ADVANCED THIN FILMS

PREMIUM LASER OPTICS & COATINGS

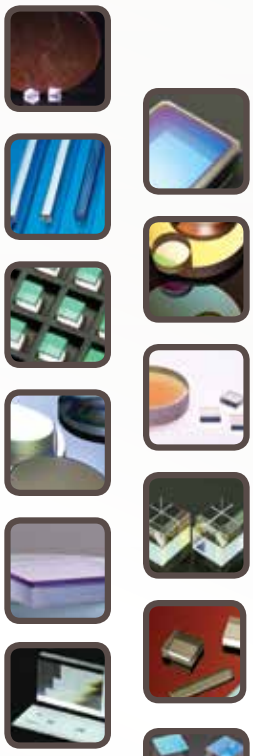
SUPPORTED BY WORLD CLASS METROLOGY

- Laser Mirrors
- High LDT
- IBS Coatings
- Beamsplitters
- Polarizers
- Waveplates
- Assemblies
- Spectrally Complex Custom
- Micro-Optics
- Filters

precision photonics / ATFilms

Precision Optics, Technical Solutions

Let Our Expertise Enhance Your Applications



Collaboration. ATFilms and Precision Photonics are now Advanced Thin Films, Inc. within the IDEX Optics and Photonics Group. We provide precision laser optics and coatings to the telecommunications, high energy research, defense, aerospace, biomedical, and semiconductor industries by taking advantage of ATFilms' advanced optical monitoring and IBS coatings as well as Precision Photonics' innovative manufacturing and epoxy-free CADB® optical bonding.

Quality. Measurement is fundamental to everything we do. Whether testing extinction ratio to 45 dB (32,000:1), verifying parallelism to less than 0.1 arc seconds or actually certifying the low absorption levels of our coatings, we believe that the numbers don't lie. Our goal is to "get it right", from the initial contact, through the quoting and manufacturing processes. We are ISO 9001:2008 Certified.

Quick. Advanced Thin Films is known for innovative engineering and responsive technical support, giving us a personal and progressive approach to product planning and technical sales. We view ourselves as your colleague and will partner with you to develop custom and OEM optics that work, at a price and lead time that meet your needs.

Customer Service. At Advanced Thin Films, our goal is to respond to your inquiries within 24 hours, so call, e-mail or fax us your questions, drawings and RFQs, and we'll get you feedback or answers right away.

QUALITY ASSURED

As an ISO:9001 certified company since 2005, we adhere to strict quality controls so you can be assured of our commitment to bringing you only the best products, high-quality manufacturing, and superior on-time delivery.

VISIT OUR WEBSITE

Visit our website at www.atf-ppc.com for the latest information and copies of our technical papers on optics, epoxy-free assembly, and IBS coatings. On our website you'll also find application notes, spectral scans and test data to assist you with your optical designs and tolerances.

SEE US AT A TRADESHOW OR OPEN HOUSE

Along with our sister companies CVI Laser Optics, Melles Griot and Semrock, Advanced Thin Films hosts open house events and exhibit at industry tradeshows throughout the year. Please stop by and visit us, or call to schedule a personalized presentation and tour of our facilities.

WORLD-CLASS MANUFACTURING IN BOULDER, CO USA

- 25,000 square feet of total manufacturing space
- 7,000 square feet clean room space (Class 100, 1000, and 10,000)
- In-house Shaping, Polishing, Coating, Metrology
  - Spherical and plano substrates
  - Laser scribe capabilities
  - Monolithic optical assembly & integration

HOW TO CONTACT US

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ADVANTAGES OF ION BEAM SPUTTERED COATINGS

SPECTRAL PERFORMANCE

- Tight spectral control (to ±1nm)
- Extreme dichroics (99.9% R at one wavelength, 99.9% T at another)
- Environmental stability

LOW LOSSES

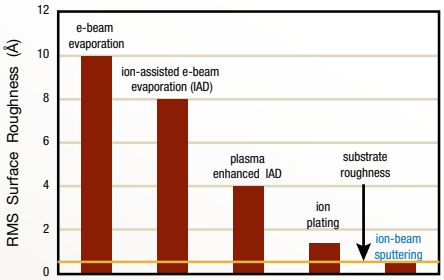
- Ultra-high reflectance mirrors
- Extremely low reflectance coatings
- Low absorption (< 1 ppm @1064 nm)

HIGH DAMAGE THRESHOLDS

- Proven LDT performance as high as 70 J/cm^2 at 3ns pulse widths (1064 nm)

MECHANICAL PERFORMANCE

- Coatings produced at low temperature
- Durable, will not delaminate
- Spectral stability in harsh environments
- Hard coatings are easy to clean



Original data published in "Optical Morphology" C. Langhorn and A. Howe, Photonics Spectra (Laurin Publishing) June 1998.

Why Choose IBS Coatings?

At Advanced Thin Films, our advanced ion-beam sputtering (IBS) technology is a repeatable and controllable process that results in dense, durable, high-damage-threshold thin films.

Unlike conventional evaporative coatings that have porous microstructures, IBS thin films have densely packed structures that make them impervious to water vapor. Consequently, our IBS coatings are insensitive to changes in environmental conditions such as heat, humidity and pressure.

Additionally, our progressive process controls allow us to deposit complex thin film structures with very high precision. By depositing material directly on the substrate and automating the process, we can deposit films in excess of 200 layers with direct control and high precision. The advantages of spectral control include sharper features, higher contrast, repeatable performance and tighter tolerances.

COATINGS COMPARISON

	Electron Beam Evaporation	Ion Assisted Deposition	Magnetron Sputtering	Ion Beam Sputtering
Laser Damage Threshold (1064 HR)	~5 to 30 J/cm^2, 20 ns	~5 to 30 J/cm^2, 20 ns	~10 J/cm^2, 20 ns	>70 J/cm^2, 20 ns
Absorption (1064 nm)	>100 ppm	>50 ppm	10 ppm	<2 ppm
Thermal Conductivity	Low	Medium	High	High
Surface Micro-Roughness -> Scatter	≥10Å RMS	≥8Å RMS	<5Å RMS	<1Å RMS (conformal)
Density / Porosity	Porous	Dense	Near Bulk	Near Bulk
Adhesion / Durability	Low	Good	Very Good	Excellent
Humidity Sensitivity	Yes	Yes, small	No	No
Aging Effects	Yes	Yes, small	No	No
Intrinsic Stress	<100 MPa	~100 MPa	Yes, few 100 MPa	Yes, few 100 MPa, reproducible

These values are typical values indicative of average industry standards. They in no way represent a specific supplier other than Advanced Thin Films and exceptions may exist.

Precision Thin Films

Although Advanced Thin Films specializes in ion beam sputtering (IBS) coating, we also have a full complementary capacity of Ion Beam Assisted Deposition (IAD) coating chambers. Whether your needs are spectrally, technically, or environmentally demanding, we will work with you to provide solutions. Please contact one of our Sales Engineers for assistance with your project.

LASER MIRROR COATINGS

- Laser-line and broadband mirrors
- Ultra-high reflectance cavity mirrors (R > 99.999%)
- Output Couplers

ANTI-REFLECTIONS COATINGS

- Multi-wavelength AR coatings
- Extremely low reflectance coatings (R < 0.01%)
- Low absorption AR coatings for high power CW systems

NON-LINEAR CRYSTAL COATINGS

- Dichroic and trichroic mirrors
- Frequency doubling applications
- LBO, PPLN, KTP crystals

BEAMSPLITTERS

- Dichroic beam splitters
- Non-polarizing beam splitters
- Polarizing beam splitters

SPECTRAL FILTERS

- Bandpass filters
- SWP filters
- LWP filters
  - Notch filters
  - Edge Filters
- Multi-spectral filters

WATERLINE COATINGS

- Coatings at 2.94 microns, 2.79 microns, and 1.39 microns
- Low losses and high damage thresholds

SPECIALTY COATINGS

- Coatings for thermal management
- Corrosion and wear resistant coatings for harsh environments
- Stress compensated coatings
- Ultra-fast mirrors
- Pump and resonator mirrors
- Coatings produced at low temperature

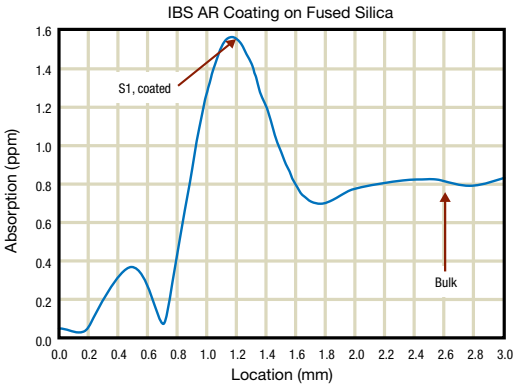
ADVANCED METROLOGY:

- NIST traceable Optical thickness accuracy to ± 1 nm
- Microscope & micro-roughness imaging for characterizing sub-Angstrom surfaces
- Extinction ratio measurement at 1064 nm to > 30,000:1
- Photo-thermal Common-Path Interferometer (PCI) absorption measurements at 1070 nm on coatings or bulk material
- Cavity ring down testing & measurement

Metrology and Manufacturing

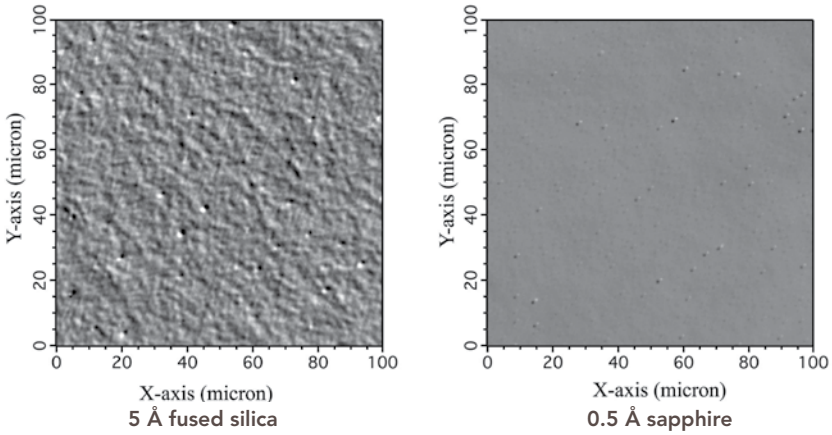
The manufacturing of precision optical components requires state of the art metrology. At Advanced Thin Films, we have developed advanced methods to manufacture and measure the optical properties of our devices; we also partner with universities and national laboratories to access the most advanced measurement tools in order to provide you with the most accurate and complete information available.

Advanced Thin Films' superpolished substrates have < 1 Å RMS micro-roughness and are ideal when low losses, low scatter, high laser damage thresholds, high energy, or high finesse are important to your application. After all, an optic is only as good as the coating AND the substrate.



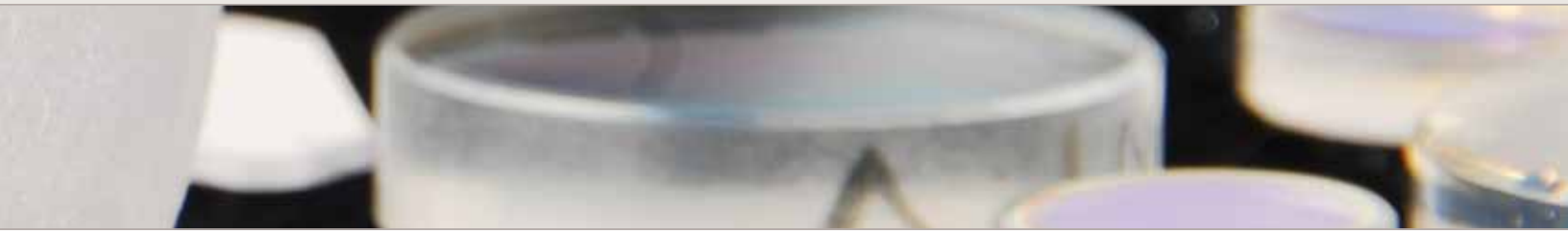
PCI measurement of an IBS AR coating on fused silica. The data shows actual coating absorption of < 1 ppm, ideal for very high power, CW laser applications.

Nomarski Microscope Surface Images



5 Å fused silica **0.5 Å sapphire**

Differential Interference Contrast Microscopy (DICM) Images of standard and superpolished surfaces. The method shown here is also known as Nomarski imaging—a primary tool used for characterizing sub-Angstrom surfaces.



Epoxy-Free Bonding

Precision Photonics has improved upon standard optical contacting by removing the "black art" from the optical bonding process. Now a part of Advanced Thin Films' process, this Chemically Activated Direct Bonding™ (CADB®) technology results in epoxy-free optical paths that are 100% optically transparent with negligible scattering and absorptive losses at the interfaces — the zero thickness bondline features no residue, no wedge and no outgassing. It offers bond strengths often times equal to the strength of the bulk materials being bonded, resulting in assemblies that are exceptionally durable, reliable and resistant to changes in temperature and humidity. Unlike diffusion bonding, CADB can be used on both coated and uncoated surfaces, making it an ideal process for zero order waveplates, high power solid state laser assemblies and polarizing beamsplitters.

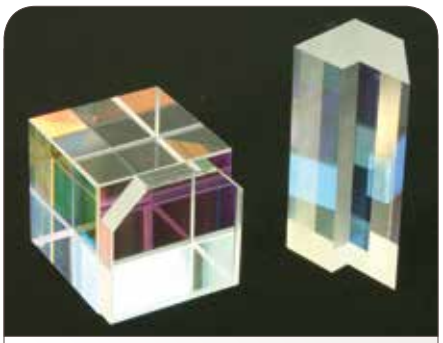
- > Completely adhesive-free
- > IBS Coated or Uncoated interfaces
- > Wide range of materials
- > Zero residue bondlines

CADB COMPONENTS

- > Beamsplitter cubes
- > ULE Reference Cavities
- > Athermal Fabry-Perot etalons
- > Zero-order waveplates
- > Laser rods with endcaps
- > Monolithic assemblies
- > Microchip and thin disk lasers
- > Polarizing beam combiners

COMMON CADB MATERIALS

- > Fused silica
- > Crystal quartz
- > N-BK7
- > Doped and undoped YAG
- > YVO4
- > KTP
- > Spinel
- > Silicon, SiC
- > Sapphire



WHY IS CADB® BETTER?

The CADB optical bonding technology is a "gentler" process than traditional diffusion bonding, working at much lower temperatures and without pressure. It is also much more durable than standard optical contacting, resulting in robust, stable components that can be further polished or coated even after assembly.

High-Energy Laser Mirrors

- > Cavity Mirrors (R > 99.999%)
- > Ideal for high-power Nd:YAG and fiber laser applications
- > High performance pump and resonator mirrors
- > Superpolished substrates available
- > Low absorption
- > Broadband and laser-line designs

Advanced Thin Films offer superior quality laser mirrors and coatings for 257 to 3000 nm. We use ion-beam-sputtered (IBS) coatings because IBS coatings offer lower scatter and absorption losses and fewer pin-hole defects in the coated surface than other coating technologies. This superior film quality and uniformity results in environmentally stable optics with laser damage thresholds exceeding 70 J/cm^2 at 1064 nm and 20 ns.

Mirror coatings are available on flat or curved substrates and, because we use all-dielectric designs, they can handle the high laser powers of both CW and pulsed systems.

Contact us for details on stress-compensated mirrors with λ/10 or better surface flatness after coating.

NEED A CUSTOM MIRROR—QUICKLY?

We offer full coating design capabilities, rapid prototyping and fast turn of your design—even in as short as 48 hours.

WHY DIELECTRIC INSTEAD OF METAL?

Metal mirrors have long been the standard for general-purpose high reflectors, but they have several significant limitations which make them a poor fit for many of today's laser applications. Although inexpensive upfront, drawbacks of metal mirrors include susceptibility to both laser damage and mechanical abrasions, tarnishing or surface degradation, and poor adhesion. In contrast, the increased reflectivity and durability of all-dielectric coatings can result in improved performance and cost savings over the lifetime of an optic or optical system.

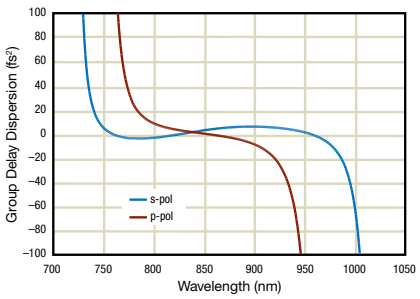
Our broadband dielectric IBS coatings cover wide wavelength ranges from the UV to NIR with > 99% reflectivity, independent of both angle and polarization. In addition, they are easy to clean, scratch resistant and insensitive to environmental changes. With high damage thresholds and low scatter and absorption coefficients, they are ideal for frequency doubled and tripled Nd:YAG lasers, fiber lasers and broadband or tunable laser applications.

Femtosecond Optics & Coatings

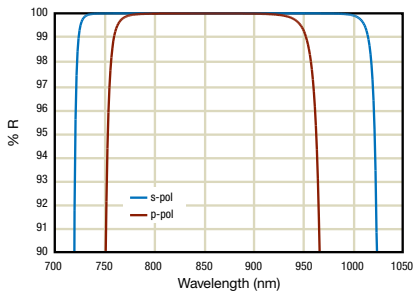
For ultrafast Ti:Sapphire and fiber laser applications, we offer a line of dispersion-free and dispersion controlled mirrors and beamsplitters that offer both broadband reflectivity and high laser-damage thresholds.

As an example, the PBS-GVD is a low dispersion, high energy prism polarizer for femtosecond applications. Designed with fused silica glass, low dispersion IBS coating materials and our epoxy-free assembly process, it offers an average extinction ratio of >10,000:1 throughout the entire design range of 700-1100 nm without sacrificing overall transmission or damage threshold. In addition, the unique "house" shape allows ultra-broadband pulses to travel in and out of the polarizer without refraction, thus avoiding spatial dispersion of the broadband pulse (prism effect).

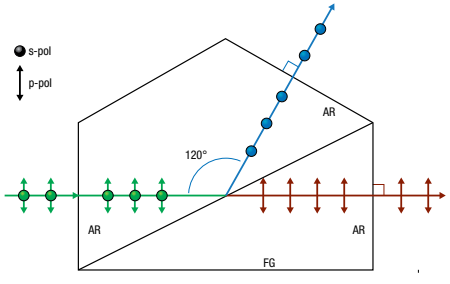
GDD of a typical mirror at 45°



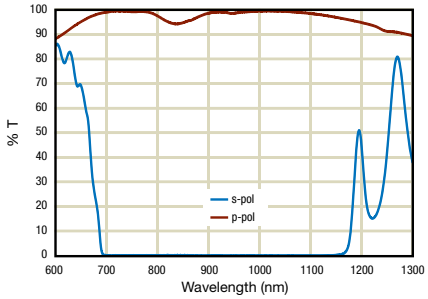
Reflectivity of a typical mirror at 45°



Beampath for PBS-GVD polarizer



PBS-GVD Cube Spectral Scan

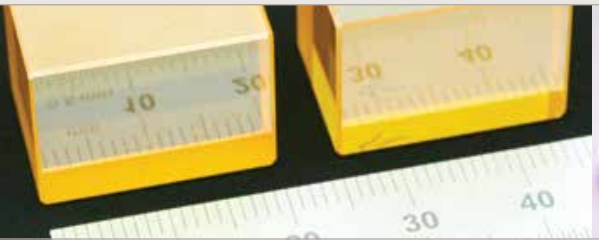


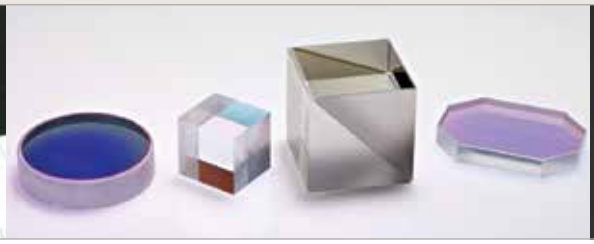
- > Ideal for high-energy broadband femtosecond applications
- > Intra-cavity optics with controlled GDD
- > GDD measurement capability for wavelengths from 400 nm to 1700 nm
- > Chirped mirror pairs
- > Negative dispersion mirrors

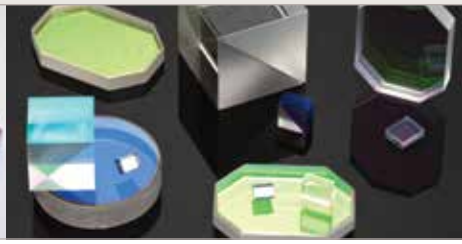
APPLICATIONS:

- Ultrafast isolators
- Multiphoton microscopy
- Regenerative amplifiers
- Non-linear imaging
- Attosecond pulse generation
- Femtosecond laser beam steering

Go to www.semrock.com for standard femtosecond mirrors and beamsplitters listed under the PulseLine™ product family.







Beamsplitters and Dichroic Mirrors

- Durable IBS coatings for precision specs and stability
- Dichroic mirrors with R > 99.9% at λ1 and T > 99% at λ2
- Anti-reflection coating to R < 0.02%
- Non-linear Crystal Coatings: LBO, PPLN, KTP
- Waterline Coatings at 2.94 µm, 2.79 µm, and 1.39 µm
- UV, Visible, NIR & SWIR
- LDT to > 20 J/cm^2 at 1064 nm

Advanced Thin Films offer many diverse optical components including beamsplitter cubes, diode-pumped Nd:YAG resonator mirrors, non-polarizing beamsplitters and high damage threshold dichroic and trichroic mirrors. These are just some of the types of coatings that we do every day on in-house and customer-supplied substrates from 1×1 mm^2 to 150 mm diameter.

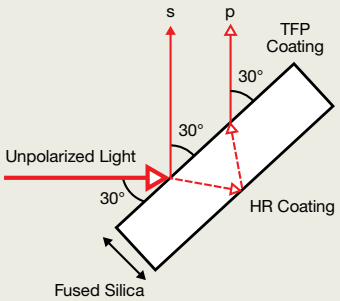
High-energy, low absorption thin films that are accurate, durable and environmentally stable are our forté, and we can turn around parts in as little as 48 hours!

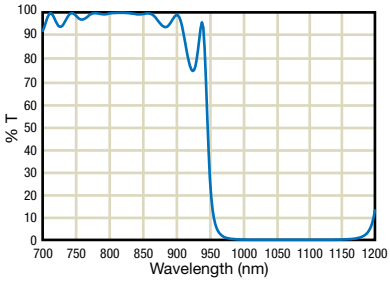
SWIR COATINGS (2.94 µm and 2–3 µm)

Our IBS coatings provide outstanding performance for the new generation of solid state lasers operating at 2 µm (Ho:YAG, Ho:YLF, Tm:fiber, Tm:YAG), 2–3 µm tunable lasers (Cr:ZnSe), and 2.94 µm lasers (Er:YAG). Designs for these systems include low absorption waterline coatings, high energy laser mirrors, thin film plate polarizers and high efficiency dichroic beam splitters.

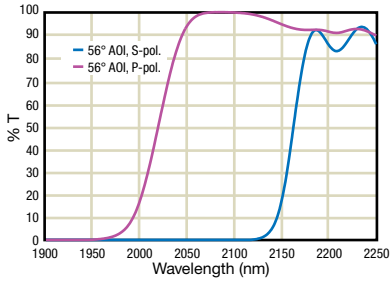
Examples of SWIR components include 1.9 µm to 2.1 µm dichroic beamsplitters and 2.05 µm thin film plate polarizers.

EXAMPLE OF A PLATE BEAMSPLITTER

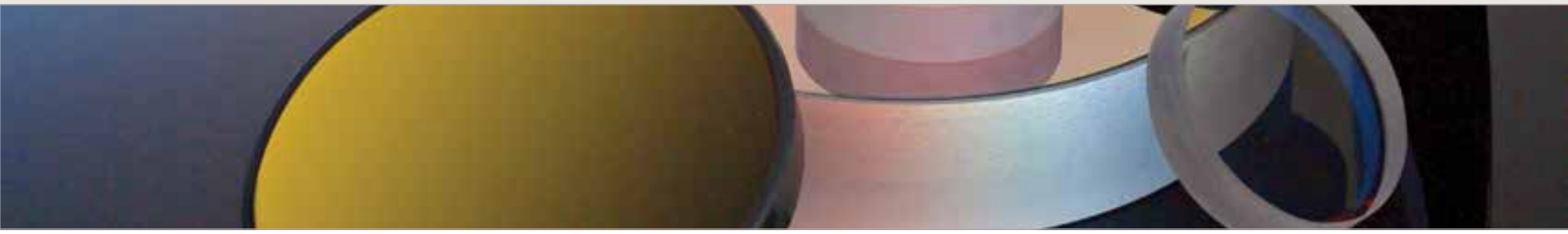




Example of NIR dichroic mirror



Example of 2.1 µm Brewster polarizer



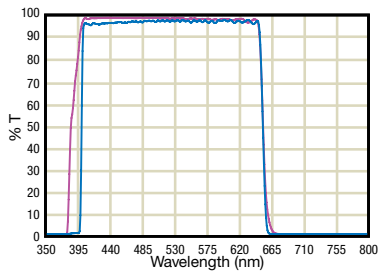
Optical Filters

Advanced Thin Films utilizes multiple process controls to enable the accurate and repeatable deposition of extremely complex optical thin film coatings while minimizing risk. This starts with in-house design software that allows for optimization of multi-layer optical thickness to meet the most challenging spectral requirements. Coatings with hundreds of layers are optimized using thousands of numerical targets for merit functions.

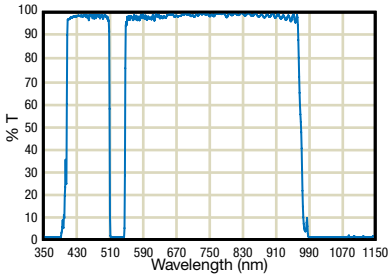
Once designed, customized software developed in-house allows for error analysis and predicted outcome during the plasma deposition process. This is critical since not all designs have an equivalent probability of success. Coating run results and design vs. performance data are reviewed regularly by both Sales and Manufacturing.

Accurate in-situ measurement of the true optical thickness of the coating is essential. We utilize a custom Optical Monitoring System (OMS) that allows for optical layer thickness control to the picometer level. In essence, the coating is measured as it is being deposited, angstrom by angstrom. The results are fed back into the deposition control for real-time correction and improvement, resulting in very high success rates, even for new coating designs.

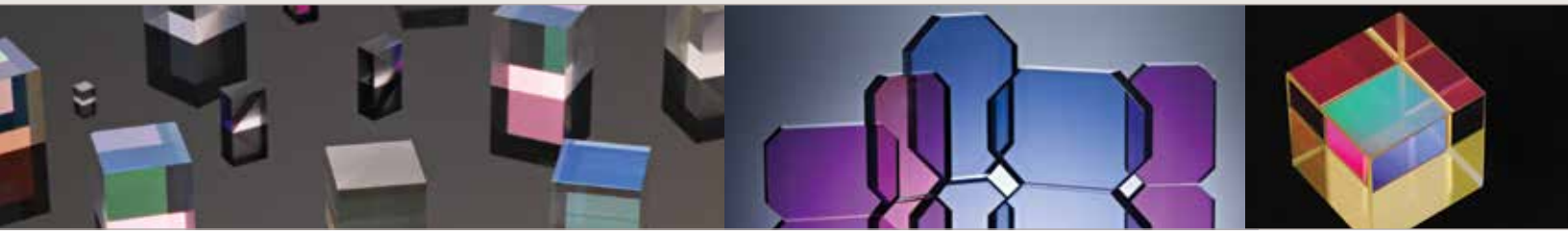
- > Complex coatings
- > Bandpass filters
- > SWP filters
- > LWP filters
- > Notch filters
- > Edge filters
- > Multi spectral filters



650nm Shortpass Filter 45° S & P



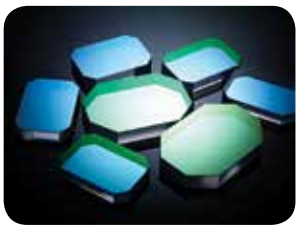
532nm Notch Filter with 1064nm OD6 blocker



High Energy Cube and Plate Polarizers

- Polarizers for wavelengths from 350 to 2940 nm.
- Extinction ratios to > 10,000:1
- High-energy laser-line and broadband designs
- Epoxy-free cubes available from 1×1 mm^3 to > 25 mm
- Plate polarizers from 1×1 mm^2 to 4" diameter
- RoHs compliant

Our polarizing beamsplitter cubes are derived from a unique combination of IBS coatings, ultraprecise fabrication and our epoxy-free bonding technology—Chemically Activated Direct Bonding™ (CADB®) which results in laser damage thresholds up to three times the power levels of other commercially available products. We can produce high-energy cube beamsplitters from 1×1 mm^2 in size, and in a wide variety of materials including fused silica, BK7 and YAG.

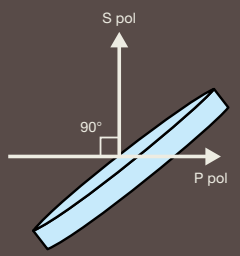


High-energy plate polarizers separate s and p polarizations with an extinction ratio (T_p/T_s) of greater than 10,000:1 in the transmitted beam and transmission (T_p) of up to 99%. Thus, they are ideal for intracavity or extracavity high-power applications where fluences are greater than 500 mJ/cm^2 and calcite or cemented cube polarizers cannot be used.

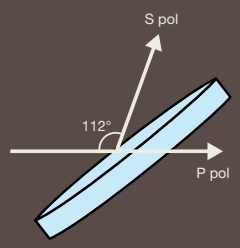
NO GLUE HERE!

Our thin-film plate polarizers achieve superior high-power performance and guaranteed transmission at a specific angle of incidence, with no angle tuning required. By combining dielectric IBS coatings with fused silica substrates, we produce stable components that are easy to align and exhibit high laser-damage thresholds in both reflection and transmission.

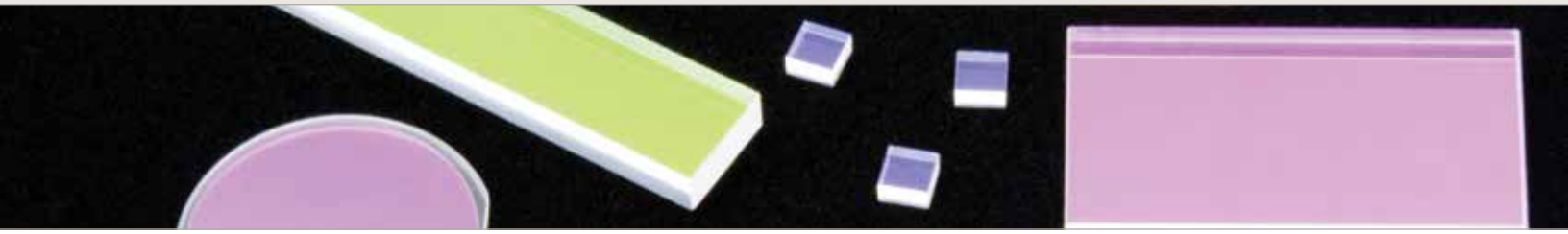
Whether you need 10 or 10,000 pieces, our precision wafer-based processes result in high yields and competitive costs, especially at higher volumes. These high-precision components have been widely used in telecommunications, semiconductor and biomedical applications where transmission efficiency, extinction ratio and wavefront quality are all critical specifications.



45° design separates beams by 90° for easy alignment



Wide acceptance angle and no angle tuning required



Zero- and Multiple-Order Waveplates

We use laser-grade crystal quartz, IBS coatings and our proprietary epoxy-free bonding technology to produce multiple-order, true zero-order and compound zero-order waveplates. This unique combination of processes results in precise, high-energy components that exhibit environmental stability and excellent transmitted wavefront.

All of our waveplates and waveplate assemblies are adhesive free, making them suitable for high power applications with energy densities exceeding 20 J/cm^2 at 1064 nm.

Multiple-order retarders are ideal for narrow- or single-wavelength applications at a specific operating temperature. For increased bandwidth and thermal stability, zero-order waveplates are recommended.

ANY SHAPE, ANY SIZE

We typically manufacture waveplates starting in wafer forms of 2" or 4" in diameter. These large retarders can be sold as-is, core-drilled or diced to almost any dimension, and they are already coated with our high energy, low loss IBS anti-reflection coatings.

Typical Waveplate Characteristics

Types
Multiple order, true zero order, compound zero order

Operating Wavelength
UV, Visible, NIR, MWIR (266–5000 nm)

Retardation Tolerance
As low as λ/500

Transmitted Wavefront
λ/10 p-v 633 nm

AR Coating
<0.1% per surface

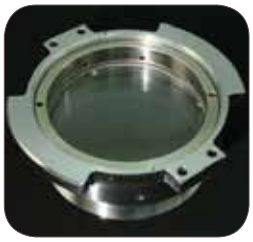
Available Materials
Crystal quartz, sapphire

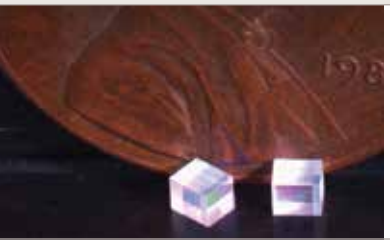
Shapes
Round, square, rectangular

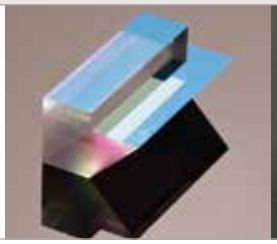
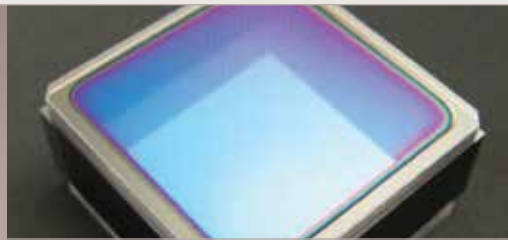
Typical Size
From 1×1 mm^2 to 100 mm

Waveplates are available as stand-alone components, or as part of a more complex optical assembly. Advanced Thin Films manufactures custom multi-element polarization assemblies in sizes from 1×1 mm^2 to > 1" for R&D, industrial, biomedical and aerospace applications.

- Epoxy-free waveplates and assemblies
- Sizes from 1×1 mm^2 to 100 mm
- Half-wave, quarter-wave and other retardations available
- Anti-reflection coatings of R < 0.1%





Micro-Optics and Assemblies

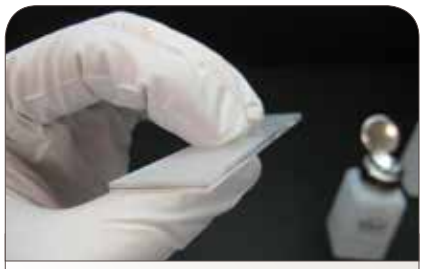
- Epoxy-free multi-element assemblies
- High precision components from 1×1 mm² in size
- Prisms & cubes with angle tolerances to <10 arcsec
- Athermal Fabry-Perot etalons (finesse > 300,000)
- ULE reference cavities
- Solid state laser optics
- Coated or uncoated interfaces

Adhesive-free assemblies are ideal for increasing the sensitivity in beam-delivery systems, fiber-optics, and endoscopic systems used in coherent communications, fluorescence spectroscopy, Raman spectroscopy, optical-coherence tomography (OCT), and microscopy.

The CADB® process enables us to create high-performance composite crystal, glass and ceramic structures which are ideal for laser amplifiers and oscillators, LIDAR, defense and aerospace, materials processing, and medical applications. These devices can be fabricated in a variety of geometries such as rod end caps, laser slabs and microchip lasers.

Our IBS coating technology can handle damage thresholds above 40 J/cm² with less than 2 ppm absorption in the coating, making it suitable for a wide variety of high power solid state lasers and laser gain media structures including microchip lasers and Q-switch lasers with Cr4+:YAG or Co:Spinel saturable absorbers.

Advanced Thin Films has the ability to laser mark fiducials, part numbers or serial numbers on individual components for both Research and OEM applications. Call us with your requirements.



NO GLUE HERE!

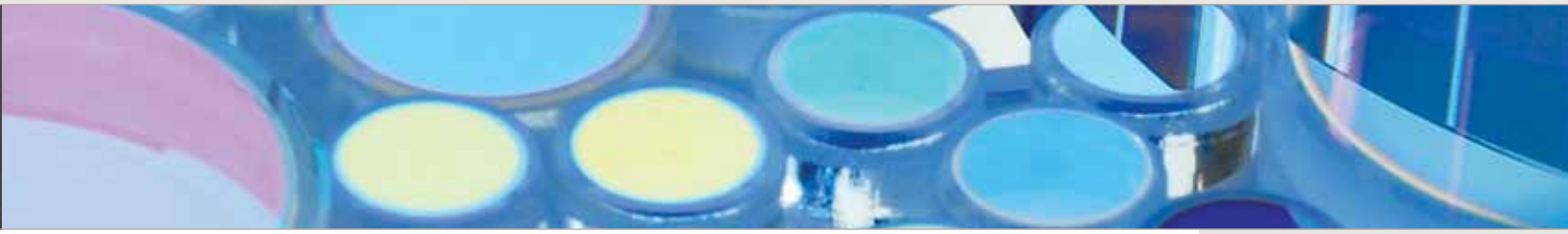
Our Chemically Activated Direct Bonding™ (CADB®) technology results in epoxy-free optical paths with negligible scattering and absorptive losses at the interfaces. It can be used on uncoated surfaces or with our ion-beam-sputtered dielectric thin films, making it ideal for monolithic optical devices and composite laser assemblies.

Products Include

- Solid and air-spaced etalons
- Polarizing beamsplitters
- Zero-order waveplates
- Beam combiners
- Reference cavities
- Monolithic assemblies
- Thin disks
- Microchip lasers
- Planar waveguides
- Laser rods with end caps

Available in a wide range of materials

- Fused silica
- ULE, Zerodur®
- YAG (doped and undoped, crystalline and ceramic)
- YVO_4
- Ti:sapphire
- Phosphate Glasses
- Spinel (crystal and ceramic)
- N-BK7
- Silicon, SiC
- KTP, LBO, BBO
- Crystal Quartz
- MgF_2



Terms and Conditions

For a complete listing of our terms and conditions, go online www.atf-ppc.com/company/termsandconditions.aspx.

SHIPMENTS WITHIN THE U.S.A.

Delivery will be made FCA, Boulder, CO, USA. In the absence of specific shipping instructions, we will ship per industry standards. Transportation charges will be prepaid and invoiced.

OVERSEAS SHIPMENTS

All quotations are in US dollars. Parts will be shipped via customer-specified international carrier against customer-provided account number. All shipping, insurance and any applicable tariffs and duties will be invoiced to that account.

For the convenience of working in your time zone and language, or for assistance regarding customs and import issues, please contact one of our international distributors. Updated lists of sales representatives can be found online at www.atf-ppc.com.

TERMS OF PAYMENT

All payments are due net thirty (30) days after the original shipment date, pending acceptance of credit application. Otherwise, prepayment will be required.

All major credit cards are accepted.

LIMITED ONE YEAR WARRANTY

Please see terms online at www.atf-ppc.com/company/termsandconditions.aspx.

HOW TO CONTACT US

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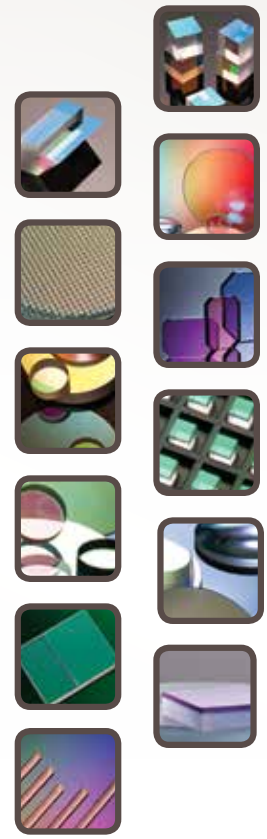
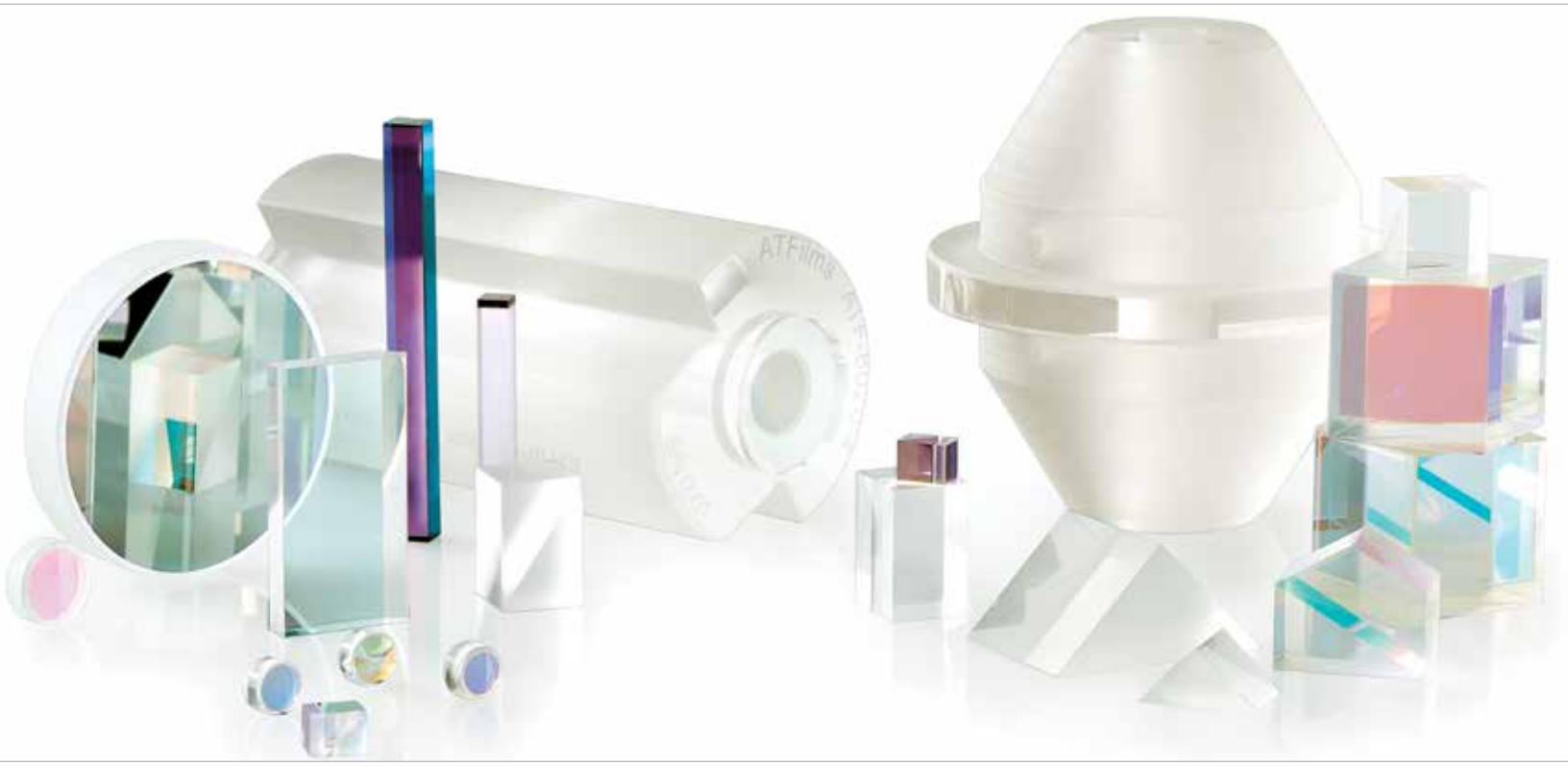


ISO 9001:2008

Advanced Thin Films adheres to ISO 9001:2008 quality standard. Please visit www.atf-ppc.com/company/certifications.aspx. to view our registration certificate.



Please contact us with your custom optical needs — we can help you make your concept a reality.

ADVANCED THIN FILMS

precision photonics / ATFilms

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