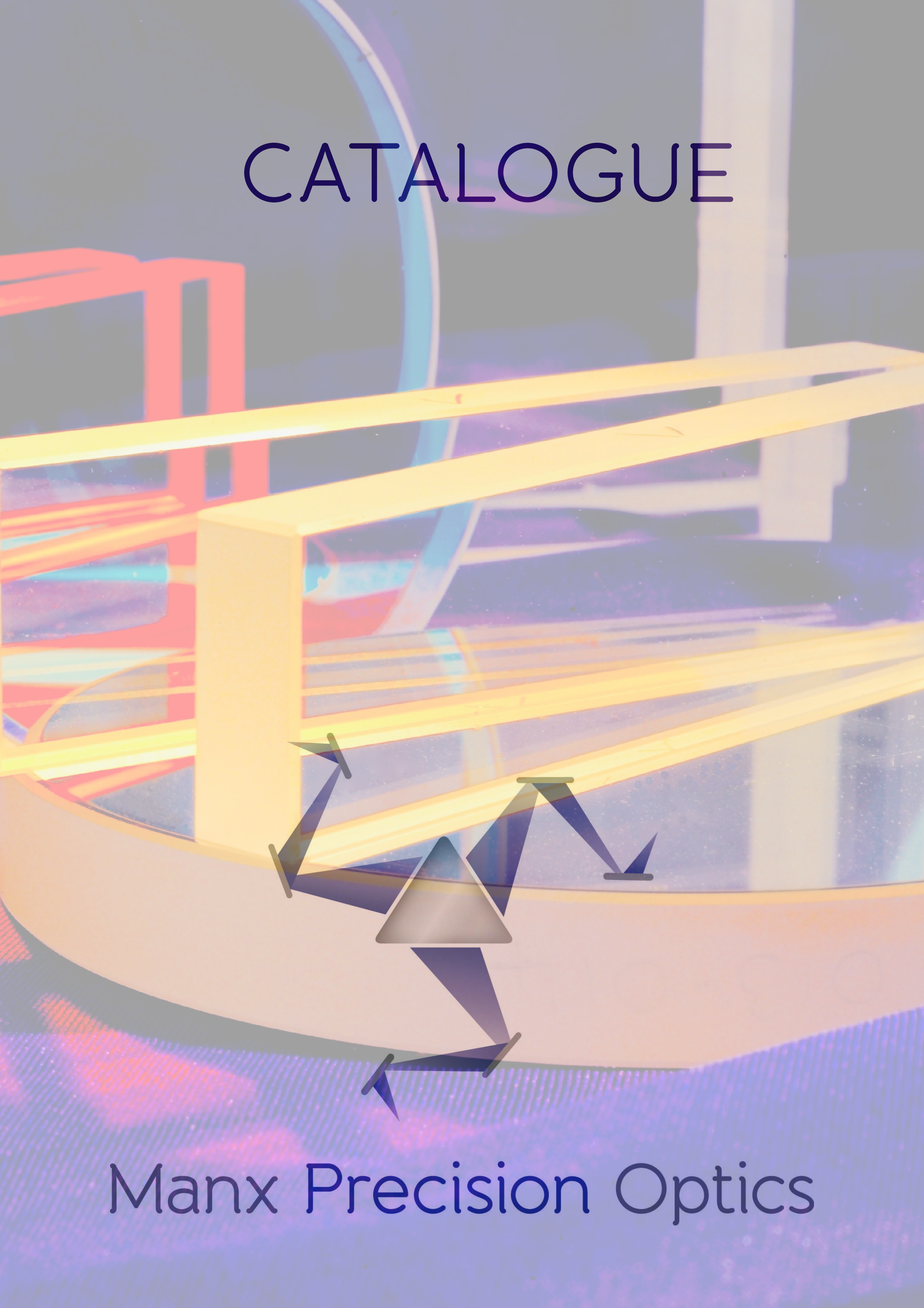
CATALOGUE



Manx Precision Optics

CONTENTS

ABOUT US

Manx Precision Optics Ltd. ('MPO') is a family owned manufacturer of high precision optics.

Based in the Isle of Man, the company was founded in 2013. MPO's ISO 9001:2015 certified manufacturing process covers the full range of optical manufacture from grinding and polishing to coating (e-beam, ion-assisted deposition (IAD) and sputtering) and assembly.

The company's modern manufacturing facility is based in a high-tech industrial park that is owned by the Isle of Man Government.

Its highly experienced workforce enables MPO to offer tailor made solutions to a wide range of applications along its wide range of off the shelf products.

HOW TO CONTACT US

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web and online shop: www.mpo.im

Facebook.com/MPOIOM

twitter.com/manxoptics

HOW MPO'S PART DESCRIPTIONS WORK

Very often, optical components are described by rather confusing part numbers, but at MPO we thought about this and decided it would be better to have a part description that is meaningful in that it tells the customer what the optical component is supposed to do. Hence, we have devised our own part description system which is explained below.

First and most important is the material so we start with that. Each MPO substrate description begins with the material code. Common codes are:

FS: Fused Silica BK7: BK7 or equivalent INF: Infrasil CaF2: Calcium Fluoride MgF2: Magnesium Fluoride SF6: Schott SF6 or equivalent

CQ: Crystal Quartz and so on...

Next in the description comes the substrate type, common abbreviations are:

FMR: Flat Mirror FWD: Flat Window SPM: Spherical Mirror

SPW: Spherical Window SPL: Spherical Lens APL: Aspheric Lens

CYL; Cylindrical Lens WMR: Wedged Mirror WWD: Wedged WIndow

CQWP: Waveplate

Following the substrate type come the measurements in mm - if three dimensions are given the first two describe the lateral directions while the third one describes the thickness. If only two measurements are present, the optic is round and the first number stands for the diameter, while the second for the thickness.

After this we add on any other useful information, for example in the case of lenses or curved substrates, the radius of curvature and whether the optic is convex or concave. In case it is a wedged substrate, we add the wedge angle etc. Following the substrate descriptions we add any coating information. Armed with this information you have a good idea as to what the optic is supposed to do.

However, as we work to ISO 9001:2015 procedures we also give a unique number to each substrate type regardless of whether the substrate is raw material, polished or coated. From this unique number we can always look at the drawing for all manufacturing details and we can check on our system when we made the optics etc.

Hence, we will always be happy to help you if you have got a question about an item you bought from us in the past or an item you want to specify and buy from us.

Here a few samples of our part description system:

FS-FWD-25.4-6.35

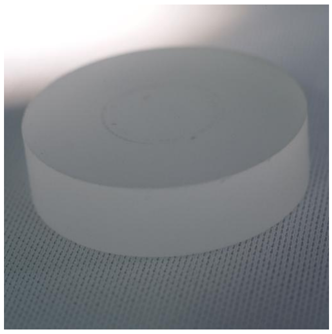
BK7-FMR-25.0-25.0-6.0

BK7-WWD-25.4-6.35-1deg-AR-AR-1064-0

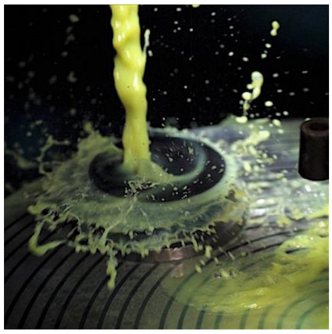
HOW A SUBSTRATE IS MADE

Manx Precision Optics Ltd. (MPO) manufactures its substrate in-house to ensure overall control of the entire optical manufacturing process. Several stages are required to get from a piece of raw material to a finished optic:

1. Raw material: This is generally bought in roughly pre-shaped from glass manufacturers. The most commonly used substrate materials are Fused Silica (in various grades) and BK7 (or equivalents). At this stage, the raw blanks still show machining marks and look generally rough.

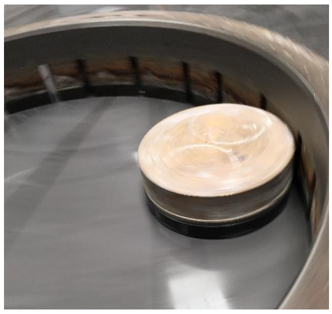


2. Shaping: At this stage the raw material is brought close to the intended shape through cutting, coring and the first stage of grinding.



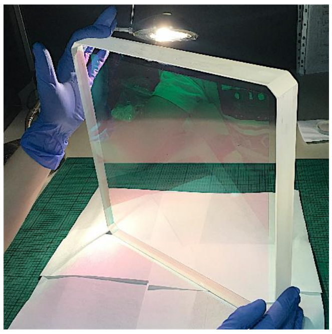
3. Bevelling: To avoid unpleasant edge chips, the edges of each optics are bevelled to protect them.

4. Grinding: This process brings the substrate close to the finished thickness and leaves it with a very fine ground finish. Specifications such as parallelism / wedge and (for spherical substrates) radius of curvature are 'ground in' during this stage.

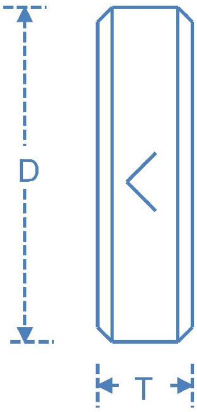


5. Polishing: The substrates can be polished on foil (a polyurethane material) or pitch, with pitch giving the highest quality finish, allowing flatnesses of up to l/100 to be achieved and roughnesses of less than 2 Angstroms.

6. Inspection: After finishing the polishing process the substrate is cleaned and inspected. The inspection involves a visual inspection of the surfaces against set international surface quality standards (ISO or MIL), a measurement of the physical dimensions and the interferometric measurement of the surface flatness and / or the transmitted wavefront distortion.



BK7 SUBSTRATES



Mirror specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish, better than 5 arc min parallel,

Window specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, λ/10 transmitted wavefront distortion, both sides 10-5 scratch-dig, better than 10 arc sec parallel

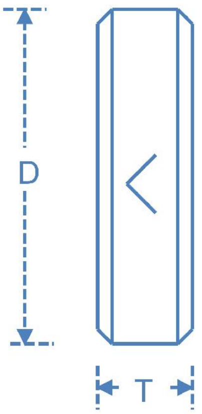
Wedged Optics have a 30arc min (+/-5 arc min) wedge, thickness specified for thick side

BK7 MIRROR SUBSTRATES	DIAMETER (D)	THICKNESS (T)
BK7-FMR-12.7-6.35	12.7mm	6.35mm
BK7-FMR-25.4-6.35	25.4mm	6.35mm
BK7-FMR-38.1-9.52	38.1mm	9.52mm
BK7-FMR-50.8-9.52	50.8mm	9.52mm
BK7-FMR-76.2-12.7	76.2mm	12.7mm
BK7-FMR-101.6-12.7	101.6mm	12.7mm
BK7-FMR-152.4-25.4	152.4mm	25.4mm
BK7-WMR-25.4-6.35-30MIN	25.4mm	6.35mm
BK7-WMR-50.8-9.52-30MIN	50.8mm	9.52mm

BK7 WINDOW SUBSTRATES	DIAMETER (D)	THICKNESS (T)
BK7-FWD-12.7-6.35	12.7mm	6.35mm
BK7-FWD-25.4-6.35	25.4mm	6.35mm
BK7-FWD-38.1-9.52	38.1mm	9.52mm
BK7-FWD-50.8-9.52	50.8mm	9.52mm
BK7-FWD-76.2-12.7	76.2mm	12.7mm
BK7-FWD-101.6-12.7	101.6mm	12.7mm
BK7-FWD-152.4-25.4	152.4mm	25.4mm
BK7-WWD-25.4-6.35-30MIN	25.4mm	6.35mm
BK7-WWD-50.8-9.52-30MIN	50.8mm	9.52mm

Other sizes and specifications are available on request - please contact us.

FUSED SILICA SUBSTRATES



Mirror specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish, better than 5 arc min parallel,

Window specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, λ/10 transmitted wavefront distortion, both sides 10-5 scratch-dig, better than 10 arc sec parallel

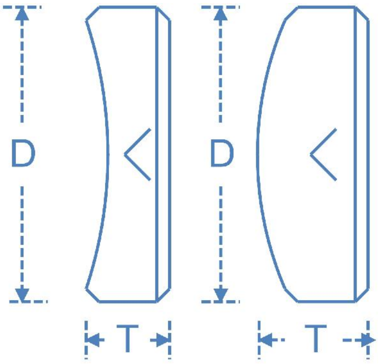
Wedged Optics have a 30arc min (+/-5 arc min) wedge, thickness specified for thick side

FUSED SILICA MIRROR SUBSTRATES	DIAMETER (D)	THICKNESS (T)
FS-FMR-12.7-6.35	12.7mm	6.35mm
FS-FMR-25.4-6.35	25.4mm	6.35mm
FS-FMR-38.1-9.52	38.1mm	9.52mm
FS-FMR-50.8-9.52	50.8mm	9.52mm
FS-FMR-76.2-12.7	76.2mm	12.7mm
FS-FMR-101.6-12.7	101.6mm	12.7mm
FS-FMR-152.4-25.4	152.4mm	25.4mm
FS-WMR-25.4-6.35-30MIN	25.4mm	6.35mm
FS-WMR-50.8-9.52-30MIN	50.8mm	9.52mm

FUSED SILICA WINDOW SUBSTRATES	DIAMETER (D)	THICKNESS (T)
FS-FWD-12.7-6.35	12.7mm	6.35mm
FS-FWD-25.4-6.35	25.4mm	6.35mm
FS-FWD-38.1-9.52	38.1mm	9.52mm
FS-FWD-50.8-9.52	50.8mm	9.52mm
FS-FWD-76.2-12.7	76.2mm	12.7mm
FS-FWD-101.6-12.7	101.6mm	12.7mm
FS-FWD-152.4-25.4	152.4mm	25.4mm
FS-WWD-25.4-6.35-30MIN	25.4mm	6.35mm
FS-WWD-50.8-9.52-30MIN	50.8mm	9.52mm

Other sizes and specifications are available on request - please contact us.

SPHERICAL SUBSTRATES



Mirror specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, front surface: λ/10 surface figure, 10-5 scratch-dig, rear surface: inspection polish, ROC tolerance +/-1%

Lens specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, λ/10 surface figure, both sides 10-5 scratch-dig, focal length tolerance: +/-0.5%

Plano- Concave substrates:
25.4mm diameter: 6.35mm edge thickness

Plano- Convex substrates:
25.4mm diameter: 6.35mm centre thickness

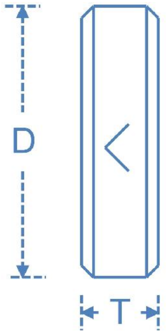
FUSED SILICA MIRROR SUBSTRATES	DIAMETER (D)	RADIUS OF CURVATURE
FS-SMR-25.4-6.35-1.0M-CC	25.4mm	1000mm concave
FS-SMR-25.4-6.35-1.5M-CC	25.4mm	1500mm concave
FS-SMR-25.4-6.35-3.0M-CC	25.4mm	3000mm concave
FS-SMR-25.4-6.35-5.0M-CC	25.4mm	5000mm concave

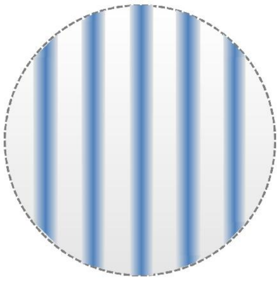
FUSED SILICA LENSES PLANO - CONVEX	DIAMETER (D)	NOMINAL FOCAL LENGTH AT 1064NM
FS-SPL-25.4-6.35-46.5-CX	25.4mm	100mm
FS-SPL-25.4-6.35-56.6-CX	25.4mm	125mm
FS-SPL-25.4-6.35-68.3-CX	25.4mm	150mm
FS-SPL-25.4-6.35-112.4-CX	25.4mm	250mm
FS-SPL-25.4-6.35-135.6-CX	25.4mm	300mm
FS-SPL-25.4-6.35-226.9-CX	25.4mm	500mm
FS-SPL-25.4-6.35-454.4-CX	25.4mm	1000mm

BK7 LENSES PLANO - CONVEX	DIAMETER (D)	NOMINAL FOCAL LENGTH AT 1064NM
BK7-SPL-25.4-6.35-46.5-CX	25.4mm	90mm
BK7-SPL-25.4-6.35-112.4-CX	25.4mm	220mm
BK7-SPL-25.4-6.35-226.9-CX	25.4mm	450mm
BK7-SPL-25.4-6.35-454.4-CX	25.4mm	900mm

Other sizes and specifications are available on request - please contact us.

REFERENCE FLATS





Specifications:
Diameter Tolerance: +0/-0.25mm Thickness Tolerance: +/-0.25mm, front surface: λ/20 flatness, 20-10 scratch-dig, rear surface: inspection polish, better than 5 arc min parallel, uncoated, supplied in wooden box

PART NUMBER	MATERIAL	DIAMETER (D)	THICKNESS (T)
ZER-REF1-25.0-12.0-L/20	Zerodur	25.0mm	12.0mm
ZER-REF1-50.0-15.0-L/20	Zerodur	50.0mm	15.0mm
ZER-REF1-100.0-19.0-L/20	Zerodur	100.0mm	19.0mm
FS-REF1-25.0-12.0-L/20	Fused Silica	25.0mm	12.0mm
FS-REF1-50.0-15.0-L/20	Fused Silica	50.0mm	15.0mm
FS-REF1-100.0-19.0-L/20	Fused Silica	100.0mm	19.0mm

Other sizes and specifications are available on request - please contact us.

INTRODUCTION TO OPTICAL COATINGS

At MPO we also coat the substrates we manufacture. This is very important for high-LIDT optical components as it gives us overall control of the entire manufacturing process.

For coating our optics we have three different coating technologies available: e-beam coatings, IAD-coatings and magnetron sputtered coatings.

The coating technology most widely used (and the one giving the highest laser-induced damage threshold (LIDT) for pulsed lasers is e-beam coating.

An e-beam coating is deposited in a vacuum chamber (the calotte diameter of MPO's largest coating chamber is 1.35m!) with the material being evaporated from crucibles via a very powerful electron beam. The evaporated material then settles on the substrates to form the coating. Optical coatings can range from a single deposited layer to well over 100 layers. The thicknesses are controlled using either a crystal monitor or an optical monitor, i.e. through a substrate whose transmission is constantly measured during the coating process.

Where a denser coating is required, the kinetic energy of the coating particles can be increased by bombarding them with ions - this is called ion-beam assisted deposition or IAD.

Another way of depositing a coating is by sputtering the coating molecules out of a target by bombarding the target with ions. This is called sputtering and at MPO we have got a magnetron sputtering coating chamber to allow us to use this process.

The selection of the coating process depends on the application of the optical components and with our wealth of experience at MPO we always ensure that we select to best coating process for your application.

In this catalogue we only list a very small selection of the optical coatings we can offer, so if you cannot find what you are looking for, please contact us and we will be happy to help. We even might have a suitable component readily available from stock.

INTRODUCTION TO LASER-INDUCED DAMAGE THRESHOLD (LIDT)

The first scientific paper to report laser damage to optical components was published in 1962 - on silver coatings used in conjunction with a ruby laser (which was invented in 1961. Since then, the attainable peak power has increased by approximately a factor 1000 every 10 years.

While a projected silver mirror can withstand about 2.5 J/cm^2 in 10ns (at 1064nm), a good dielectric mirror can withstand more than 35 J/cm^2 in 10ns. To achieve such high LIDTs, it is important to consider all the contributing factors, the ‘ingredients of an optical component’:

1. Substrate
    1.1. Material
    1.2. Preparation
        1.2.1. Surface flatness
        1.2.2. Surface quality (cleanliness, roughness)

2. Coating
    2.1. Coating materials
    2.2. Deposition method
    2.3. Process parameters
        2.3.1. coating morphology
        2.3.2. coating adhesion

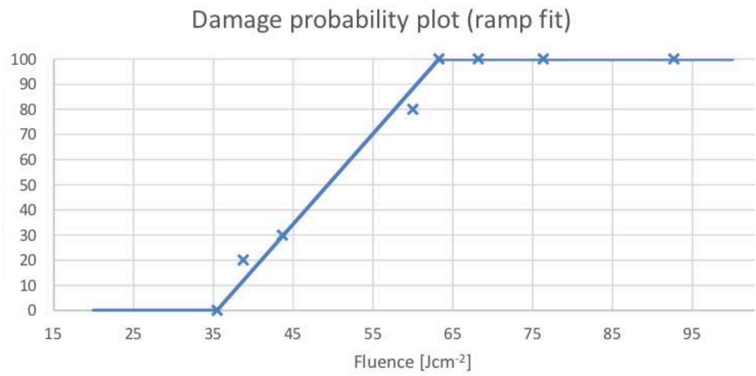
This is the reason why at MPO we manufacture both our substrates and coatings in-house - it gives us all control of the overall (ISO9001:2015 certified) process.

When assessing and comparing LIDT values, the measurement setup is a very important factor as pulse duration, beam diameter and total number of shots per test site have a significant influence over the result. Within the ns-pulse duration regime, it is possible to scale the results, but even this is dependent on the beam diameter.

At MPO will will always give you the LIDT value reflecting a 100% survival power - this is the more conservative and useful value when compared with some approaches, where the LIDT is stated as the arithmetic average between highest survival power and lowest damage power.

Below is an example of a typical LIDT result of one of MPO's high power laser components, a high reflecting mirror at 1030nm /45deg.

This mirror was tested at the HiLase facility in the Czech Republic at a pulse duration of 10ns and at 1000-on-1, i.e. firing 1000 shots on each test site.



The result shows an LIDT of 35 J/cm^2 in 10ns. Scaled to 1ns, the result equates to 11J/cm^2 in 1ns.

When moving towards shorter pulses, i.e. pulses in the pico- or femtosecond regime, different damage mechanisms come into play where fundamental material properties such as the electron band gap become important and appear to provide a theoretical maximum to the LIDT achievable. Especially the damage mechanisms at work in the picosecond regime are still subject to a lot of research with many factors still not understood.

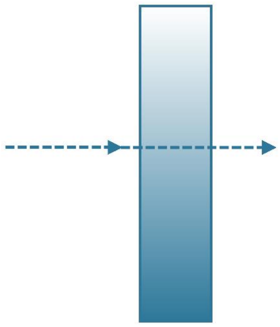
Stating an LIDT for all components listed in this catalogue to cover the different possible pulse durations is therefore not feasible. However, in the following overview we are giving some examples of LIDT values that we can achieve.

Optical Coating	LIDT
>99.7%R @ 532nm /0deg (on standard substrate)	>=5J/cm^2 in 1ns (2000-on-1)
>99.3%R @ 740-860nm /0deg, low GDD coating	>=0.75J/cm^2 in 150fs (2000-on-1)
>99.5%R @ 1030nm /45deg p-POL on high-LIDT substrate	>=10J/cm^2 in 1ns (1000-on-1)
AR (<0.2%R) @ 1030nm /0deg on high-LIDT substrate	>=40J/cm^2 in 10ns (1000-on-1)
>99.5%R @ 1030nm /45deg p-POL on high-LIDT substrate	>=10J/cm^2 in 1ns (1000-on-1)
Optically contacted cube polariser, >99.5%R s-POL & >95%T p-POL @ 1064nm /45deg, outside faces: AR (<0.25%R) @ 1064nm /0deg	>=6J/cm^2 in 1ns (2000-on-1)

The above values indicate the high LIDT values that MPO achieves with its components.

Please do not hesitate to contact us if you would like to discuss any specific applications and challenges. We look forward to hearing from you.

AR-COATED WINDOWS



Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, $\lambda/10$ transmitted wavefront distortion, both sides 10-5 scratch-dig, better than 10 arc sec parallel

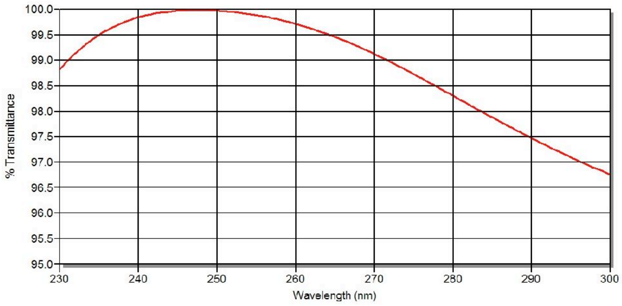
All single wavelength AR coatings give <0.25%R for the respective wavelength.
The broadband AR coatings for 245nm-410nm give (<1%R avg.) while all other listed broadband AR coatings give (<0.5%R avg.).

PART NUMBER	DIAMETER (D)	THICKNESS (T)	COATING WAVELENGTH
FS-FWD-25.4-6.35-AR/AR-248-0	25.4mm	6.35mm	248nm
FS-FWD-25.4-6.35-AR/AR-266-0	25.4mm	6.35mm	266nm
FS-FWD-25.4-6.35-AR/AR-355-0	25.4mm	6.35mm	355nm
FS-FWD-25.4-6.35-AR/AR-532-0	25.4mm	6.35mm	532nm
FS-FWD-50.8-9.52-AR/AR-532-0	50.8mm	9.52mm	532nm
FS-FWD-25.4-6.35-AR/AR-1030-0	25.4mm	6.35mm	1030nm
FS-FWD-50.8-9.52-AR/AR-1030-0	50.8mm	9.52mm	1030nm
FS-FWD-25.4-6.35-AR/AR-1064-0	25.4mm	6.35mm	1064nm
FS-FWD-50.8-9.52-AR/AR-1064-0	50.8mm	9.52mm	1064nm
FS-FWD-25.4-6.35-AR/AR-245-440-0	25.4mm	6.35mm	245nm-410nm
FS-FWD-50.8-9.52-AR/AR-245-440-0	50.8mm	9.52mm	245nm-410nm
FS-FWD-25.4-6.35-AR/AR-400-700-0	25.4mm	6.35mm	400nm-700nm
FS-FWD-50.8-9.52-AR/AR-400-700-0	50.8mm	9.52mm	400nm-700nm
FS-FWD-25.4-6.35-AR/AR-630-1100-0	25.4mm	6.35mm	630nm-1100nm
FS-FWD-50.8-9.52-AR/AR-630-1100-0	50.8mm	9.52mm	630nm-1100nm

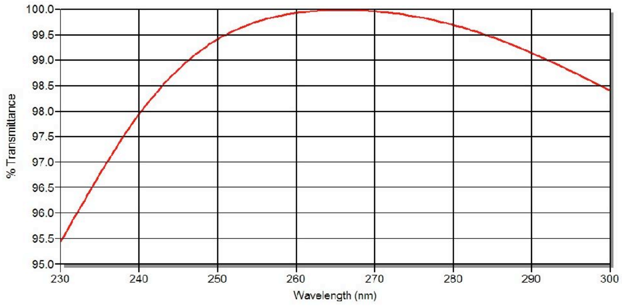
Other sizes and specifications are available on request - please contact us.

AR-COATED WINDOWS

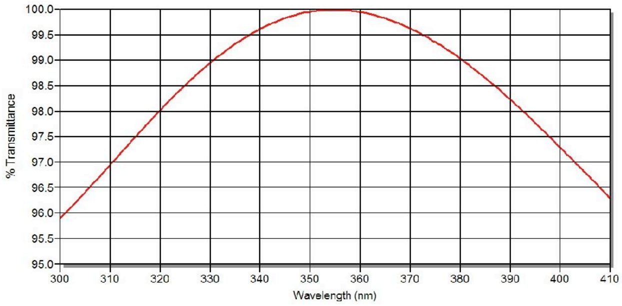
AR @ 248nm /0º



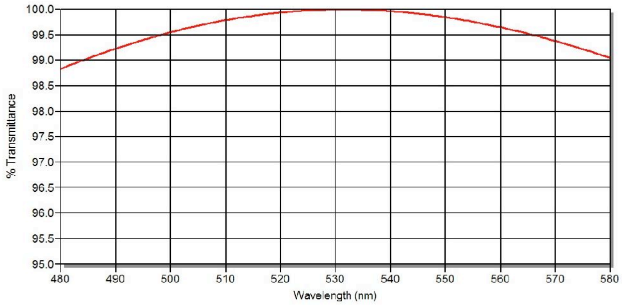
AR @ 266nm /0º



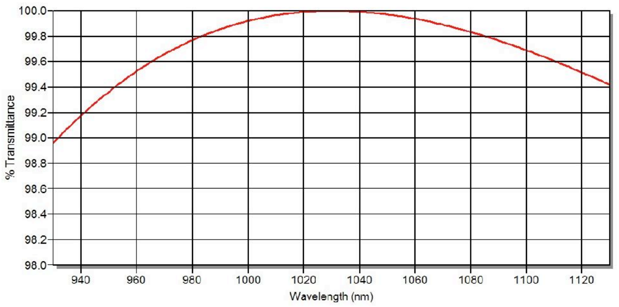
AR @ 355nm /0º



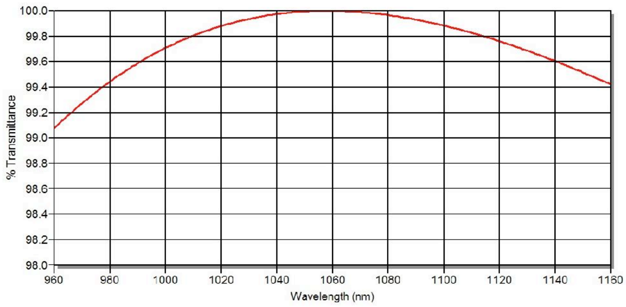
AR @ 532nm /0º



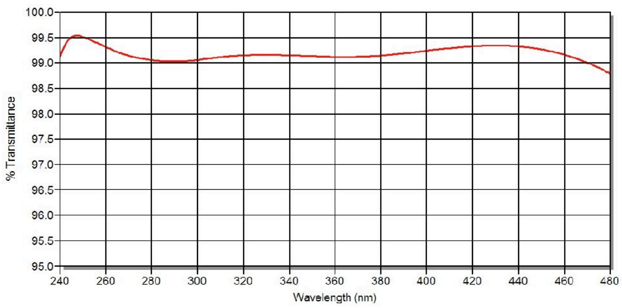
AR @ 1030nm /0º



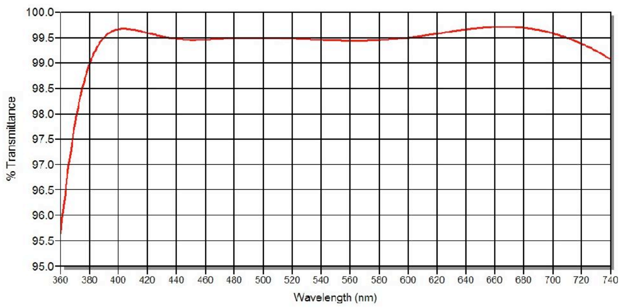
AR @ 1064nm /0º



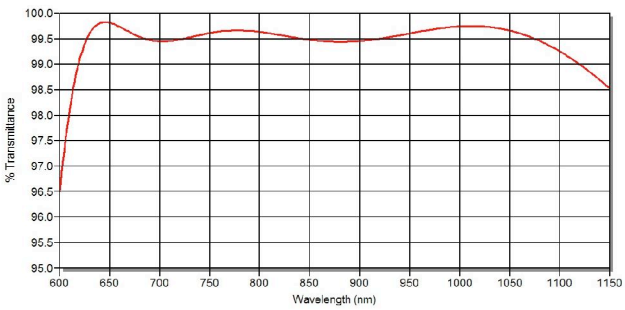
AR @ 245-440nm /0º



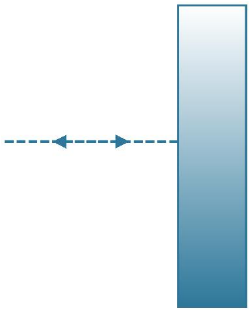
AR @ 400-700nm /0º



AR @ 630-1100nm /0º



LASER LINE MIRRORS 0° INCIDENCE



Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

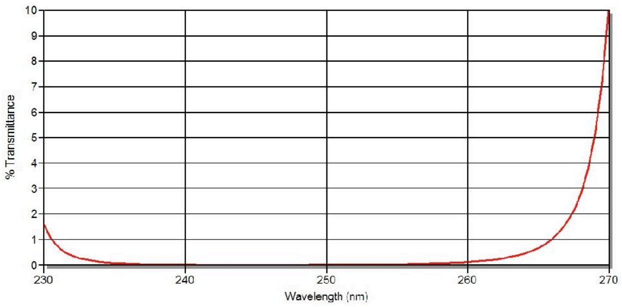
All coatings will give >99.7%R at the respective wavelength.

PART NUMBER	DIAMETER (D)	THICKNESS (T)	COATING WAVELENGTH
FS-FMR-25.4-6.35-HR-248-0	25.4mm	6.35mm	248nm
FS-FMR-50.8-9.52-HR-248-0	50.8mm	9.52mm	248nm
FS-FMR-101.6-12.7-HR-248-0	101.6mm	12.7mm	248nm
FS-FMR-25.4-6.35-HR-266-0	25.4mm	6.35mm	266nm
FS-FMR-50.8-9.52-HR-266-0	50.8mm	9.52mm	266nm
FS-FMR-101.6-12.7-HR-266-0	101.6mm	12.7mm	266nm
FS-FMR-25.4-6.35-HR-355-0	25.4mm	6.35mm	355nm
FS-FMR-50.8-9.52-HR-355-0	50.8mm	9.52mm	355nm
FS-FMR-101.6-12.7-HR-355-0	101.6mm	12.7mm	355nm
FS-FMR-25.4-6.35-HR-532-0	25.4mm	6.35mm	532nm
FS-FMR-50.8-9.52-HR-532-0	50.8mm	9.52mm	532nm
FS-FMR-101.6-12.7-HR-532-0	101.6mm	12.7mm	532nm
FS-FMR-25.4-6.35-HR-1030-0	25.4mm	6.35mm	1030nm
FS-FMR-50.8-9.52-HR-1030-0	50.8mm	9.52mm	1030nm
FS-FMR-101.6-12.7-HR-1030-0	101.6mm	12.7mm	1030nm
FS-FMR-25.4-6.35-HR-1064-0	25.4mm	6.35mm	1064nm
FS-FMR-50.8-9.52-HR-1064-0	50.8mm	9.52mm	1064nm
FS-FMR-101.6-12.7-HR-1064-0	101.6mm	12.7mm	1064nm

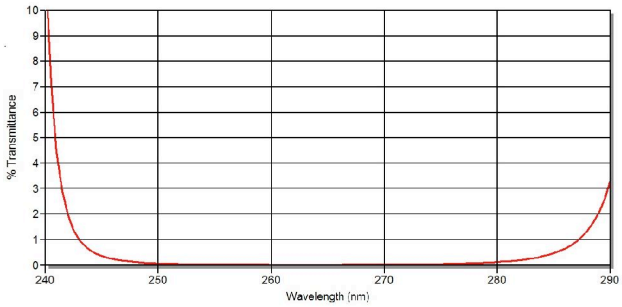
Other sizes and specifications are available on request - please contact us.

LASER LINE MIRRORS 0° INCIDENCE

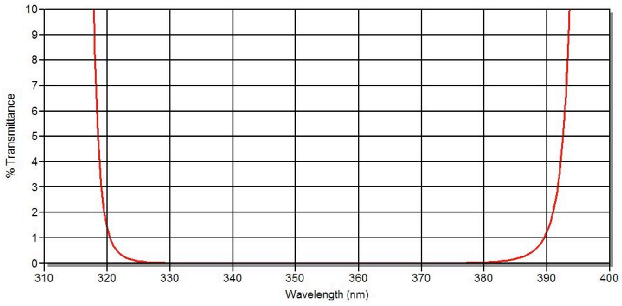
HR @ 248nm /0°



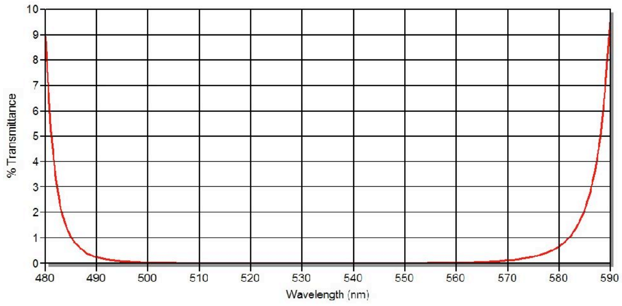
HR @ 266nm /0°



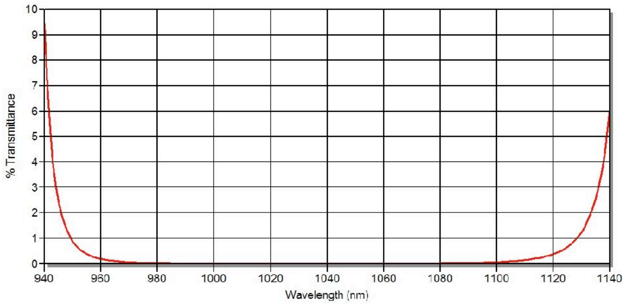
HR @ 355nm /0°



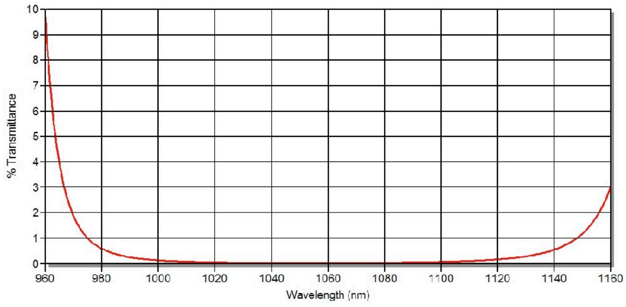
HR @ 532nm /0°



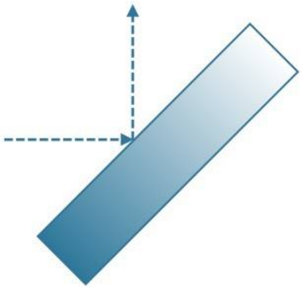
HR @ 1030nm /0°



HR @ 1064nm /0°



LASER LINE MIRRORS 45° INCIDENCE



Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

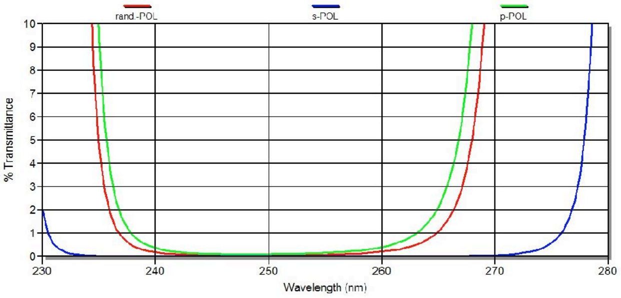
All coatings will give >99.3%R in rand.-POL at the respective wavelength.

PART NUMBER	DIAMETER (D)	THICKNESS (T)	COATING WAVELENGTH
FS-FMR-25.4-6.35-HR-248-45	25.4mm	6.35mm	248nm
FS-FMR-50.8-9.52-HR-248-45	50.8mm	9.52mm	248nm
FS-FMR-101.6-12.7-HR-248-45	101.6mm	12.7mm	248nm
FS-FMR-25.4-6.35-HR-266-45	25.4mm	6.35mm	266nm
FS-FMR-50.8-9.52-HR-266-45	50.8mm	9.52mm	266nm
FS-FMR-101.6-12.7-HR-266-45	101.6mm	12.7mm	266nm
FS-FMR-25.4-6.35-HR-355-45	25.4mm	6.35mm	355nm
FS-FMR-50.8-9.52-HR-355-45	50.8mm	9.52mm	355nm
FS-FMR-101.6-12.7-HR-355-45	101.6mm	12.7mm	355nm
FS-FMR-25.4-6.35-HR-532-45	25.4mm	6.35mm	532nm
FS-FMR-50.8-9.52-HR-532-45	50.8mm	9.52mm	532nm
FS-FMR-101.6-12.7-HR-532-45	101.6mm	12.7mm	532nm
FS-FMR-25.4-6.35-HR-1030-45	25.4mm	6.35mm	1030nm
FS-FMR-50.8-9.52-HR-1030-45	50.8mm	9.52mm	1030nm
FS-FMR-101.6-12.7-HR-1030-45	101.6mm	12.7mm	1030nm
FS-FMR-25.4-6.35-HR-1064-45	25.4mm	6.35mm	1064nm
FS-FMR-50.8-9.52-HR-1064-45	50.8mm	9.52mm	1064nm
FS-FMR-101.6-12.7-HR-1064-45	101.6mm	12.7mm	1064nm

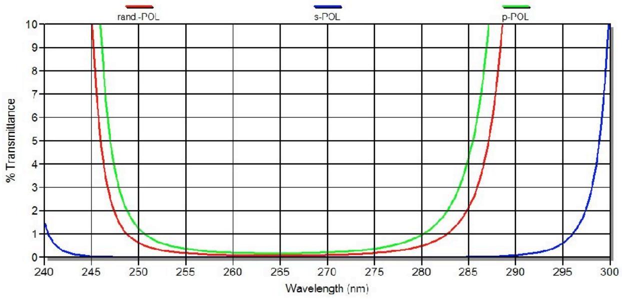
Other sizes and specifications are available on request - please contact us.

LASER LINE MIRRORS 45° INCIDENCE

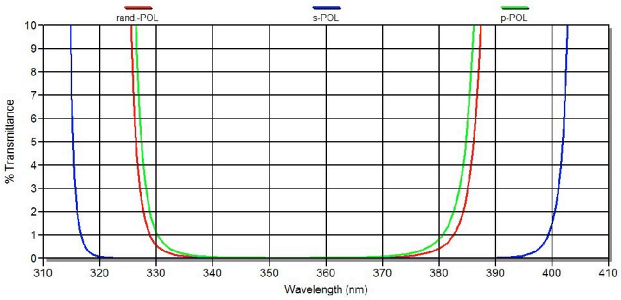
HR @ 248nm /45°



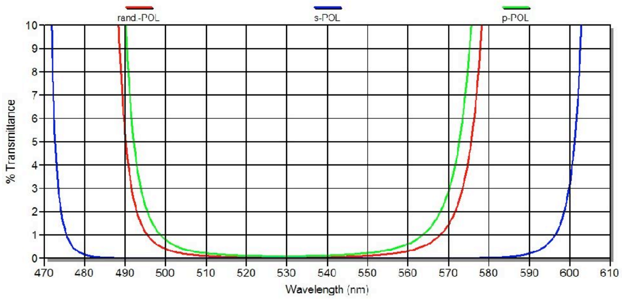
HR @ 266nm /45°



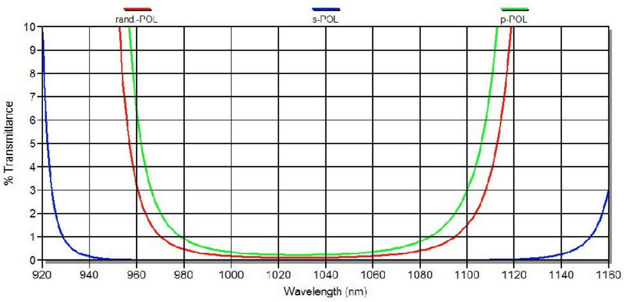
HR @ 355nm /45°



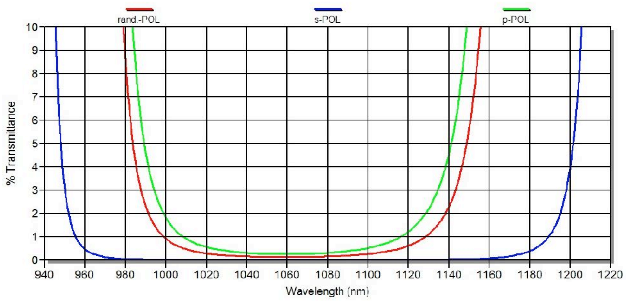
HR @ 532nm /45°



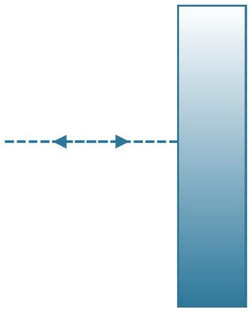
HR @ 1030nm /45°



HR @ 1064nm /45°



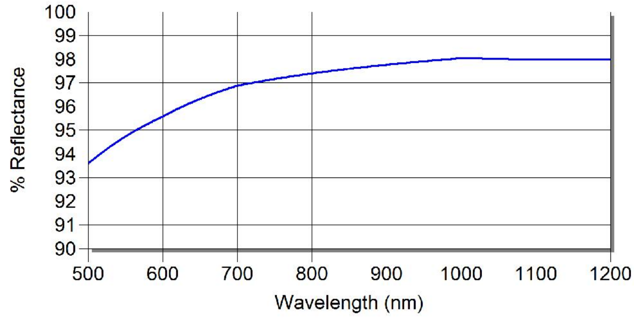
METAL COATED MIRRORS



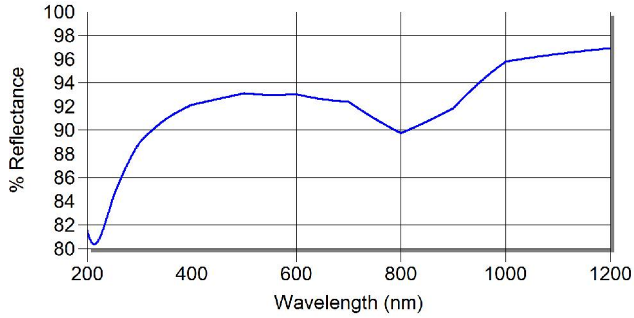
Specifications:
N-BK7, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

PART NUMBER	DIAMETER (D)	THICKNESS (T)	COATING MATERIAL
BK7-FMR-25.4-6.35-PAG	25.4mm	6.35mm	Protected Silver
BK7-FMR-50.8-9.52-PAG	50.8mm	9.52mm	Protected Silver
BK7-FMR-101.6-12.7-PAG	101.6mm	12.7mm	Protected Silver
BK7-FMR-25.4-6.35-PAL	25.4mm	6.35mm	Protected Aluminium
BK7-FMR-50.8-9.52-PAL	50.8mm	9.52mm	Protected Aluminium
BK7-FMR-101.6-12.7-PAL	101.6mm	12.7mm	Protected Aluminium

Protected Silver, 0°

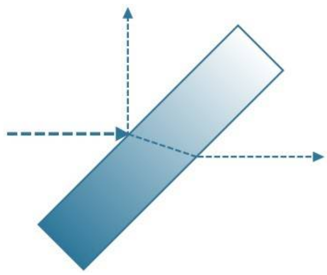


Protected Aluminium, 0 °



Other sizes and specifications are available on request - please contact us.

BEAMSPLITTER COATINGS



Please select the required beamsplitter coating from the table of standard splitting ratios / AR coatings below, applicable to substrates up to 101.6mm (4”) in diameter.

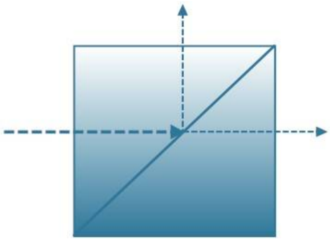
If you need beamsplitters larger than 4” (101.6mm) in diameter or if you cannot find the coating you require in the the table, please do not hesitate to contact us for a quotation. We might even have a suitable optic readily available from stock.

COATING TYPE	WAVELENGTH - 355 nm/ 532 nm / 633 nm / 800 nm / 1030 nm or 1064 nm
Partial reflector - splitting ratio 20% / 50% / 80% / 90% / 95% or 98% at 0° or 45° rand.-POL	Standard coating for 1” - 4” diameter substrate
Anti reflection (AR) coating for 0° or 45° rand.-POL	Standard coating for 1” - 4” diameter substrate

Partial reflectors reflectivity tolerance:
+/- 3% for 20%R and 50%R
+/- 2% for 80%R and 90%R
+/- 1% for 95%R
+/-0.75%R for 98%R

Anti-reflection coatings: <0.25%R for 0° and <1%R for 45° rand.-POL

HIGH LIDT CUBE POLARISERS



Specifications:
Fused Silica cube, optically contacted, Dimensional Tolerance: +0/-0.25mm ,
λ/8 transmitted wavefront distortion, 20-10 scratch-dig

Polarising coating immersed to give >99.5%R s-POL & >95%T p-POL @ operational wavelength.

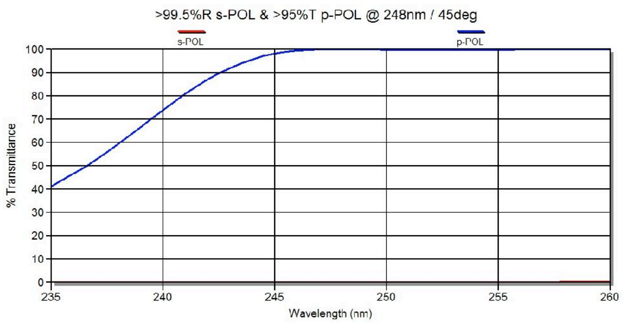
All outside faces AR (<0.25%R) coated at operational wavelength.

PART NUMBER	SIZE	COATING WAVELENGTH
FS-CPOL-25.4-248	25.4mm x 25.4mm x 25.4mm	248nm
FS-CPOL-25.4-266	25.4mm x 25.4mm x 25.4mm	266nm
FS-CPOL-25.4-355	25.4mm x 25.4mm x 25.4mm	355nm
FS-CPOL-25.4-532	25.4mm x 25.4mm x 25.4mm	532nm
FS-CPOL-25.4-1030	25.4mm x 25.4mm x 25.4mm	1030nm
FS-CPOL-25.4-1064	25.4mm x 25.4mm x 25.4mm	1064nm

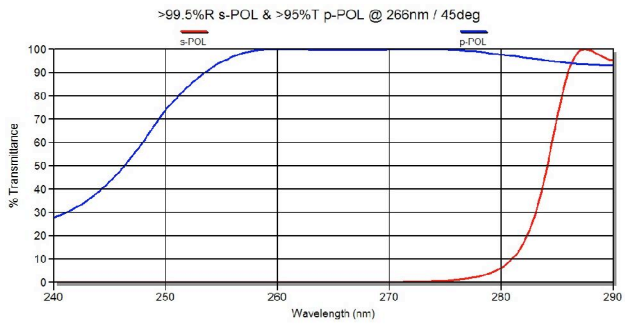
Other sizes and specifications are available on request - please contact us.

HIGH LIDT CUBE POLARISERS

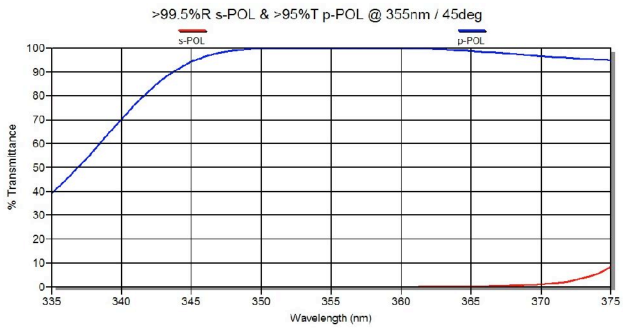
FS-CPOL-25.4-248



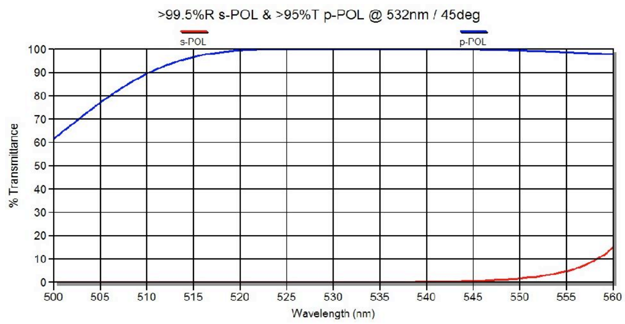
FS-CPOL-25.4-266



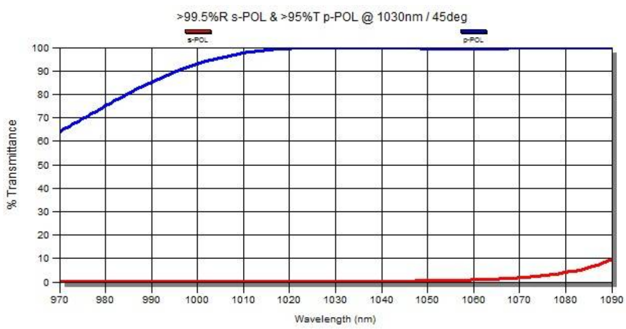
FS-CPOL-25.4-355



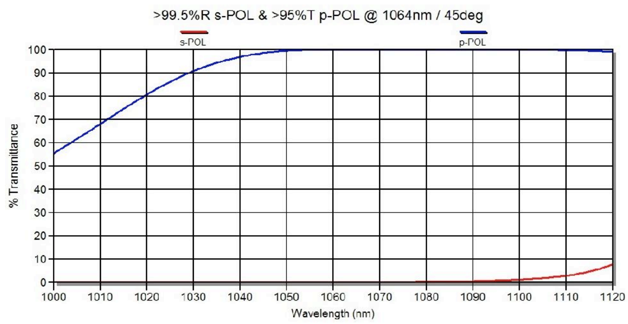
FS-CPOL-25.4-532



FS-CPOL-25.4-1030



FS-CPOL-25.4-1064



TTS Range

The TTS range of mirrors is designed to offer an uncomplicated, low coating stress design suitable for a wide range of applications and is aimed at very high power applications. At 800nm, mirrors from the TTS range achieve an LIDT of >=0.75 J/cm2 in 150fs. For LIDTs relating to other pulse durations please do not hesitate to contact us, we are happy to advise you.

Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

Coating specifications:

400nm mirrors designed for 0deg angle of incidence: >99.3%R @ 370-430nm /0deg

400nm mirrors designed for 45deg angle of incidence: >99.7%R @ 360-440nm /45deg s-POL&
>99%R @ 380-420nm /45deg p-POL

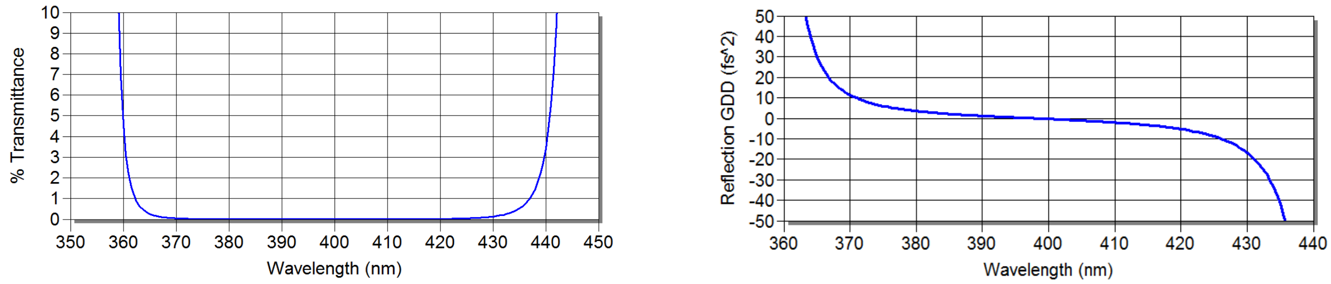
800nm mirrors designed for 0deg angle of incidence: >99.3%R @ 740-860nm /0deg

800nm mirrors designed for 45deg angle of incidence: >99.7%R @ 730-870nm /45deg s-POL &
>99%R @ 765-835nm / 45deg p-POL

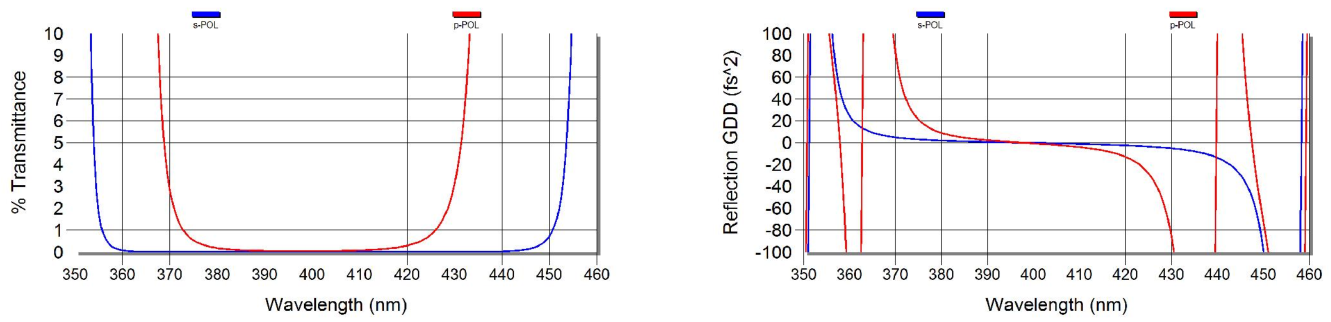
Part Number	Diameter (D)	Thickness (T)	Coating centre wavelength	Angle of Incidence
TTS-25.4-6.35-400-0	25.4mm	6.35mm	400nm	0 degrees
TTS-50.8-9.52-400-0	50.8mm	9.52mm	400nm	0 degrees
TTS-25.4-6.35-400-45	25.4mm	6.35mm	400nm	45 degrees
TTS-50.8-9.52-400-45	25.4mm	6.35mm	400nm	45 degrees
TTS-25.4-6.35-800-0	25.4mm	6.35mm	800nm	0 degrees
TTS-50.8-9.52-800-0	50.8mm	9.52mm	800nm	0 degrees
TTS-76.2-12.7-800-0	76.2mm	12.7mm	800nm	0 degrees
TTS-101.6-12.7-800-0	101.6mm	12.7mm	800nm	0 degrees

Part Number	Diameter (D)	Thickness (T)	Coating centre wavelength	Angle of Incidence
TTS-25.4-6.35-800-45	25.4mm	6.35mm	800nm	45 degrees
TTS-50.8-9.52-800-45	50.8mm	9.52mm	800nm	45 degrees
TTS-76.2-12.7-800-45	76.2mm	12.7mm	800nm	45 degrees
TTS-101.6-12.7-800-45	101.6mm	12.7mm	800nm	45 degrees

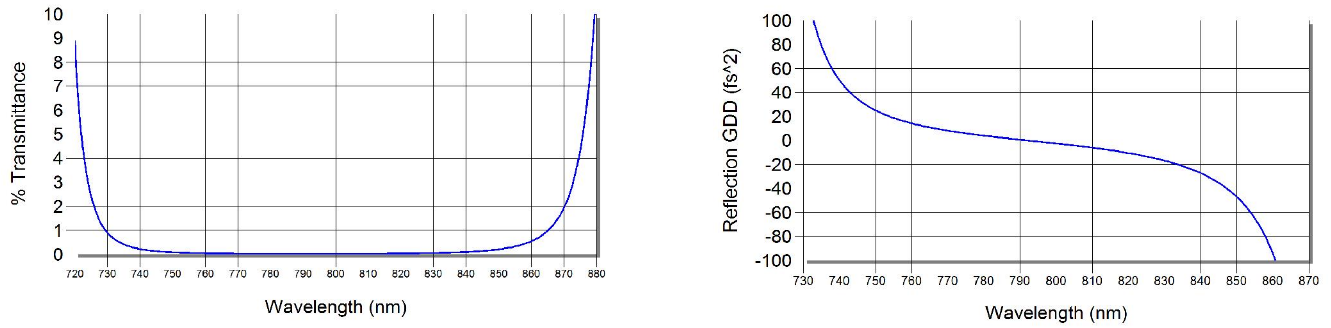
TTS-type mirror for 400nm / 0deg



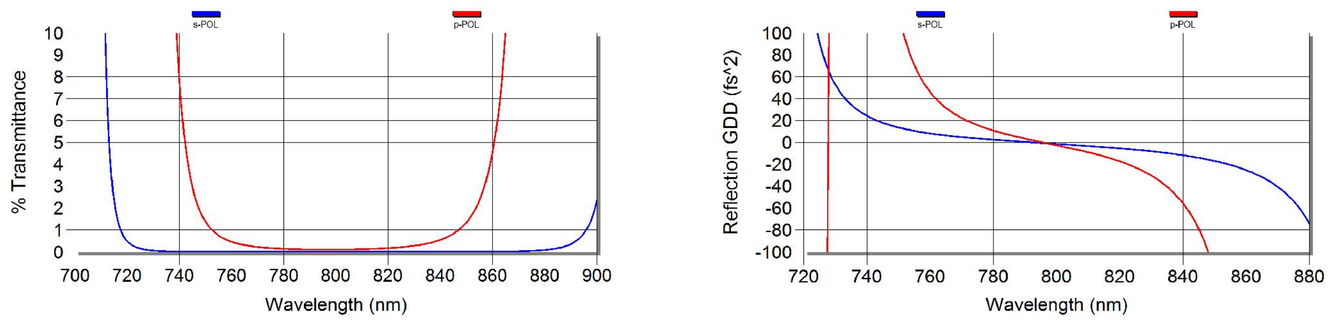
TTS-type mirror for 400nm / 45deg



TTS-type mirror for 800nm / 0deg



TTS-type mirror for 800nm / 45deg



TTB Range

The TTB range of mirrors is based on a specialist coating design to offer a broader reflectivity bandwidth than the TTS range while maintaining a good Group Delay Dispersion (GDD) and high Laser-induced damage threshold (LIDT). At 800nm, mirrors from the TTB range achieve an LIDT of >=0.45 J/cm2 in 25fs and >=1.15 J/cm2 in 500fs. For LIDTs relating to other pulse durations please do not hesitate to contact us, we are happy to advise you.

Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

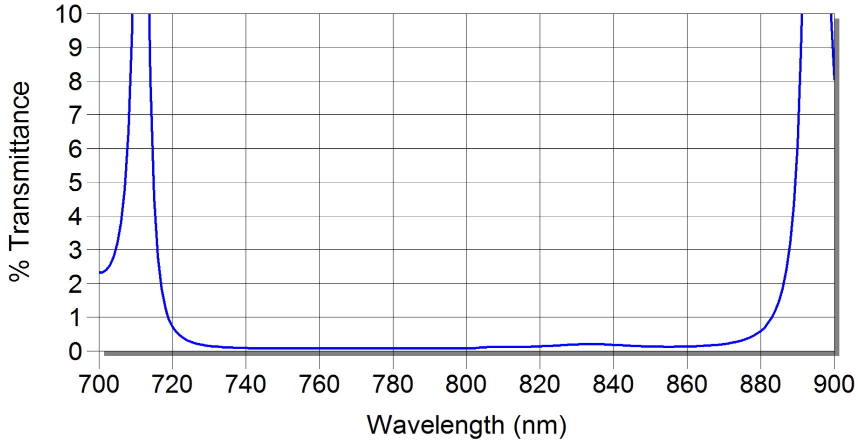
Coating specifications:

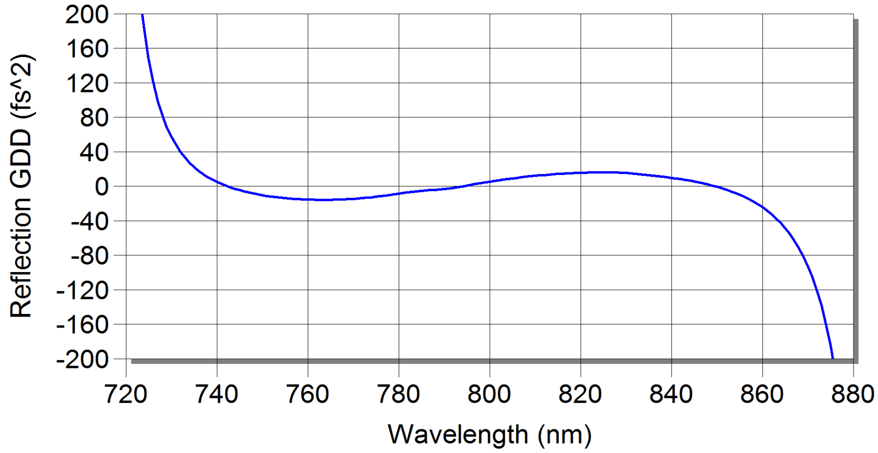
800nm mirrors designed for 0deg angle of incidence: >99.3%R @ 730-870nm / 0deg

800nm mirrors designed for 45deg angle of incidence: >99.5%R @ 710-890nm /45deg s-POL &
>99%R @ 750-850nm / 45deg p-POL

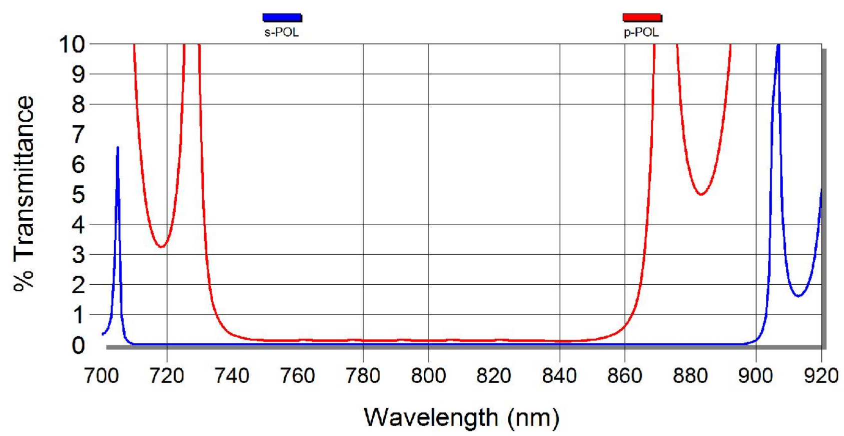
Part Number	Diameter (D)	Thickness (T)	Coating centre wavelength	Angle of Incidence
TTB-25.4-6.35-800-0	25.4mm	6.35mm	800nm	0 degrees
TTB-50.8-9.52-800-0	50.8mm	9.52mm	800nm	0 degrees
TTB-76.2-12.7-800-0	76.2mm	12.7mm	800nm	0 degrees
TTB-101.6-12.7-800-0	101.6mm	12.7mm	800nm	0 degrees
TTB-25.4-6.35-800-45	25.4mm	6.35mm	800nm	45 degrees
TTB-50.8-9.52-800-45	50.8mm	9.52mm	800nm	45 degrees
TTB-76.2-12.7-800-45	76.2mm	12.7mm	800nm	45 degrees
TTB-101.6-12.7-800-45	101.6mm	12.7mm	800nm	45 degrees

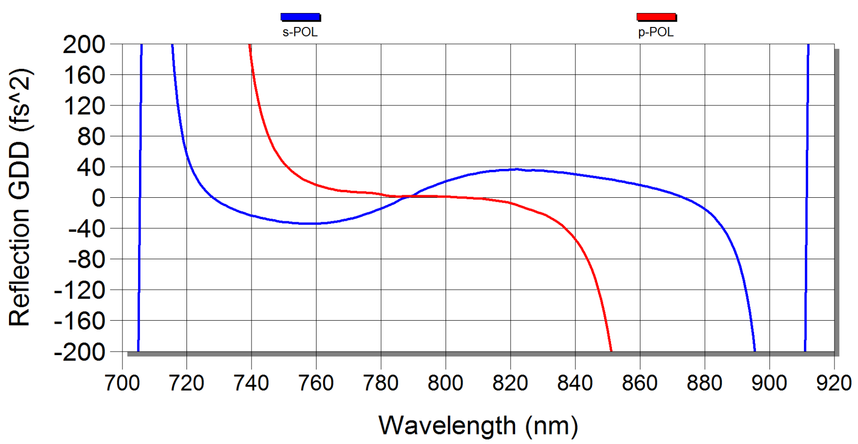
TTB-type mirror for 800nm / 0deg





TTB-type mirror for 800nm / 45deg





TTW Range

The TTW range of mirrors, like the TTB range, is based on a specialist coating design to offer a very broad reflectivity bandwidth based only on dielectric coating materials while maintaining a good Group Delay Dispersion (GDD) and high Laser-induced damage threshold (LIDT). As the LIDT of this mirror is very dependent on the application (pulse duration and pulse profile), please contact us for information on the LIDT, we are happy to advise you.

Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

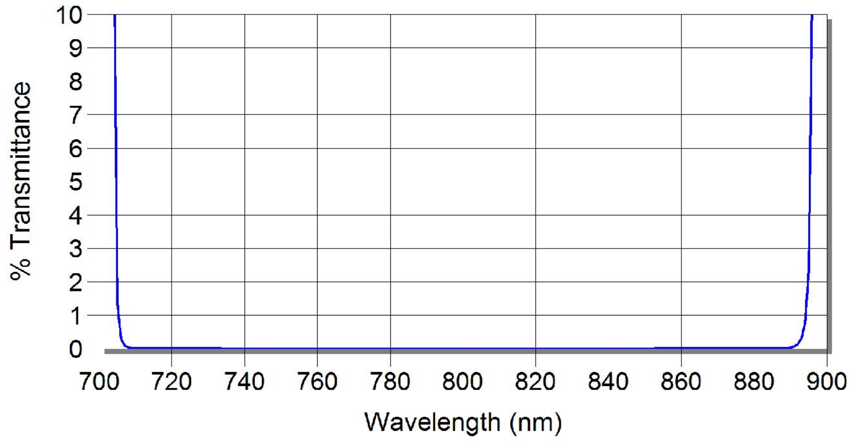
Coating specifications:

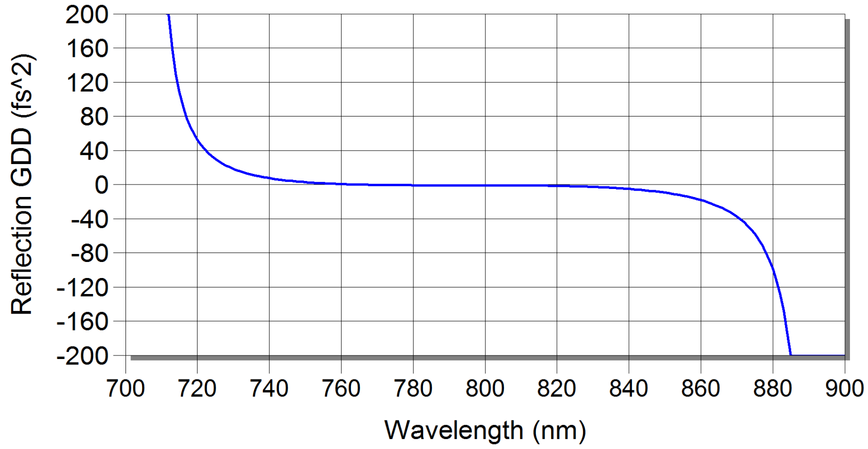
800nm mirrors designed for 0deg angle of incidence: >99.3%R @ 720-880nm / 0deg

800nm mirrors designed for 45deg angle of incidence: >99.3%R @ 700-900nm /45deg s-POL &
>99.3%R @ 740-860nm / 45deg p-POL

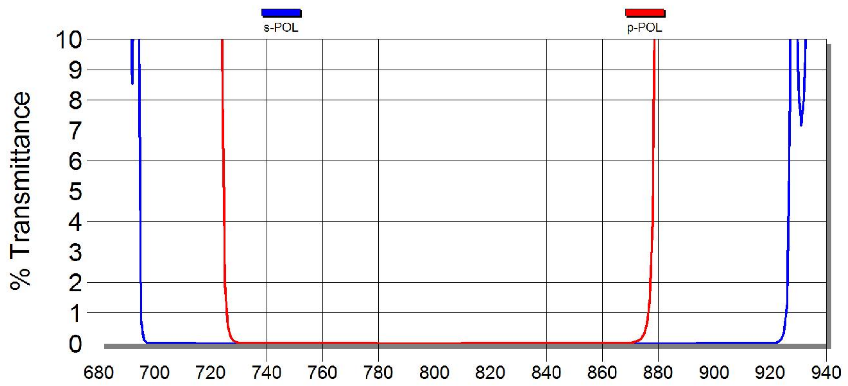
Part Number	Diameter (D)	Thickness (T)	Coating centre wavelength	Angle of Incidence
TTW-25.4-6.35-800-0	25.4mm	6.35mm	800nm	0 degrees
TTW-50.8-9.52-800-0	50.8mm	9.52mm	800nm	0 degrees
TTW-76.2-12.7-800-0	76.2mm	12.7mm	800nm	0 degrees
TTW-101.6-12.7-800-0	101.6mm	12.7mm	800nm	0 degrees
TTW-25.4-6.35-800-45	25.4mm	6.35mm	800nm	45 degrees
TTW-50.8-9.52-800-45	50.8mm	9.52mm	800nm	45 degrees
TTW-76.2-12.7-800-45	76.2mm	12.7mm	800nm	45 degrees
TTW-101.6-12.7-800-45	101.6mm	12.7mm	800nm	45 degrees

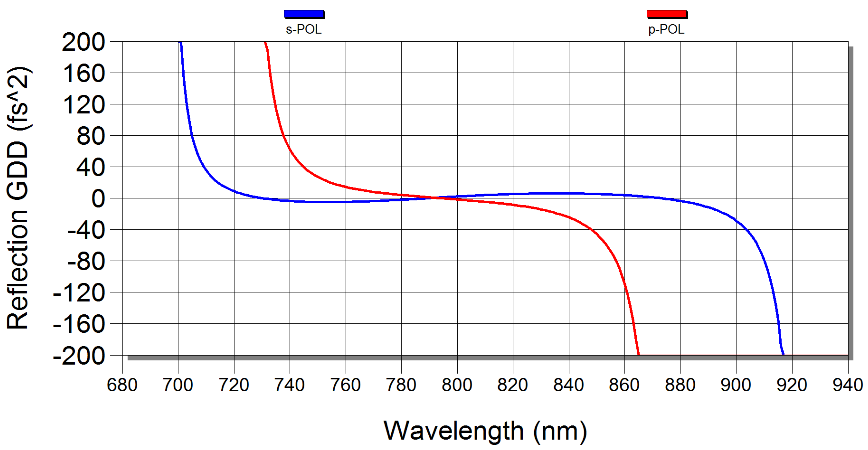
TTW-type mirror for 800nm / 0deg





TTW-type mirror for 800nm / 45deg





TTMP Range

The TTMP range of mirrors has a protected silver coating optimised for the use with ultrafast components

Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm ,Thickness Tolerance: +/-0.25mm, front surface: λ/10 flatness, 10-5 scratch-dig, rear surface: inspection polish

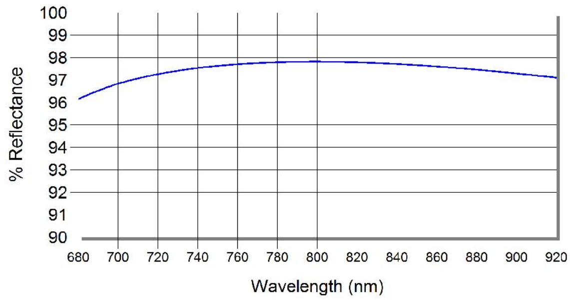
Coating specifications:

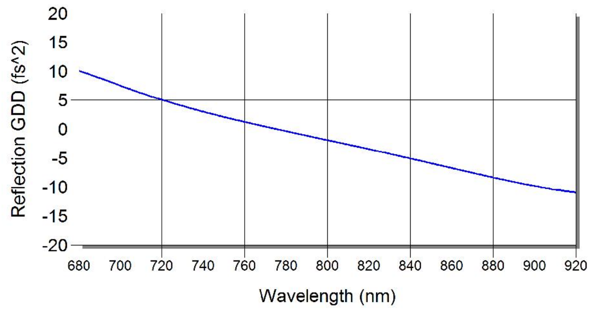
800nm mirrors designed for 0deg angle of incidence: >97%R (avg.) @ 700-900nm / 0deg

800nm mirrors designed for 45deg angle of incidence: >97.5%R (avg.) @ 700-900nm /45deg s-POL &
>96%R (avg.) @ 700-900nm / 45deg p-POL

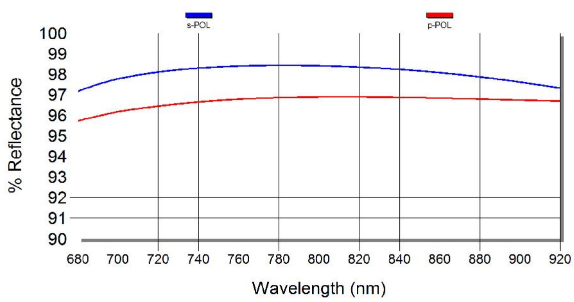
Part Number	Diameter (D)	Thickness (T)	Coating centre wavelength	Angle of Incidence
TTMP-25.4-6.35-800-0	25.4mm	6.35mm	800nm	0 degrees
TTMP-50.8-9.52-800-0	50.8mm	9.52mm	800nm	0 degrees
TTMP-76.2-12.7-800-0	76.2mm	12.7mm	800nm	0 degrees
TTMP-101.6-12.7-800-0	101.6mm	12.7mm	800nm	0 degrees
TTMP-25.4-6.35-800-45	25.4mm	6.35mm	800nm	45 degrees
TTMP-50.8-9.52-800-45	50.8mm	9.52mm	800nm	45 degrees
TTMP-76.2-12.7-800-45	76.2mm	12.7mm	800nm	45degrees
TTMP-101.6-12.7-800-45	101.6mm	12.7mm	800nm	45 degrees

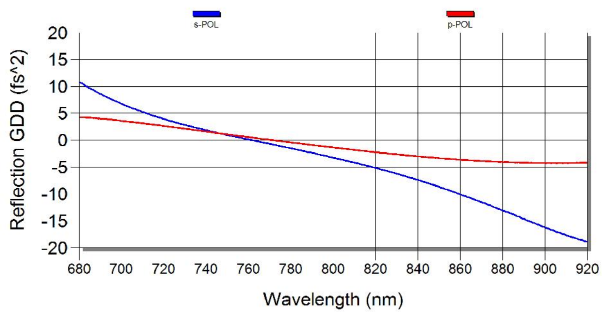
TTMP-type mirror for 800nm / 0deg





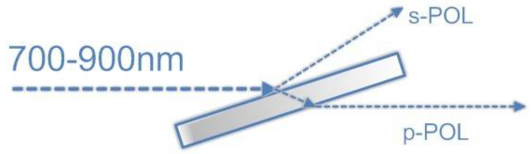
TTMP-type mirror for 800nm / 45deg

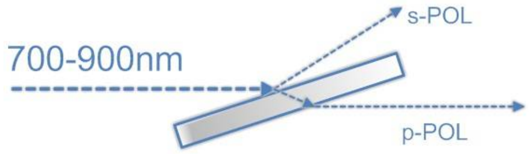




COMPONENTS FOR ULTRAFAST LASERS

POLARISERS





FS-FWD-28.6-14.3-3.175-PPOL-700-900-72

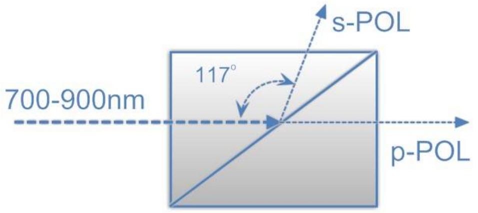
Fused Silica window, 28.6mm x 14.3mm (+0/-0.25mm), 3.175mm (+/-0.25mm) thick, λ/10 transmitted wavefront distortion, 10-5 scratch-dig

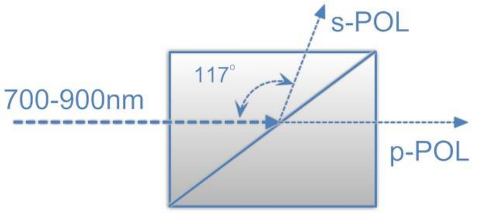
Coating side 1: >85%R (av.) s-POL & >85%T (av.) p-POL @ 700-900nm / 72°
Coating side 2: AR (<2%R avg.) @ 700-900m / 72° p-POL

FS-FWD-60.0-20.0-3.0-PPOL-700-900-72

Fused Silica window, 60.0mm x 20.0mm (+0/-0.25mm), 3.0mm (+/-0.25mm) thick, λ/4 transmitted wavefront distortion, 10-5 scratch-dig

Coating side 1: >85%R (av.) s-POL & >85%T (av.) p-POL @ 700-900nm / 72°
Coating side 2: AR (<2%R avg.) @ 700-900m / 72° p-POL





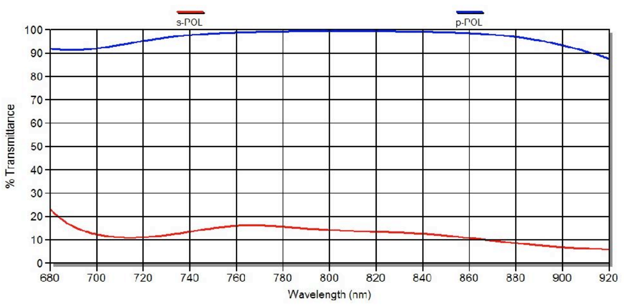
FS-ECPOL-25.4-700-900

Fused Silica cube polariser, optically contacted, 1" x 1" x 1.38" (25.4mm x 25.4mm x 35.0mm), λ/8 transmitted wavefront distortion, 10-5 scratch-dig, polarising coating immersed
Coating immersed: >99.5%R sPOL & >95%T p-POL @ 700-900nm / 54° low GDD coating
Coating side 2: AR (<0.5%R) @ 700-900nm / 0°

FS-ECPOL-50.8-700-900

Fused Silica cube polariser, optically contacted, 2" x 2" x 2.76" (50.8mm x 50.8mm x 70mm), λ/8 transmitted wavefront distortion, 10-5 scratch-dig, polarising coating immersed
Coating immersed: >99.5%R sPOL & >95%T p-POL @ 700-900nm / 54° low GDD coating
Coating side 2: AR (<0.5%R) @ 700-900nm / 0°

PPOL-700-900-72



FS-ECPOL-25.4-700-900

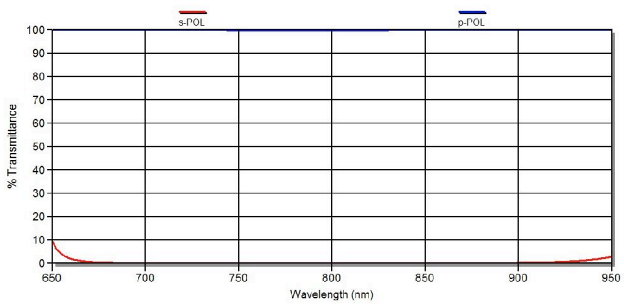
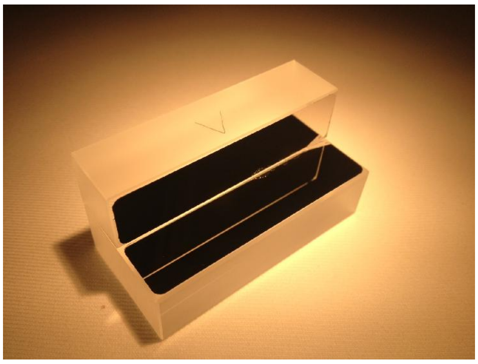


Table of Common/useful angles - Clear aperture 85% (n=1.5)			
Diameter/mm	Thickness/mm	Angle of Incidence/°	Useful Aperture/mm
25.4	6.35	45	12.87
		56	9.72
		72	5.06
50.8	9.52	45	26.93
		56	20.62
		72	10.93
76.2	12.70	45	41.00
		56	31.51
		72	16.80
101.6	12.70	45	56.27
		56	43.58
		72	23.47

Other sizes and specifications are available on request - please contact us.

ROOF MIRRORS



All coatings can also be applied to optically contacted roof mirrors for beam delay lines. Due to the two reflecting mirrors being optically contacted together these mirrors are comparatively easy to mount and to adjust as the two reflecting mirrors maintain their angle and orientation towards each other.

Please contact us for further information.

WAVEPLATES

Specifications:
Synthetic single crystal quartz, dimensional tolerance: +0/-0.25mm diameter, λ/10 transmitted wavefront distortion, 10-5 scratch-dig, better than 0.5 arc sec parallel, >85% clear aperture
retardation tolerance: λ/100 - λ/600 typical (dependent on wavelength)
unmounted

Both faces AR (<0.25%R) coated at operational wavelength.

The Manx Precision Optics part number for waveplates follows the following pattern:

CQWP-	Z (for zero order) or M (for multiple order)	- diameter in mm -	2 (for half wave retardation) or 4 (for quarter wave retardation)	-	Operational wavelength in nm

For example: CQWP-Z-25.4-2-248 is a 25.4mm diameter, zero order, half wave retardation waveplate for 248nm.

STANDARD DIAMETERS

25.4mm (1”)　　　　50.8mm (2”)

STANDARD OPERATIONAL WAVELENGTHS IN NM

248	257	266	308	355
400	405	488	514	532
633	670	694	780	800
810	1030	1047	1053	1064
1315	1319	1550		

All waveplates can also be mounted. When mounted, the 25.4mm diameter waveplates will have a minimum 22.1mm clear aperture and an outside mount diameter of 38.1mm, while the mounted 50.8mm diameter waveplates will have a minimum 44.2mm clear aperture and an outside mount diameter of 76.2mm.

Waveplates for other than standard operational wavelengths, different waveplate diameters and uncoated waveplates are also available - please contact us.

ETALONS

SOLID ETALONS

Specifications:
UV Fused Silica, Diameter Tolerance: +0/-0.25mm, >=80% clear aperture, Thickness Tolerance: +/- 5% of thickness (up to 2mm thickness), better than 1 arc sec parallel, $\lambda/20$ flatness, 10-5 scratch-dig

PART NUMBER	DIAMETER (D)	THICKNESS (T)
ET-FS-25.4-0.2	25.4mm	0.2mm
ET-FS-25.4-0.3	25.4mm	0.3mm
ET-FS-25.4-0.5	25.4mm	0.5mm
ET-FS-25.4-1.0	25.4mm	1.0mm
ET-FS-25.4-2.0	25.4mm	2.0mm

Other specifications are available. All Solid Etalons are also available with optical coatings. Please contact us for further details.

AIR-SPACED ETALONS

Please contact us for further details about air-spaced etalons. We can manufacture traditional air-spaced etalons (with three spacer legs) and ring-spaced etalons (for applications that require very rigid etalons. We hold stock of 30mm diameter (20mm clear aperture) etalon plates and also carry a vast selection of ready-made spacers in stock.

With our in-house software we can find the best specification for your application.

VIRTUALLY IMAGED PHASE ARRAY (VIPA) ETALONS

Manx Precision Optics manufactures a wide range of VIPA Etalons. Please contact us for further information.

Technical Information

Common Substrate Materials

	UV GRADE FUSED SILICA	IR GRADE FUSED SILICA (HERAEUS INFRASIL)	SCHOTT N-BK7	SCHOTT SF10	CAF_2	SAPPHIRE
Transparency Range	190nm-2000nm (some absorption bands within this range)	300nm - 3000nm	400nm - 1800nm	400nm - 2000nm	130nm - 7000nm	400nm - 4000nm
Refractive Index @						
200nm	1.55				1.495	
300nm	1.488	1.49			1.454	
400nm	1.47	1.47	1.531	1.778	1.442	1.786
500nm	1.462	1.462	1.521	1.742	1.436	1.775
1000nm	1.45	1.45	1.508	1.703	1.429	1.756
1500nm	1.444	1.444	1.501	1.694	1.426	1.747
3000nm		1.419			1.418	1.71
GDD fs^2/mm @						
400nm	98	98	120	640	68	150
800nm	36	36	45	160	28	58
1064nm	16	16	22	100	17	29
1500nm	-22	-22	-19	38	1.9	-25
TOD fs^2/mm @						
400nm	30	30	41	500	19	47
800nm	27	27	32	100	16	42
1064nm	44	44	49	100	21	65
1500nm	130	130	140	140	46	180

Please note that the above values are only approximate and that MPO cannot guarantee their accuracy.

Technical Information

Homogeneity, Striae, Bubble Content

INHOMOGENEITY CLASS (PER ISO 10110, PART 4)	MAX. VARIATION OF THE REFRACTIVE INDEX WITHIN A PART OF 10^{-6}
0	+/-50
1	+/-20
2	+/-5
3	+/-2
4	+/-1
5	+/-0.5

STRIAE CLASS (PER ISO 10110, PART 4)	DENSITY OF STRIAE CAUSING AN OPTICAL PATH DIFFERENCE OF AT LEAST 30NM IN %
1	<=10
2	<=5
3	<=2
4	<=10
5	Striae free - 30nm path difference rule does not apply

ISO 10110 Part 3 defines the bubble content of optical components. In drawings, it is denoted by code number 1 in the form of

1/NxA

where N is the number of of bubbles and inclusions of the maximum permitted size as defined in the ISO standard while A denotes the grade number measuring the size of the bubbles. A equals the square root of the projected area of the largest permissible bubble in mm. As long as the the sum of the projected area of all bubbles does not exceed NxA^2 (= maximum total area), a larger number of bubbles of a smaller size is allowed.

Care must be taken, as concentrations of bubbles with more than 20% of of the number of allowed bubbles in any one test region are not allowed. Where the total number of bubbles is less than 10, 2 or more bubbles within any 5% sub-area are also classed as a concentration and are therefore not permitted.

Please contact MPO for further information. We are happy to assist you in choosing the correct material quality for your application.

Technical Information
Surface Cleanliness

The industry standard for surface cleanliness is defined through either ISO or MIL specifications. While we can work to both standards, the surface cleanliness of our catalogue optics are defined by MIL specifications.

SCRATCH DENOMINATION	MAXIMUM WIDTH IN MM	MAXIMUM WIDTH IN INCHES
80	0.08	0.0031
60	0.06	0.0024
40	0.04	0.0016
20	0.02	0.0008
10	0.01	0.0004
5	0.005	0.0002

PLEASE NOTE: THE TOTAL LENGTH OF ALL SCRATCHES OF MAXIMUM SIZE MUST NOT EXCEED 25% OF THE DIAMETER OF THE CLEAR APERTURE

DIG DENOMINATION	MAXIMUM DIAMETER IN MM	MAXIMUM DIAMETER IN INCHES
50	0.5	0.02
40	0.4	0.016
30	0.3	0.012
20	0.2	0.008
10	0.1	0.004
5	0.05	0.002

PLEASE NOTE: THE SUM OF THE DIAMETER OF ALL DIGS MUST NOT BE GREATER THAN TWICE THE DIAMETER SIZE OF THE MAXIMUM DIG SIZE

Technical Information
Coatings

- In dielectric coatings it is always easier to reflect s-polarised light and transmit p-polarised light

- Using a coating designed for 0° under and angle of incidence of 45° will shift the centre of the coating down by approximately 10%.

- For pulse lengths down to 0.5ns the LIDT scales with the square root. For example, if the LIDT for a 10ns pulse is known, divide it by the square root of (10/3) to work out the LIDT for a 3ns pulse.

- For pulse lengths shorter than 0.5ns the above rule of thumb does not work reliably. Please contact us for further information.

- Current research suggests that when working with short pulses (in the ps and fs regime), the LIDT depends very much on the electron band gap in the respective dielectric materials while the deposition technique does not play any significant role as far as the coating is cosmetically very good. If you would like to know more, please do not hesitate to contact MPO - we enjoy technical discussions.

- The table below lists a number of commonly used coating materials

MATERIAL	REFRACTIVE INDEX (AT 550NM)	TRANSMITTANCE RANGE
SiO_2	1.45	185nm - 9000nm
Al_2O_3	1.64	190nm - 7000nm
HfO_2	1.98	240nm - 8000nm
Ta_2O_5	2.1	350nm - 10000nm
TiO_2	2.25	400nm - 8000nm
Nb_2O_5	2.3	400nm - 8000nm
MgF_2	1.38	150nm - 8000nm

Please note that the above values are only approximate and that MPO cannot guarantee their accuracy.

Technical Information
Etalons

- Air-spaced etalons are more thermally stable than solid etalons

- The larger the free spectral range of an air-spaced etalon (i.e. the smaller the air-gap), the more mechanically stable it becomes. Air gaps as small as 20µm are feasible.

- Air-spaced etalons can be pressure- and angle-tuned.

- Solid etalons are more compact and mechanically stable than air-spaced ones, but air-spaced etalons generally have a better effective finesse.

- The range of achievable free spectral ranges for air-spaced etalons is wider than for solid ones.

- The two reflection coatings in air-spaced etalons are generally perfectly matched as both plates are coated together, while solid etalons require two different coatings runs, meaning a higher risk of coating mis-match, especially for broad-band coatings.

- Reflectivity Finesse F of an etalon:

$$F = \frac{\pi\sqrt{R}}{(1-R)}$$

R: Coating Reflectivity

- Free Spectral Range (FSR) of an etalon:

$$FSR = \frac{\lambda^2}{2nd}$$

λ : wavelength
n: refractive index
d: spacing distance

- Full-width at half maximum (FWHM) of an etalon:

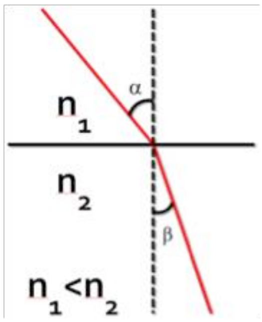
$$FWHM = \frac{FSR}{F}$$

Technical Information Equations

Speed of Light: c = 299792458 km/s

Snell's Law:

$$\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1}$$



Focal length of a curved mirror:

$$f = \frac{r}{2}$$

r: radius of curvature

Lensmaker's Equation (approximate focal length of a thin lens):

$$\frac{1}{f} \approx (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

f: focal length, R_1, R_2: radii of curvature of the lens surfaces

Fresnel reflection of a surface at 0°:

$$R = \frac{n_2 - n_1}{n_2 + n_1}$$

Optical Density OD:

$$OD = \log_{10}\frac{1}{T}$$

T: Transmission

f-stop number N:

$$N = \frac{f}{D}$$

f: focal length
D: effective aperture

Manx Precision Optics – Quality Policy

Manx Precision Optics Ltd. operates to BS EN ISO 9001:2015 offering high quality optical components, systems and integrated solutions to customers within the photonics industry.

Manx Precision Optics Ltd. focuses on meeting customer requirements through the provision of sound advice. The company encourages all employees to participate in a process of continuous improvement and to adopt a systematic approach to processes in manufacturing and problem solving, working in partnership with its suppliers.

Manx Precision Optics Ltd. adopts the following principles for its operations:

- Creation and maintenance of trusted relationships with suppliers and customers

- Focus on customer requirements and meeting commitments made

- Encourage a work ethic that ensures all employees feel responsible for quality and maintain the highest level of craftsmanship

- Meeting legal and statutory requirements

- Adopting a proactive approach to continual improvement of its quality systems

- Setting a quality objectives program to encourage continuous improvement

Dr Helmut Kessler
Managing Director

Date: 20/06/2017

Manx Precision Optics

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