

IBS COATED OPTICS FOR ULTRA VIOLE [N]T LASERS



OPTO MAN

YOUR SIDEKICK FOR
LASER OPTICS DEVELOPMENT

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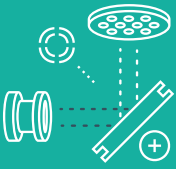
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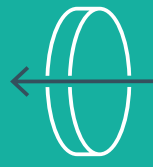
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HIGHLY CUSTOMIZED AND APPLICATION OPTIMIZED LASER OPTICS FOR DEMANDING APPLICATIONS FROM DEMANDING MARKETS



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**

**80 % 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 from 140 participants, 2023.



DESIGN CAPABILITIES

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 ppm.

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 $50\% \pm 1\%$).
- 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.
- Zero phase shift mirrors.
- Coatings on metal substrates.
- Optical assemblies.
- Coatings on fast axis collimators (FAC).
- Coatings on fibers and end caps.



- Custom shape, curvature and size.
- High reflection, anti-reflection, polarizing and other type of coatings available.
- **Spectral range 193 nm - 5000 nm.**
- **Size range from 3 mm up to 360 mm (500 mm is under development).**
- Optimization for 2, 3, 4 or more wavelengths.
- Various angles of incidence.

METROLOGY CAPABILITIES

OPTOMAN metrology capabilities are based on partners oriented investments. Current metrology capabilities are below, but soon they will be supplemented.

- **LIDT & lifetime** - CW, ns, ps, fs
- **GD, GDD, TOD** - 500 nm - 1400 nm
- **Surface form errors** - Down to $\lambda/20$
- **Environmental testing** - To MIL-C-484197
- **Cosmetic surface quality** - To MIL & ISO
- **CRD** - 532 nm, 1064 nm
- **Absorption** - 355 nm, 532 nm, 1064 nm
- **Roughness/scattering** - 355 nm, 532 nm, 1064 nm
- **Spectral measurements** - Tsp, Rsp @ 200 nm - 5000 nm



LIDT CAPABILITIES

High laser-induced damage threshold (LIDT) is a buzzword when talking about laser optics. Laser damage is a complex phenomenon and, while the result is the same – the optical component is ruined and not suitable for further use, there are different laser damage types and mechanisms. OPTOMAN takes innovation very seriously and makes sure that optical components are able to resist the

ongoing increase of laser power and decrease in pulse duration, thus high LIDT is OPTOMAN's bread and butter.

Dr. Damage – the antagonist of the world of OPTOMAN can be beaten by measuring LIDT of laser optics. And OPTOMAN does just that.

Reading the values:

> Fluence @ Wavelength, pulse duration, repetition rate, beam diameter

Femtosecond pulse

High reflectance coatings:

- > 1.183 J/cm² @ 1030 nm, 507 fs, 1 kHz, 136.5 μm
- > 0.286 J/cm² @ 343 nm, 180 fs, 10 kHz, 30 μm
- > 0.267 J/cm² @ 258 nm, 180 fs, 10 kHz, 30 μm

Anti-reflective coatings:

- > 0.052 J/cm² @ 515 nm, 191.4 fs, 300 kHz, 58.7 μm

Polarizing coatings:

- > 0.77 J/cm² @ 1030 nm, 500 fs, 10 kHz, 175 μm

Nanosecond pulse

High reflectance coatings:

- > 168 J/cm² @ 1064 nm, 9.8 ns, 100 Hz, 223 μm
- > 29.5 J/cm² @ 532 nm, 6 ns, 100 Hz, 137.6 μm

Anti-reflective coatings:

- > 44 J/cm² @ 1064 nm, 10 ns, 100 Hz, 225 μm
- > 10 J/cm² @ 532 nm, 10 ns, 10 Hz, 421 μm

Polarizing coatings:

- > 49.4 J/cm² @ 1064 nm, 10 ns, 100 Hz, 206 μm

Continuous-wave

High reflectance coatings:

- > 426 kW/cm @ 1070 nm, 30 s, 137.6 μm*

Anti-reflective coatings:

- > 426 kW/cm @ 1070 nm, 30 s, 137.6 μm*

* 426 kW was the power limit of the laser.

Picosecond pulse

High reflectance coatings:

- > 2.58 J/cm² @ 1064 nm, 370 ps, 20 Hz, 2.4 mm
- > 1.64 J/cm² @ 532 nm, 350 ps, 20 Hz, 2.1 mm
- > 8.313 J/cm² @ 1030 nm, 10 ps, 1 kHz, 154 μm

Anti-reflective coatings:

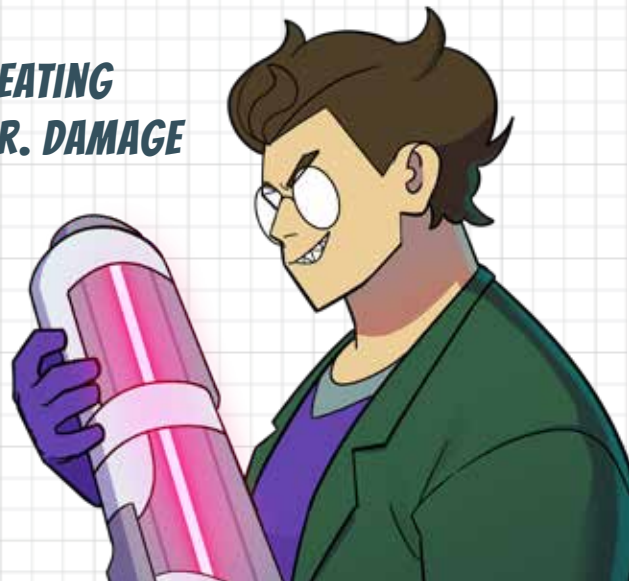
- > 5.5 J/cm² @ 1064 nm, 370 ps, 20 Hz, 2.3 mm
- > 2.1 J/cm² @ 532 nm, 350 ps, 20 Hz, 2.1 mm
- > 0.39 J/cm² @ 343 nm, 1 ps, 1 kHz, 1 mm
- > 0.353 J/cm² @ 800 nm, 1 ps, 1 kHz, 163 μm

Polarizing coatings:

- > 2.7 J/cm² @ 1030 nm, 10 ps, 10 kHz, 115 μm

DISCLAIMER: Values are the result of LIDT test procedure according to ISO standards or based on the measurements done at customer sites. While the values are trustworthy, it doesn't mean that they can be transferred to final product specifications as the safety factor should be considered.

BEATING DR. DAMAGE





IBS COATED OPTICS FOR ULTRA VIOLE[n]T LASERS

Inspired by the challenges that industrial players in the micromachining market face, 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



ENHANCED LIFETIME

Coatings made by OPTOMAN feature extremely **low absorption (reaching <1 ppm)** resulting in increased longevity of optics.

WHY NOT METAL OR FLUORIDE COATINGS?

Fluoride coatings:

Soft coatings



High surface roughness



Scattering and rapid coating degradation

Metal coatings:

High absorption



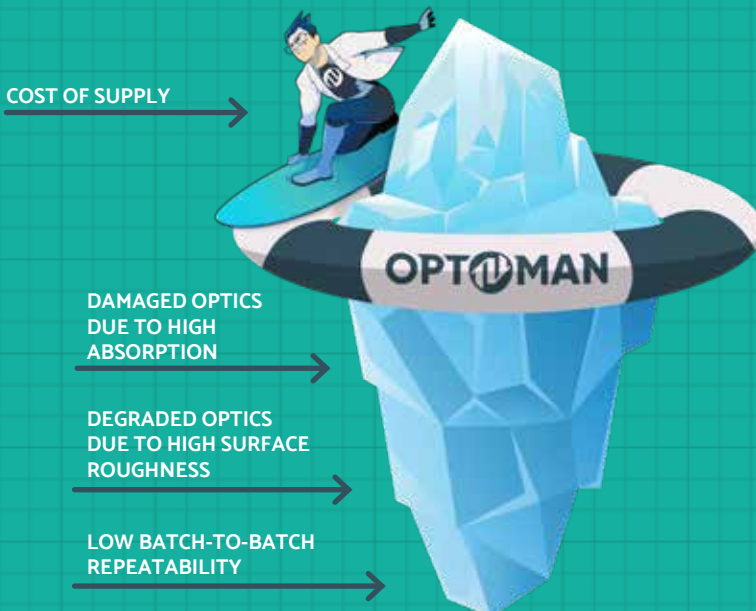
Heating

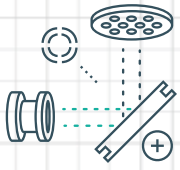


Laser damage

OPTOMAN is able to lower Total Cost of Ownership

Laser optics made by OPTOMAN, due to low absorption, low surface roughness and high batch-to-batch repeatability, offer higher longevity than optics produced by others, thus lowering the Total Cost of Ownership and ensuring the cost of supply wouldn't be just the tip of the iceberg when purchasing optics.

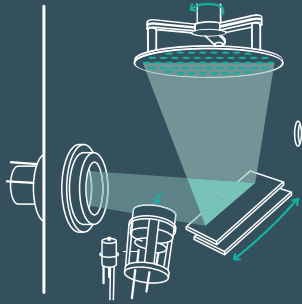




ABOUT ION-BEAM SPUTTERING TECHNOLOGY

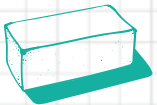
Ion Beam Sputtering (IBS) is a technique when the layer of a desired material is formed by molecules extracted from the target material by a highly energetic and precisely controlled ion beam.

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.



IBS
Near Bulk
Density



E-beam
Porous
Structure

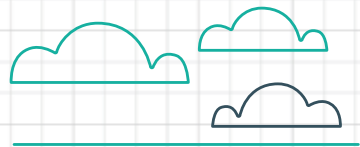
Bulk-like packing density

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?!

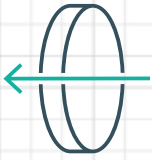
Due to the near-bulk IBS coating density, the surface roughness of the coated component is mainly determined by the initial substrate roughness. Combine this with the completely amorphous coating layers and you will end up with almost scatter-free optics!

IBS



E-beam





ANTI-REFLECTIVE COATINGS

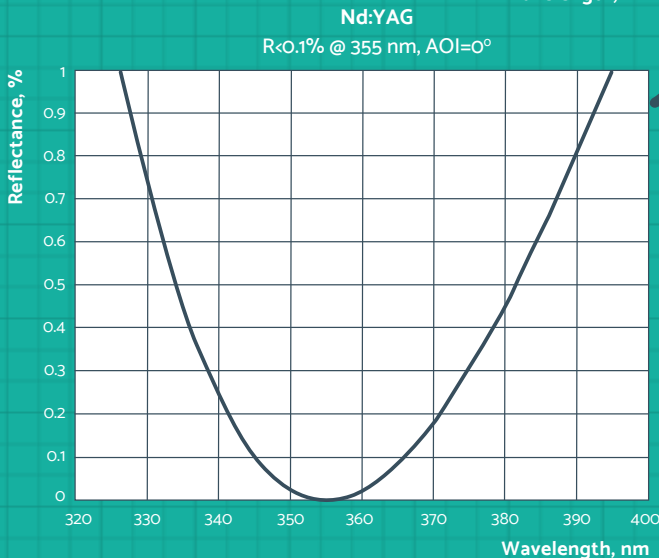
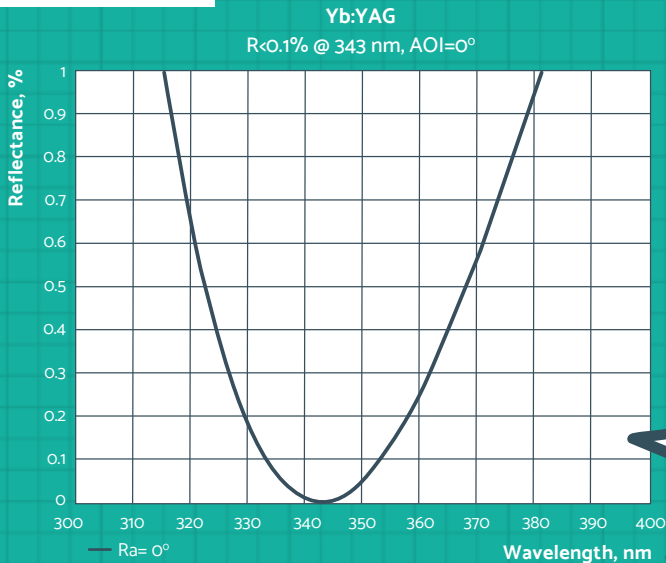
One of the main challenges that UV coatings face is low transparency due to absorption. This is, obviously, particularly evident in AR coatings. OPTOMAN, by mastering the IBS technology and using fluoride coatings, minimizes the absorption loss of AR laser optics and ensures stability in the UV and even the Deep-UV region.

OPTOMAN has a number of 1 inch plano-concave lenses with focal lengths ranging from -1000 to -50 mm and plano-convex lenses with focal lengths between +50 and +2000 mm always available in stock to be coated on. It allows reducing the end product cost by at least 250%.



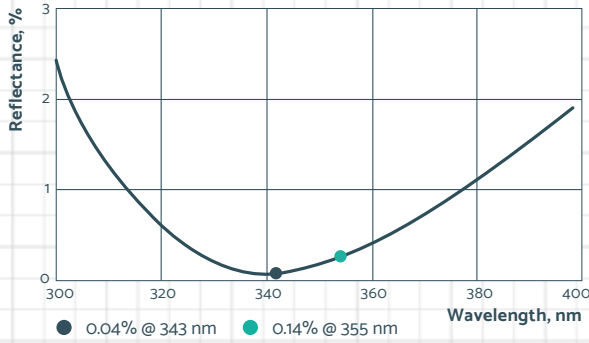
Scan to find out more

Design examples



**LET THOSE
PRECIOUS
UV PHOTONS PASS**

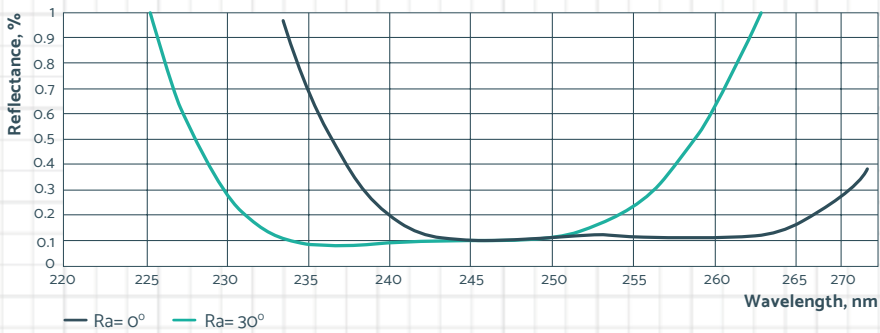
S1/S2: AR<0.2% @ 343 nm - 355 nm, AOI = 0°-25°



Deep-UV

Coatings (IBS):

S1/S2: AR<0.3% @ 247-250 nm, AOI = 0°-30°

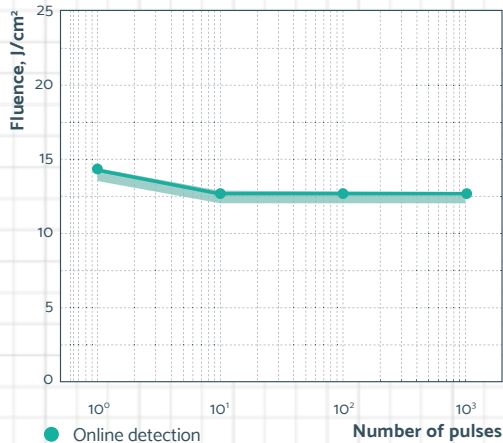


Looking for SuperHero power?

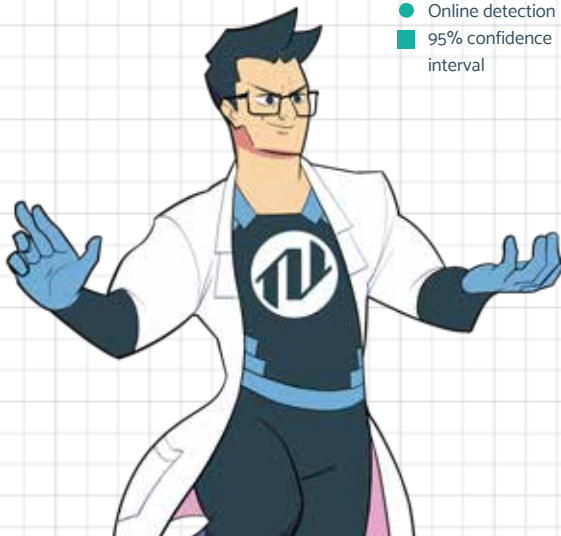
Superhero power coating technology is applicable for AR coatings @ 266 - 355 nm

Measured LIDT: >12.66 J/cm² @ 355 nm, 6 ns, 100 Hz

Ongoing R&D towards LIDT target of >20 J/cm² @ 355 nm, 6 ns, 100 Hz



- Online detection
 - 95% confidence interval
- Wavelength: 355 nm
 Pulse duration (FWHM): (5.6 ± 0.3) ns
 Repetition rate: 100 Hz
 AOI: 0°
- Polarization: Linear
 Beam diameter (1/e²): (223.4 ± 2.3) μm





HIGH REFLECTIVE COATINGS

High Reflective (HR) coatings are also affected by absorption, which can induce laser damage on coated optics. OPTOMAN deposits ultra hard dielectric coatings for high damage threshold in most demanding laser applications.

OPTOMAN has a number of 1/2", 1" and 2" spherical mirror substrates with focal lengths ranging from -10000 to -25 mm always available in stock to be coated on. It allows reducing the end product cost by at least 400%.

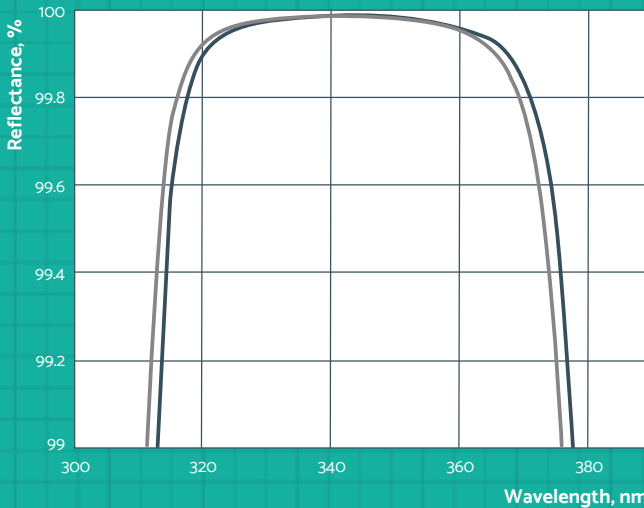


Scan to find out more

Design examples

Coatings (IBS) (Yb:YAG):

HR > 99.9% @ 343 nm. AOI = 0 - 10°.

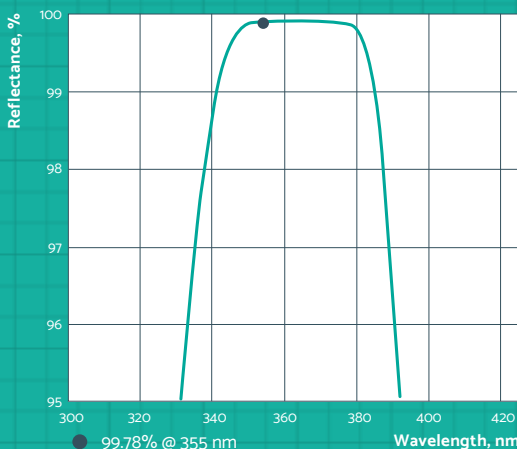


Get it at OPTOSHOP

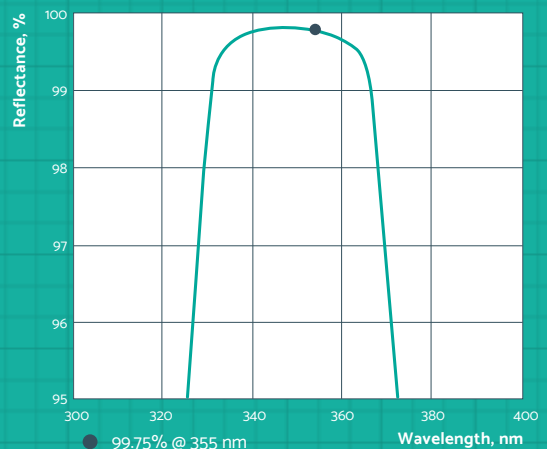
Coatings (IBS) (Nd:YAG):

HRa > 99.7% @ 355 nm, AOI = 32-45°.

For high power nanosecond applications.

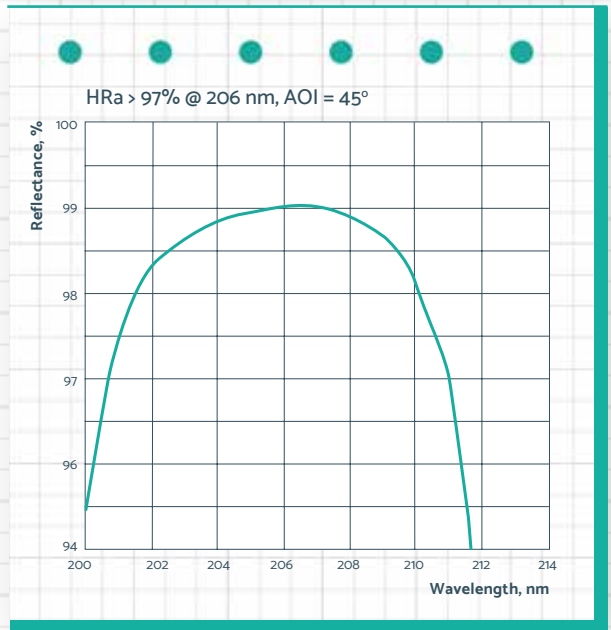
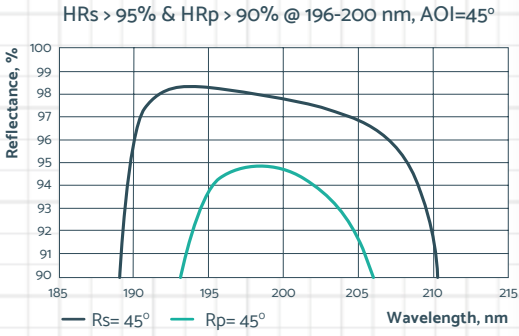


● 99.78% @ 355 nm
Measured average reflectance spectrum, AOI = 32°



● 99.75% @ 355 nm
Measured average reflectance spectrum, AOI = 45°

Deep-UV



Get it at OPTOSHOP

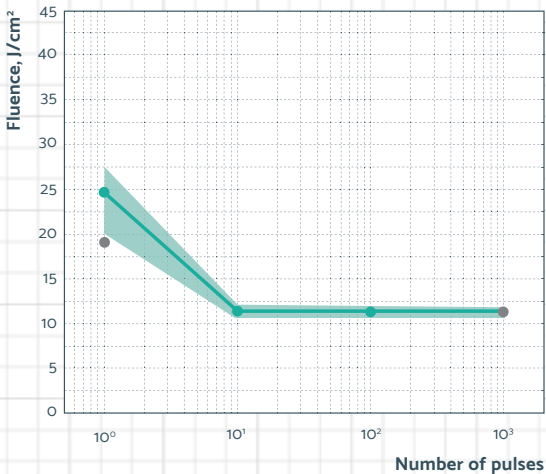
Looking for SuperHero power?

Laser damage is the arch-enemy of UV optics.

To fight it, one must measure it. So OPTOMAN does, for femtosecond and nanosecond scale.

HR @ 355 nm:

LIDT: >11.20 J/cm² @ 355 nm, 6 ns, 100 Hz, s-pol,
10³ - on - 1



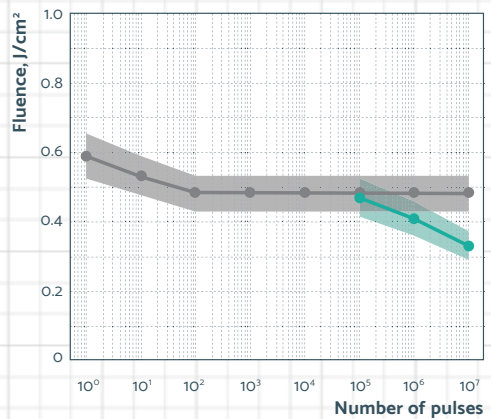
● Offline detection
● Online detection
■ 95% confidence interval

Wavelength: 355 nm
Pulse duration (FWHM): (5.7 ± 0.3) ns
Repetition rate: 100 Hz
AOI: 45°
Polarization: Linear S
Beam diameter (1/e²): (218.4 ± 3.3) μm

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



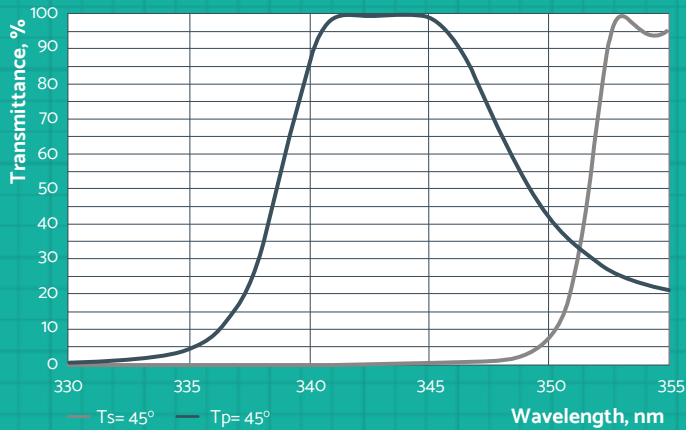
THIN FILM POLARIZERS

Scattering and absorption losses need to be well managed to ensure a high degree of polarization in the UV range, as they increase considerably when the wavelengths go down. OPTOMAN has optimized the IBS coating process to make low absorption and high longevity dielectric polarizers for Ultraviolet lasers.

Low Absorption Polarizer 343 nm (Yb:YAG):

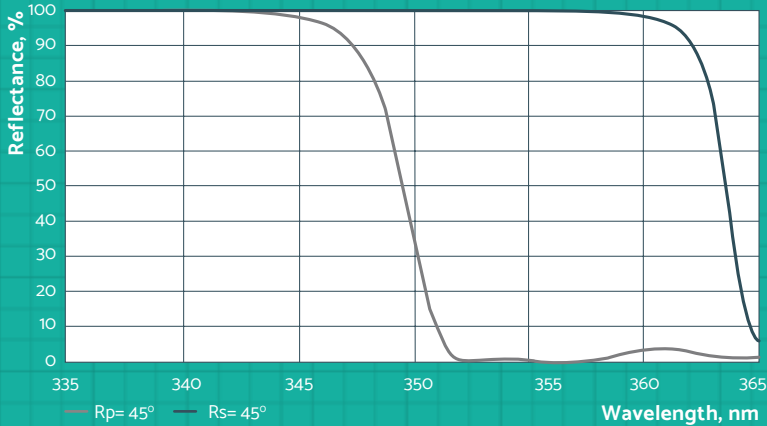
S1: $R_s > 99.7\%$ & $T_p > 95\%$ @ 343 nm, AOI = $45^\circ \pm 2^\circ$

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



Thin Film Polarizer 355 nm (Nd:YAG)

S1: $R_s > 99.8\%$ & $T_p > 97\%$ @ 355 nm, AOI = $45^\circ \pm 1^\circ$



WHERE DOES OPTOMAN WORK?

OPTOMAN spends a significant amount of time in manufacturing facilities, therefore he wants to show you how does his 270 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.



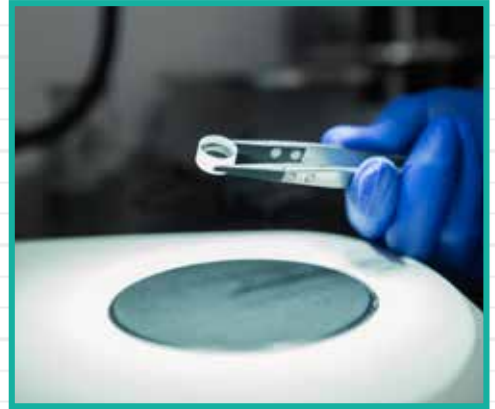
LOOKING FOR ROBUST MIRROR MOUNTING SOLUTIONS?



OPTOMAN recommends highly precise and robust mounting and packaging solutions from PHOTONICPARTS.

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:

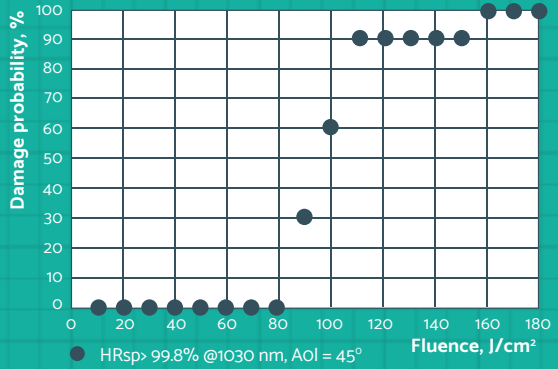
- INTENSITY – Development of low total loss coatings for VIS-NIR range.
- UNIPULSE – Development of high LIDT coatings for ps-fs applications for VIS-NIR range.
- INOSTART – Development of MID-IR (1-5 μm) coatings based on oxide / semiconductor materials.
- Neo2Fast – Development of broadband mirrors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

High resistance to laser irradiation

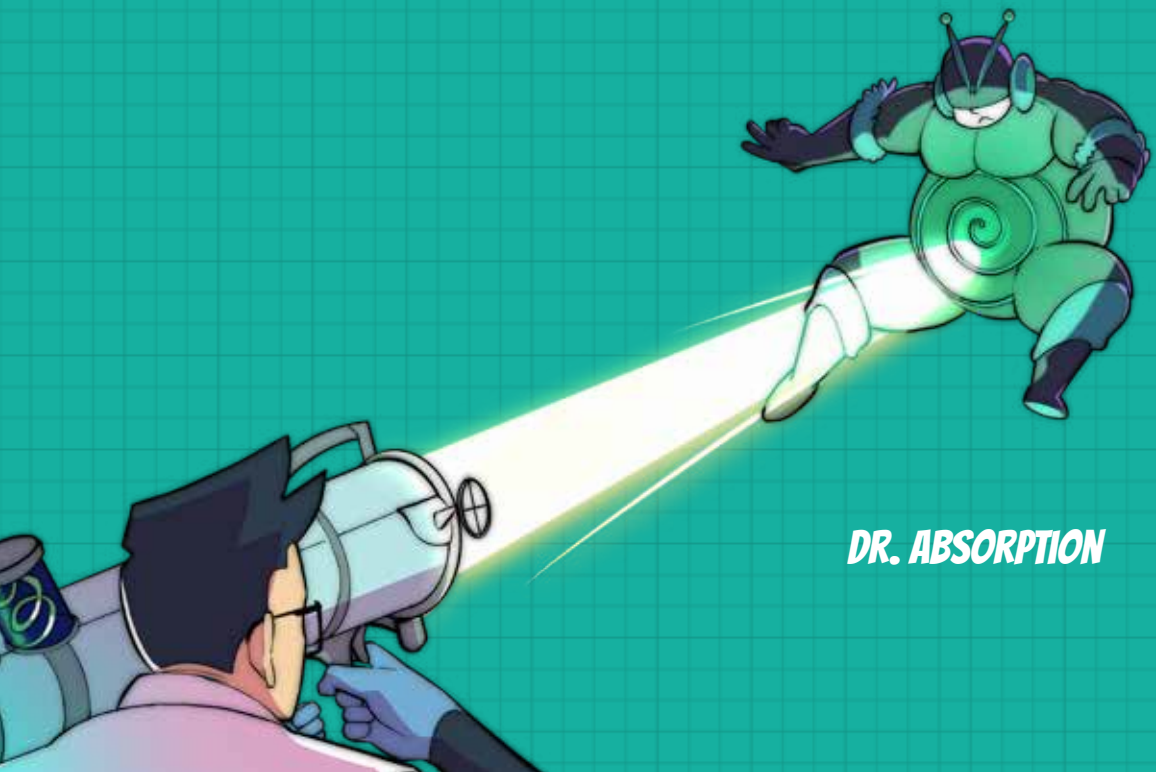
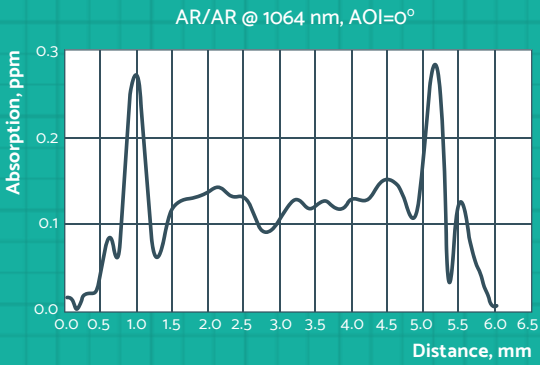
By choosing proper deposition parameters and ensuring cleanliness in every step of the manufacturing chain, OPTOMAN is able to produce coatings with very low defect densities. That is the reason why IBS coatings exhibit excellent resistance to laser irradiation!



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!



IBS FAMILY

Currently OPTOMAN has 5 IBS machines, each of them is specialized in a specific set of superpowers and has a unique Marvel character name. Well almost all of them, at the time of writing this sentence, we are waiting for the 5th machine to be named....

PETRA

Effective coating area:
ø270 mm x 2 pallets

Superpowers:

- Universal
- Super efficient
- Extreme low loss coatings

HYPERION

Effective coating area:
ø270 mm x 2 pallet

Superpowers:

- Universal
- Super efficient
- Extreme low loss coatings

TBD

Effective coating area:
ø270 mm x 2 pallet

Superpowers:

- Universal
- Super efficient
- Extreme low loss coatings

ALBERT - THE ATOM SMASHER

Effective coating area:
ø600 mm x 2 pallets

Superpowers:

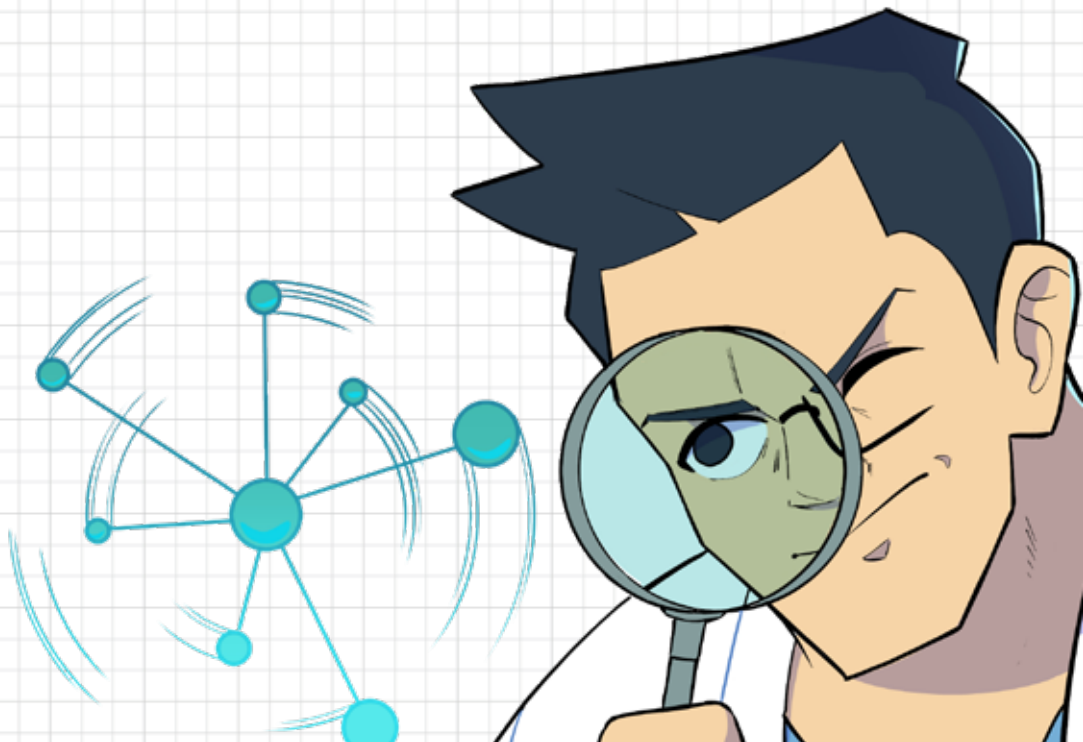
- Ability to coat big optics
- Volume production

WANDA - SCARLET WITCH

Effective coating area:
ø270 mm x 1 pallet

Superpowers:

- Mid-IR coatings
- Extreme low loss coatings

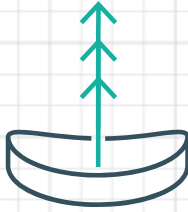


SUSTAINABLE PRODUCT LIFECYCLE

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?

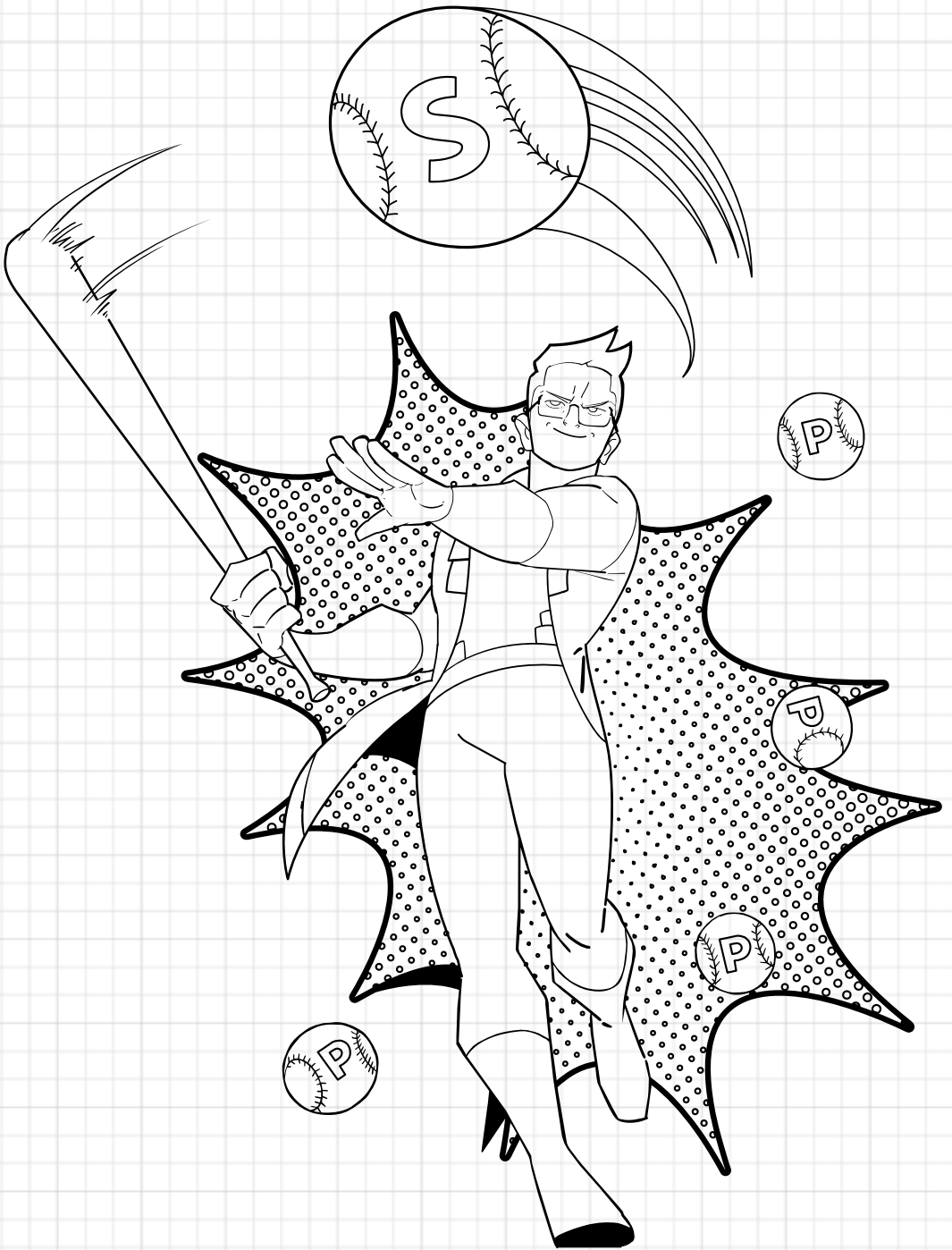
**OPTOSHOP -
YOUR GATEWAY
TO ADVANCED
LASER OPTICS**

OPTOSHOP
by OPTOMAN

www.optoshop.optoman.com



COLOR OPTOMAN!

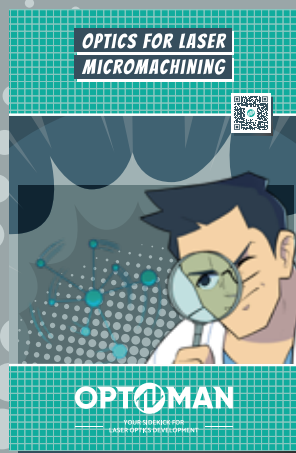
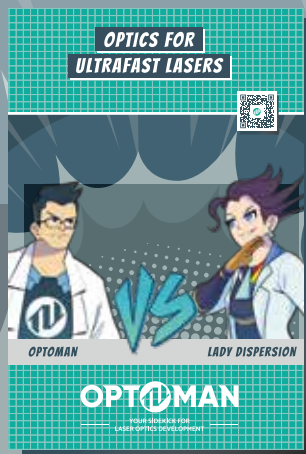


Is the catalogue too heavy to bring it home or to your workplace?
At least bring this page back to your kids so they can have some fun!

OPTOMAN

YOUR SIDEKICK FOR
LASER OPTICS DEVELOPMENT

OTHER CAPABILITIES



CONTACT US

Ukmergės g. 427, LT-14185,
Vilnius, Lithuania
info@optoman.com