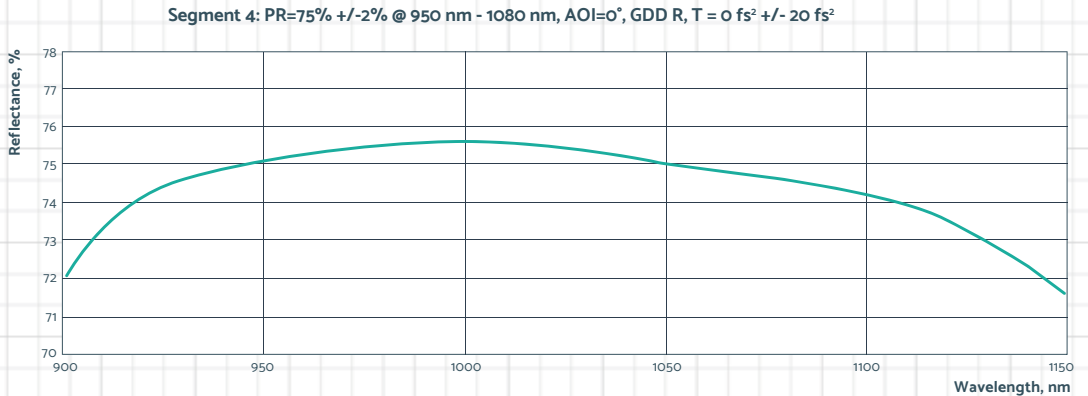
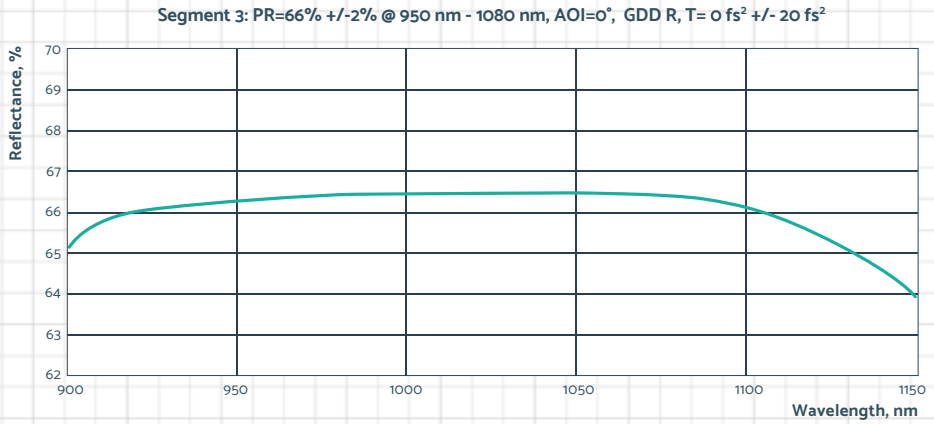
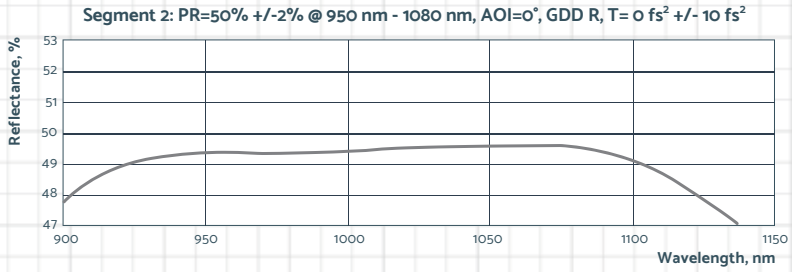
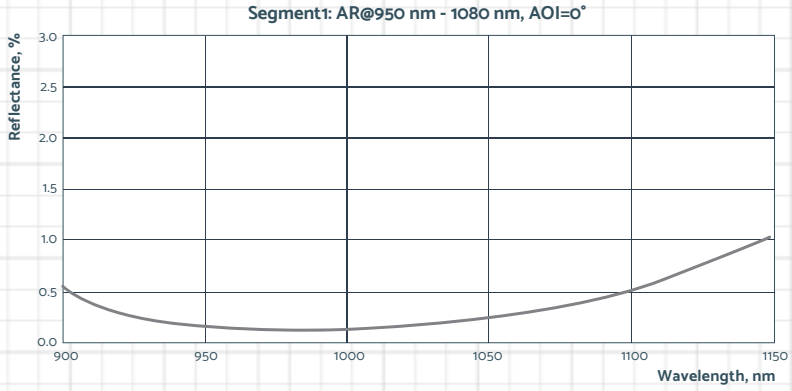
Design examples

Segment 1: AR@950 nm - 1080 nm, AOI=0°

Segment 2: PR=50% +/-2% @ 950 nm - 1080 nm, AOI=0°, GDD R, T= 0 fs² +/- 10 fs²

Segment 3: PR=66% +/-2% @ 950 nm - 1080 nm, AOI=0°, R, T= 0 fs² +/- 20 fs²

Segment 4: PR=75% +/-2% @ 950 nm - 1080 nm, AOI=0°, GDD R, T= 0 fs² +/- 20 fs²





OPTICAL ASSEMBLIES WITH CUSTOM IBS COATINGS

OPTOMAN has mastered a new skill and is moving up the value chain by making robust optical assemblies!



Reliable, low absorption (<1ppm) and high LIDT (>1 J/cm² @ 1030 nm, 500 fs) IBS coated laser components can be assembled together according to specific optical design.

FEATURES

- Low-outgassing glues;
- Possibility of cementing;
- Custom assemblies;
- Adaptation to specific optical design;
- Assembly development,
- Possibility for low quantities.

YOUR LASER IS AS DURABLE AS ITS WEAKEST LINK



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.



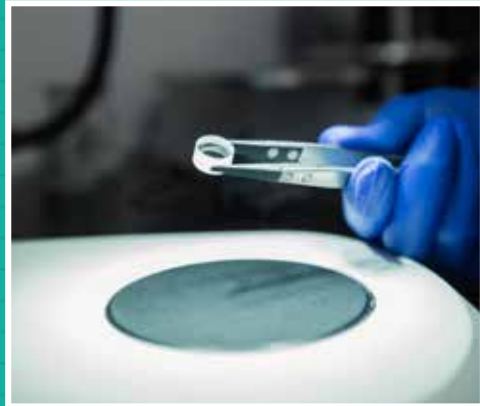
Coating deposition

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 Mjölhnir 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

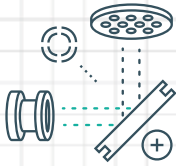
- OPTOMAN heavily invests in R&D activities.
- OPTOMAN cooperate with leading research institutions for extensive characterization and proof of concepts.

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.

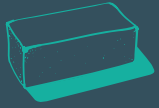
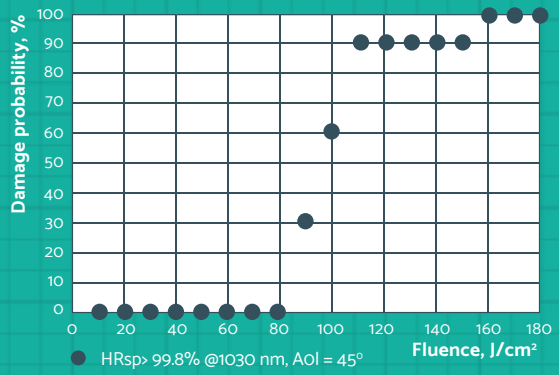


Inherently stable sputtering process

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



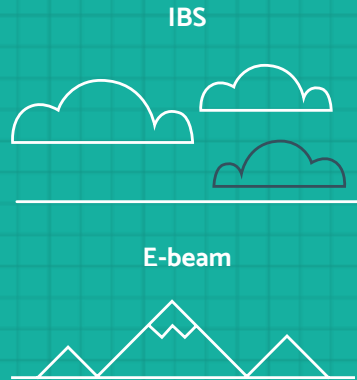
E-beam
Porous
Structure

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?!

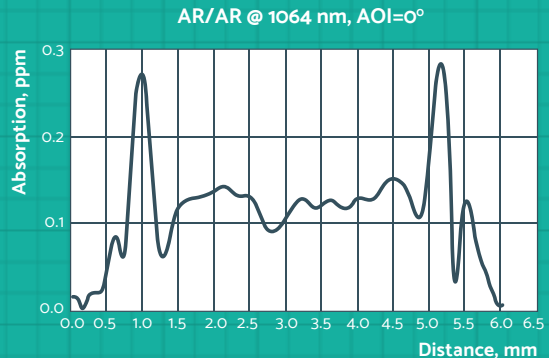
Due to the near-bulk IBS coating density, the surface roughness of the coated component is mainly determined by the initial substrate roughness. Combine this with the completely amorphous coating layers and you will end up with almost scatter-free optics!



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!

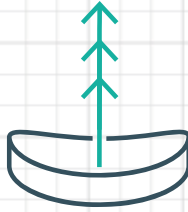


SUSTAINABLE PRODUCT LIFECYCLE

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?

**OPTOSHOP -
YOUR GATEWAY
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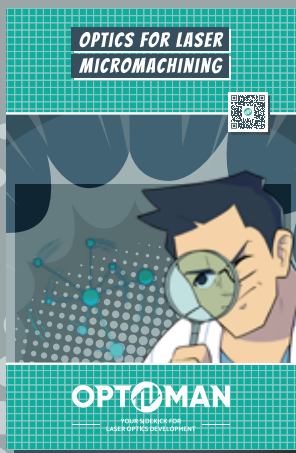
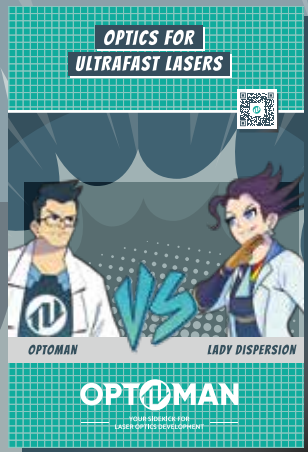
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