



MATERION

// BALZERS OPTICS

Space

Optical Solutions for Space Applications



Materion Balzers Optics

Materion Balzers Optics, a global leader in optical thin film coating solutions, emerged in 2020 from the union of Optics Balzers and Materion Precision Optics. This collaboration created a premier market leader in optical solutions, showcasing extensive expertise in the field of photonics technology. We have been the preferred partner for providing innovative optical coatings and solutions for over 70 years. From the UV through the Far IR, we custom manufacture and supply precision optical filters and coatings. As a high-tech company with five production sites worldwide, our focus is on a variety of markets such as Automotive, Consumer, Defense, Industry, Life Science, Lighting, Semiconductors and Space.

With a full range of unparalleled products, services, and support technologies, our customers benefit from our strategically located global facilities that provide regional manufacturing and technical support. Materion Balzers Optics' superior quality products are fully supported by a large volume manufacturing environment that produces highly repeatable results, contributing to reduced costs and market advantage. We also have scalable processes that are economical for customers who require small quantities. Our technical expertise and access to broad resources throughout Materion, make us uniquely positioned to offer solutions to our customer's most demanding challenges.



Production Balzers/Principality of Liechtenstein



Production Jena / Germany



Production Penang / Malaysia



Production Shanghai / China



Production Westford / United States

Space Solutions & Applications

Our optical components are made for filtering, selection and sensing of light in space-based applications.

Materion Balzers Optics has longtime experience in design and manufacturing of coated components for remote sensing from space, space-based science missions and ground-based astronomy applications.

Optical multi-spectral remote sensing of the earth from air and space uses various spectral bands in the VIS and NIR (VNIR) region and several channels in the short-wave infrared (SWIR) to determine diverse bio-geophysical variables. Also, mid-wave and far-infrared channels are of interest. Key requirement for these products is extreme reliability under harsh environmental conditions.

High quality bandpass filters with steep- band edges, excellent homogeneity and wide and deep blocking require sophisticated layer designs with a multiplicity of layers and perfect monitored stable coating processes. Materion Balzers Optics delivers bandpass filters as stripes, for filter wheels, and as filter assemblies. Filter assemblies can be supplied as monolithic array or as butcher block assembly. In addition, Materion Balzers Optics also delivers dichroic splitter devices, located in back- focal path of telescopes, telescope relay lenses, linear variable filters, and redirection mirrors and laser windows.

At Materion Balzers Optics, a team of project managers is familiar with the planning and performing of developments, qualification programs and manufacturing and testing of flight hardware for the space industry.

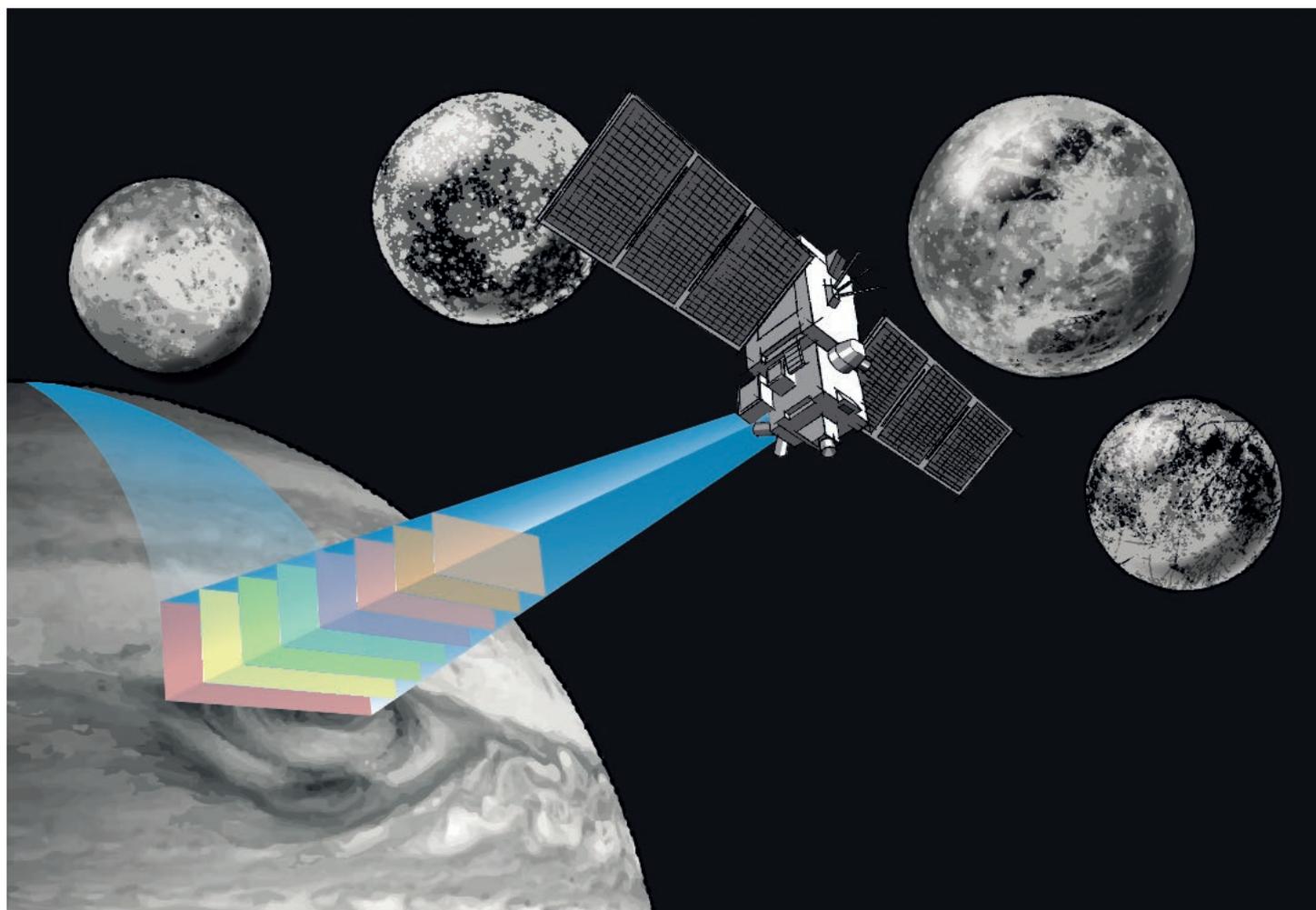


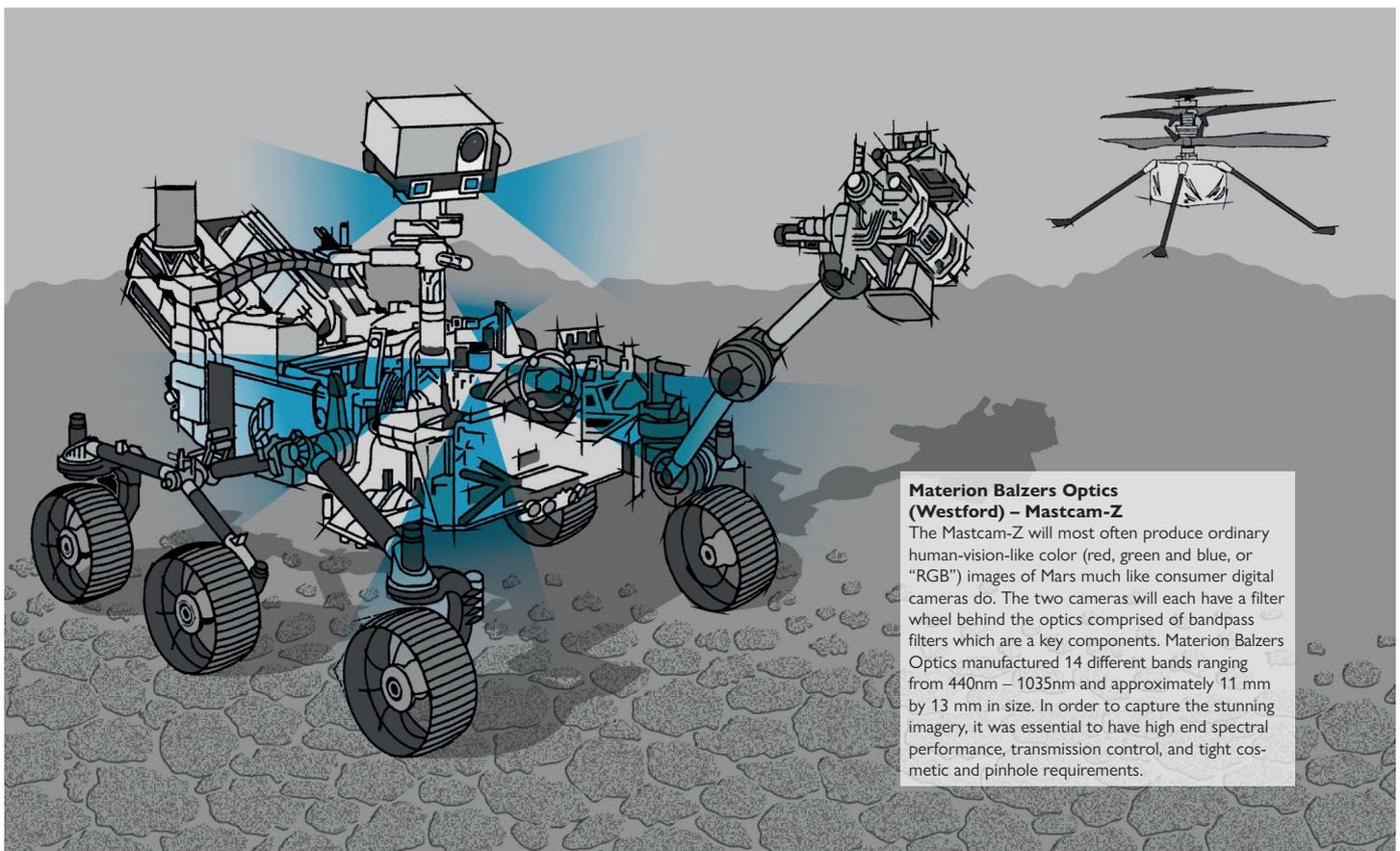


Photo: ESA – P. Carill
Sentinel-2 satellite operates with spectral filters from Materion Balzers Optics

Heritage List

Mission	Components developed and manufactured by Materion Balzers Optics
Sentinel 2	VNIR and SWIR Bandpass filters, beam splitter coating
Sentinel 4	UVN spectrometer mirror coating
Sentinel 5p	UVVIS mirror coatings
Sentinel 5	TSBOA homogenizer and beam splitters, UV1 linear variable filter and mirror coatings, UV2VIS mirrors, UV2VIS GRISM ARs
JUICE	JANUS VNIR filters, RGB pixel array
EUCLID	Dichroic plate, NISP filters, GRISM filter coating
FLEX	Bandpass filter, linear variable filter, folding mirror coating
MetOp	METimage VNIR filters coating, 3MI filter VNIR and SWIR components
JWST	Bandpass filters for NIRCAM, FGS
Landsat	Multispectral Filter assemblies
VIIRS	Multispectral Filter assemblies (VIS – LWIR)
Proba V	Detector window assemblies
GAIA	RVS Prism plate optical coatings
MARS Curiosity Rover	MastCam Filters

Materion Balzers Optics on its way to Mars



Materion Balzers Optics (Westford) – Mastcam-Z
 The Mastcam-Z will most often produce ordinary human-vision-like color (red, green and blue, or “RGB”) images of Mars much like consumer digital cameras do. The two cameras will each have a filter wheel behind the optics comprised of bandpass filters which are a key components. Materion Balzers Optics manufactured 14 different bands ranging from 440nm – 1035nm and approximately 11 mm by 13 mm in size. In order to capture the stunning imagery, it was essential to have high end spectral performance, transmission control, and tight cosmetic and pinhole requirements.

Multispectral Imaging & Sensing

Space qualified optical components for high precision wavelength selections.

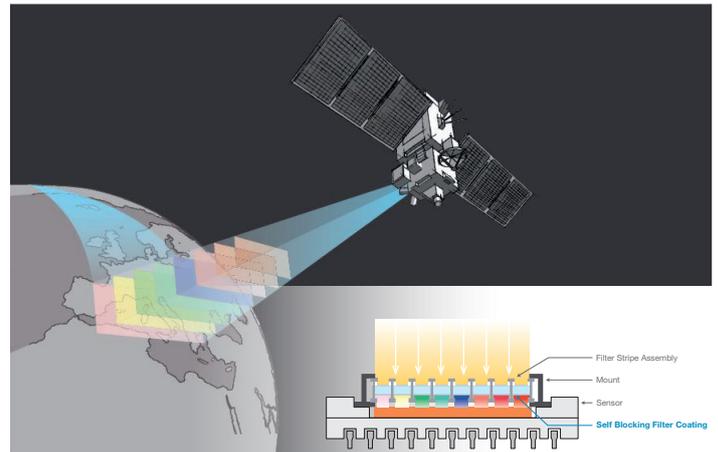


Space Based Imaging

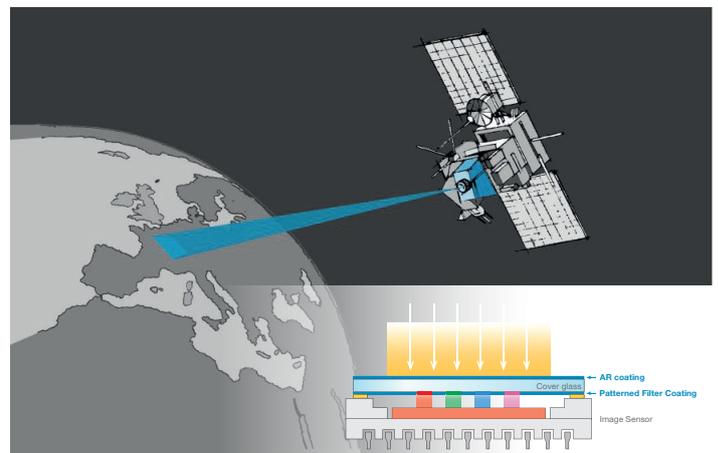
The improved utilization of natural resources, the detection of undiscovered reservoirs and the examination of climate changes – these are only some of the challenges which are met using geostationary satellites. Science today owes a great deal to these “artificial” eyes in space. That’s why the optical system integrated in the satellite plays such an important role – it is crucial for the success of a mission. Materion Balzers Optics has made a name for itself as manufacturer of optical filters for space applications. Whether it’s about bandpass filters in the VIS, NIR or SWIR range, sometimes with a range of mere nanometers – our experience in production and qualification provide the foundation for a great number of successful projects.

Environmental Sensing & Detection

Multispectral and hyperspectral imaging technology is widely used for remote sensing applications like for meteorology, environmental testing, and in agriculture. Especially for drone applications, compact and light-weight components are required to achieve a complete spectrum for each pixel of the image. By using photolithographic techniques, up to 10 microfilters can be arranged side by side on typical substrates with filter features down to 20 μm . Even direct coating of imaging sensors is feasible to eliminate the filter substrate. To detect more spectral bands beyond 10 channels, linear variable filters combined with patterned black chromium coatings are applied. The complete sensor can be protected by a hermetically sealed cover lid, which can be added by using a patterned Gelot™ solderable coating. Butcher block assemblies increase the variety of the applications by tailoring with assemblies band with up to more than 100 spectral bands.



Remote Multi-Spectral Imaging from Space



Multi- and Hyperspectral Monitoring from Space

Laser Communication

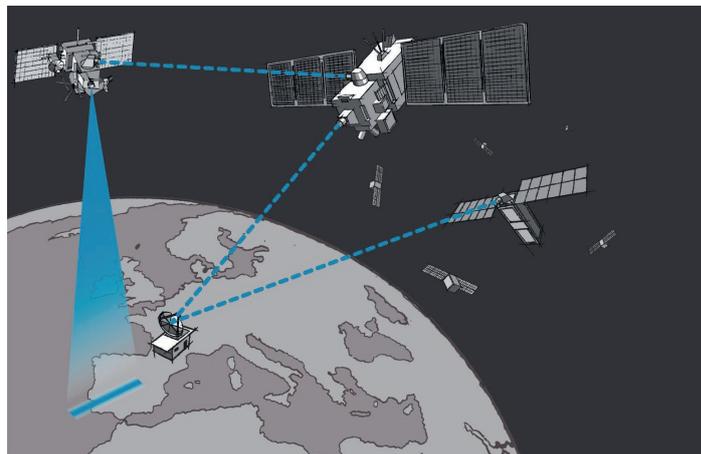
High performance optics for space to space and space to ground applications



In satellite communication, laser light is used to transport data over large distances from satellite to satellite or from satellite to ground stations. To do so, optical systems guiding and tailoring the laser wavelength are necessary. Typical components are mirrors, band pass filters, dichroic beam splitters, and sun blocking filters. Sun blocking filters have a crucial role by blocking the light of the sun spectrum while effectively transmitting the used laser wavelength. For communication of large distances optical components with stringent requirements on transmittance, reflectance, and wavefront error are needed. Beside spectral performance, the resistance against harsh space environment is necessary for components for satellite communication. Successful qualification for space environment was part of many projects at Materion Balzers Optics in the past decade.

Materion Balzers Optics offers a variety of products to support laser communication in space such as:

- Sun blocking filters
- Narrow band pass filters
- Beam splitters
- Anti reflective coatings
- Dielectric mirrors



Satellite-Laser-Communication

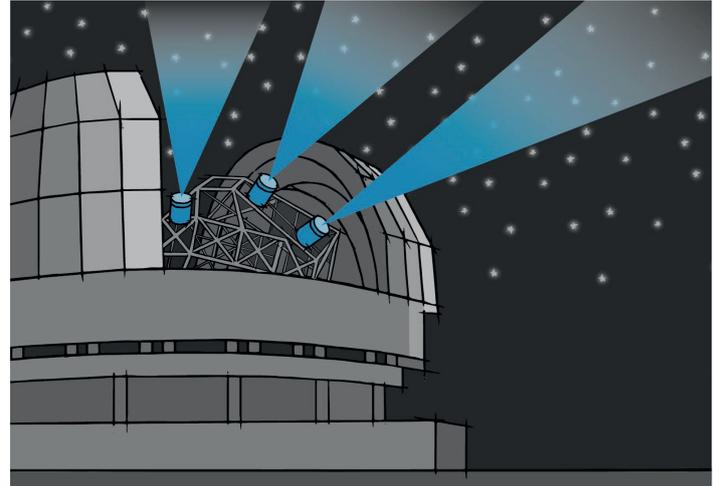
Astronomical Filters

Custom filters for astronomical observation



Materion's knowledge and experience in ground-based astronomical optics is unsurpassed. As a pioneer in the science of filter design, we manufacture filters for imaging & spectrometer instrumentation on major telescopes. Our dedicated team of scientists and engineers understand the special requirements of observatory optics and have developed technologies specifically tailored to ground-based astronomy applications. Our products are recognized globally for their exceptional performance and reliability. Ground-based astronomy relies on precision optical components to produce high quality science. For more than four decades, Materion has worked with observatories around the world, supporting them from concept through operation and helping them optimize their observation of celestial objects and events.

- Customized filters to meet the most challenging specifications
- Over 100 coating chambers for the widest range of technologies in the industry
- Coatings for deformable mirrors
- Environmentally stable for long product life
- Capability to coat large filters up to 1.4M in diameter
- Bessell Photometric set (U,B,V,R,I)
- SDSS (u,g,r,I,z) filter set
- J,H,K,L,M band set
- H-alpha filters
- OIII filters
- LiDAR filters
- Ultra-narrow bandpass filters (FWHM < 0.1nm)



Ground based Astronomical Observation

Optical Coatings & Components

The core competencies of Materion Balzers Optics are the design and manufacture of high precision thin-film optical coatings and integrating them into sophisticated optical components. Materion Balzers Optics' coatings and components are characterized by excellent spectral performance, low defect quality and superior environmental stability. The coatings are produced with state-of-the-art evaporation and sputtering equipment platforms with process and product specific adaptations. The components are both customized to the specific product requirements and optimized for high yield production. Continuous process control like monitoring of the coating process or customer specific component characterization ensures consistent and high quality in volume manufacturing.



Multispectral
Imaging & Sensing



Laser
Communication



Astronomical
Filters

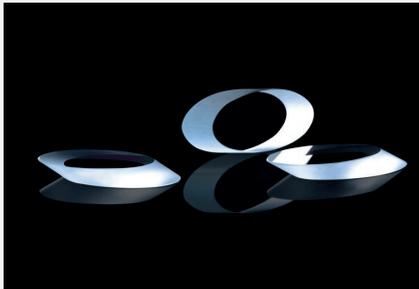
	Multispectral Imaging & Sensing	Laser Communication	Astronomical Filters
Alflex™	x	x	x
Beamsplitters	x	x	x
Diflex™ Broadband Dielectric Mirrors	x	x	x
Goldflex™	x	x	x
Iralin™ – Duolin™ – Supertriolin™	x	x	x
Laser Beamsteering Mirrors		x	
Laser Scanning Mirrors		x	
Linear Variable Filters	x		
LWIR Filters Coatings	x		x
Multispectral filter arrays	x		
Narrow Bandpass Filters in the VIS and NIR range	x	x	x
NIR, IR Blocking Filters	x	x	x
Order Sorting Filter	x		
Silflex™ Coating	x	x	x
VIS, NIR and SWIR Bandpass Filters	x	x	x



Laser Beamsteering Mirrors



Materion Balzers Optics designs and produces flat mirrors for use in all mirror applications. Their features are excellent quality, impressive flatness, low scattering and they are easy to use over a wide range of angles and wavelengths because of their consistent reflectivity. Dielectric coated mirrors are extremely durable; they have a long lifetime and can be cleaned repeatedly. Compare the surface quality of Materion Balzers Optics mirrors to that of others and you will find no mirror with this convincing quality in this price range.



Laser Scanning Mirrors



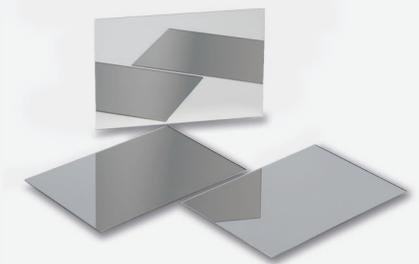
Materion Balzers Optics offers a large variety of customer specific laser scanning mirrors as they are applied for example in mirror galvanometer scanner units. High reflectivity $R \geq 99.5\%$ for 1064 nm for a customized large range of angles of incidence e.g. from 22° to 57° allows this coating to be applied for example in scanning units for laser marking.



Diflex™ Broadband Dielectric Mirrors



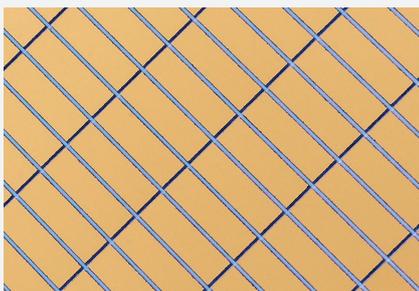
Materion Balzers Optics provides the best choice of broadband high reflectivity mirrors. Diflex™ mirrors are characterized by extreme reflectivity, low scattering and a wide acceptance range for the angle of incidence. The consistent and high reflectivity for any polarization covers the wavelength range between 320 nm to 2000 nm. Diflex™ mirror coatings are composed of metal-oxide layers. They withstand harsh environmental conditions and can be cleaned repeatedly.



Silflex™ Coating



Mirrors with a Silflex™ coating can be used over a broad spectral range with a reflectivity better than 94.5% from 350 – 600nm and 98 % from 450 nm to beyond 12 μm . Their proprietary silver-based coating makes them highly reflective from 0° to 45° and virtually insensitive to polarization. Protective dielectric coatings make them resistant to tarnish and oxidation. Silflex™ is the coating of choice for many astronomy applications. Plus they have minimal phase distortion, so they are useful for ultrafast-pulsed applications with Ti:Sapphire and other lasers.



Goldflex™



All types of network and optical sensing devices utilize light which needs to be routed by reflectors. To optimize this, Goldflex™, a novel, gold based metallic reflector is recommended. It is characterized by excellent reflectivity and lowest polarization dependence through all telecom bands in the near infrared range. In addition to outstanding environmental durability this reflector increases the quality and efficiency of network devices. Materion Balzers Optics offers a broad range of bonding techniques, based on experience in a wide range of applications and volume productions. Goldflex™ coated glass tested for 1000 hours after Telcordia GR-1221.



Alflex™

The versatile aluminum mirrors show an excellent stable performance in a wide range of application. The Alflex™ standard mirror has proven itself many times over by its hardness and durability. The Alflex™ product line incorporates a broadband and a color optimized narrow band mirror. Depending on the application it is generally insensitive to polarization and angle of incidence over a wide range. All types of Alflex™ are equipped with a protective layer.



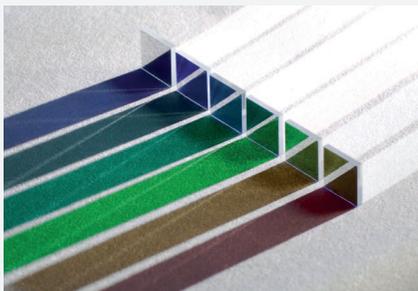
Iralin™ – Duolin™ – Supertrioilin™

Materion Balzers Optics offers a range of different anti-reflection coatings to cover a large field of applications. Multilayer AR-coatings designed for maximum efficiency in the visible range. Our **Iralin™** family can be shifted either into the UV range down to 350 nm or into the near infrared up to 1100 nm. **Duolin™** is laid out for the visible range plus an additional laser line. This can be any conventional low power laser. **Supertrioilin™** covers a very broad range of the spectrum between 450 nm up to 1100 nm. The bandwidth can even be extended as well at the cost of slightly higher reflectivity. All these coatings are useable for most commercial glass substrates.



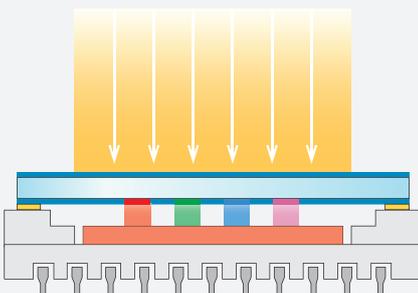
Beamsplitters

Beamsplitters – either as cubes or plates – can be used to separate incoming light in two intensities, polarizations or wavelength ranges. For analytical purposes a portion can be separated from the incident beam or a selected wavelength can be extracted from or coupled into the optical path. The variety goes from simple plates to sophisticated beamsplitter assemblies. Such components are typically customized and can include custom IP.



Narrow Bandpass Filters in the VIS and NIR range

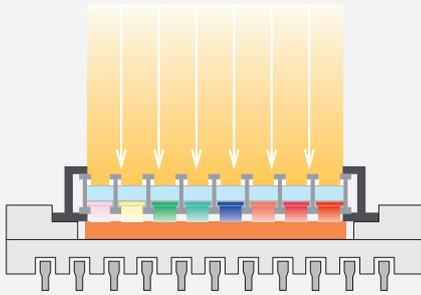
Materion Balzers Optics narrow bandpass filters are characterized by high passband transmittance, accurate center wavelength, and steep filter edges between pass- and blockband, and broadband blocking range. With typical passband width between 2 and 20 nm, and a blocking depth of OD5 the filters provide an excellent signal to noise ratio. In manifold applications, the filters are used to select the appropriate part of the spectrum either from a light source or in front of a photodetector.



Multispectral filter arrays

Multispectral image sensors require cover glass lids with integrated color selective dichroic filters. Materion Balzers Optics provides patterned color filters for selective spectral filtering on different zones of the cover glass lids. Such dichroic filters may include R/G/B, NIR and PAN Filters or monochrome UV or IR Filters. Number of different filters can be customized up to 100+ bands. The individual filter zones may be masked with an opaque black layer containing alignment marks. Filter arrays can be offered as monolithic or butcher block solution.

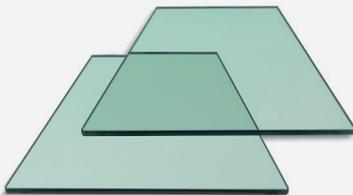




VIS, NIR and SWIR Bandpass Filters



VIS, NIR and SWIR bandpass filters with standard or self-blocking filter design for spectral sensing and imaging combine wide blocking and high passband transmittance. They feature extreme stability in terrestrial and space environments and are customized for Si, InGaAs or HgCdTe sensor applications.



NIR, IR Blocking Filters



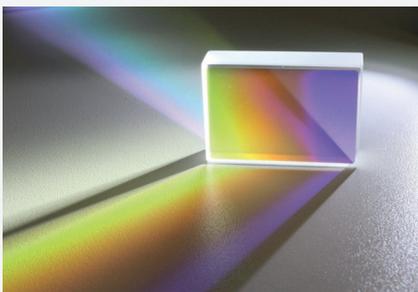
Materion Balzers Optics' NIR and IR-Blocker effectively remove unwanted infrared radiation produced by broadband light sources. A dielectric oxide coating design provides excellent transmission over the entire visible spectrum, without distorting the spectral emission of the light source in the visible spectrum. Filters can be optimized according to the spectral characteristic of the source and are particularly well suited for use in applications with high thermal loads or where NVIS compliance is required (e.g. AMLCD modules in avionics applications).



LWIR Filter Coatings



Expansion of the commercial market is already evident with the availability of IR imagers for fire and rescue personnel, and the installation of IR imagers on automobiles. Mobile phones and cameras also introduce an IR capability. These popular applications were made possible by the economical development of wafer-level production capability of micro-bolometers for the 8 to 12 μm region. Materion Balzers Optics specifically prepares and refines infrared (IR) coating materials to meet these increasing demands in various applications.

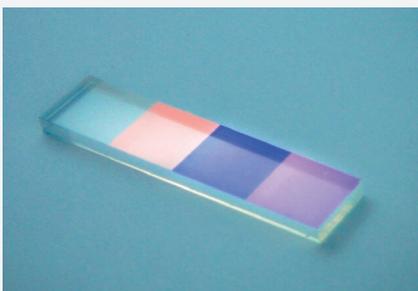


Linear Variable Filters



Linear variable filters (LVF) are applied in numerous optical fields like spectroscopy, hyperspectral imaging (HSI) and fluorescence microscopy. LVFs are in particular beneficial in applications which require lightweight and compact instrument like HSI devices, installed on unmanned aerial vehicles (UAV), which are increasingly used in agriculture or for environmental observations.

LVFs components are applied as wavelength selectors, order sorting filters in grating based systems or in purely filter based spectrometers.



Order Sorting Filters



Miniaturized photospectrometers are an integral part of an increasing number of optical systems. A compact set-up for such minispectrometers is based on a fixed grating for wavelength separation. However, using diffraction gratings, one has to face higher diffraction orders which have to be eliminated. One way to effectively achieve their suppression is to use well positioned longpass filters. Materion Balzers Optics provides tailored filters deposited by a plasma assisted process and showing excellent optical performance and long-term stability.

CoatingPlus™: More Than Just Coating

Sophisticated optical thin-film components and subsystems require additional process steps beyond coating.

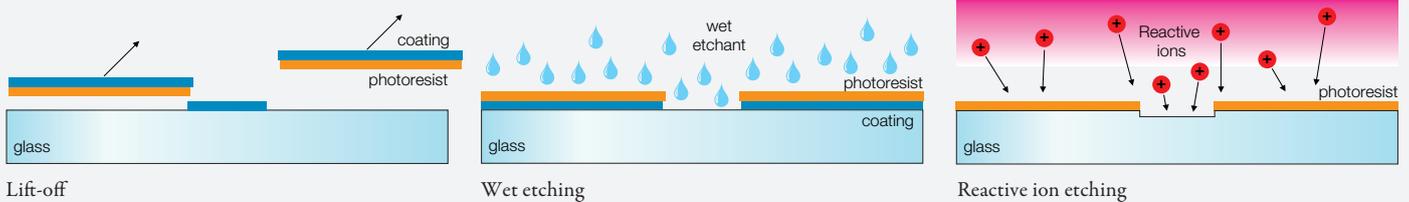


Patterning

Materion Balzers Optics offers patterning solutions for high quality optical components. Depending on the product and its applications, various patterning techniques such as photolithography, laser ablation or masked coatings are available to meet a broad range of customer requirements for feature sizes and shapes. The lift-off technology allows the deposition of filter arrays onto cover glasses or directly onto photodetector wafers.

Photolithography

Photolithography capabilities such as lift-off and etching techniques allow the production of precision patterned coatings and submicron gratings. The photolithography techniques are specifically used in producing selective dichroic filters. Such filters may include R/G/B-Filters or monochrome UV or IR Filters into one piece.



Masked Coatings

Precision etched metal masks attached to the substrates provide patterned coatings during the coating process. While the achievable feature sizes and shapes are limited with direct masking, patterning can be applied with almost any coating process and coating material, also with processes that require higher temperatures.

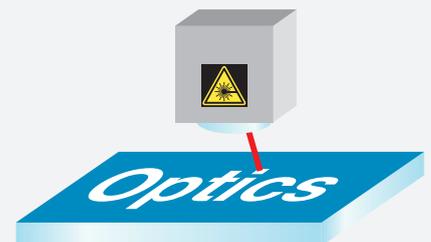


Marking

Application of thin-film optical components may require unambiguous marking and labeling, either on the substrate surface or on the coating. The pattern can be generated according to customers' specific needs.

Laser Ablation

Laser ablation offers novel opportunities in patterning of optical filter coatings. By using adapted processes for each specific application, high precision patterns can be produced on the coated components. Laser ablation offers excellent flexibility for customized shapes and patterns together with high-speed processing capabilities.



CoatingPlus™

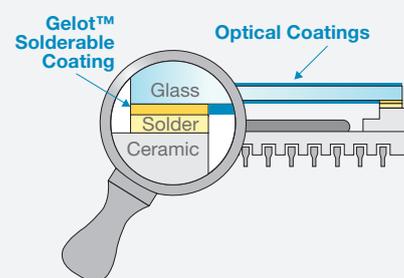
More Than Just Coating

Bonding and Sealing

In various applications, thin-film optical components need to be precision-mounted on other components such as sensors or subassemblies. Materion Balzers Optics offers epoxy bonding patterns as well as solder seed layers with a hermetic sealing quality.

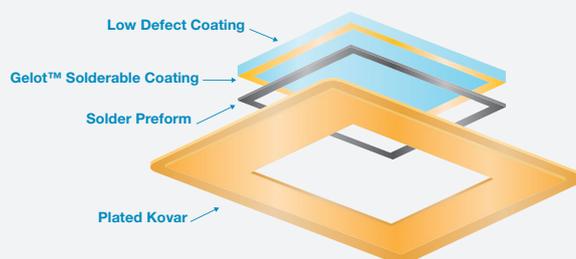
Gelot™ Solderable Coatings

A lot of optical components, e.g. laser crystals, lenses or mirrors, used in a large variety of applications, require a solderable coating. Soldering is the assembly technology which provides best hermeticity values of such packaging. Gelot™ solderable coating gives the glass a surface with good adhesive properties for soldering such as gold or palladium.



Soldered Kovar Lids

On top of the Gelot™ solderable coating an assembled glass-to-metal solution can be offered for stringent hermetic requirements. The soldered Kovar Lids are the choice for demanding applications such as sensors in space or in the shortwave infrared range.



ITO and IMITO – Conductive and Transparent Coating

Indium-Tin-Oxide (ITO) is a widely used material for thin-film coatings with electrically conductive and optically transparent properties. The reflectance of light on interfaces or surfaces of an ITO layer may be reduced considerably by integrating it into an anti-reflective multilayer – a so called Index Matched ITO (IMITO). The Materion Balzers Optics ITO is very dense and remarkably free of pinholes.



Glass Processing

Efficient light management requires ultra precise surfaces. Therefore, Materion Balzers Optics continuously extends the limits of its polishing and glass handling capabilities. Our experience is based on the manufacturing of products where exceptional surface quality is essential. Further, Materion Balzers Optics applies semiconductor cutting technology on coated glass wafers. This is the way to provide cost effective high-volume components with small dimensions.

High Volume Production

Growing demand in complexity and quality of high-volume parts has led us to establish more competency in automated processing. Applying a mix of custom developed and off-the shelf manufacturing technology our production lines define the state-of-the-art in optics manufacturing. For the miniaturization of cuboid and prism shaped optics we have invented an entirely new process flow, which enables new applications for our customers.

Wafer Dicing and Scribing

The economical production of thin-film coating components often requires substrate wafer based processing. With advanced dicing and scribing capabilities, Materion Balzers Optics manufactures thin-film components to customer specific shapes and sizes with high precision.

Grinding & Polishing

The performance of any optical surface is highly dependent on the grinding and polishing process. Materion Balzers Optics constantly develops its in-house capabilities for these critical manufacturing steps. Based on our long-standing experience, we are able to identify the most economical solution for your specific application.

Faceting

Faceting helps to avoid the chipping of the workpiece edges in the subsequent manufacturing flow as well as in the final application. Our capabilities include manual as well as fully automated faceting for various workpiece geometries. Standard 45° chamfers as well as other shapes (e.g. C-shape) are available.

Varnishing

High-accuracy dispensing technologies enable continuous or selective blackening of optical parts and complement the low reflection, high absorption coating portfolio from Materion Balzers Optics.

Subassembly

Materion Balzers Optics offers customized optical subassemblies to support its customers' ever increasing demands. We develop individual solutions for and together with our customers.

Volume Production

The utilization of high-tech singulation equipment paired with sophisticated manufacturing processes allow for a cost-effective mass production of optical parts with small physical dimensions.

Packaging and Handling

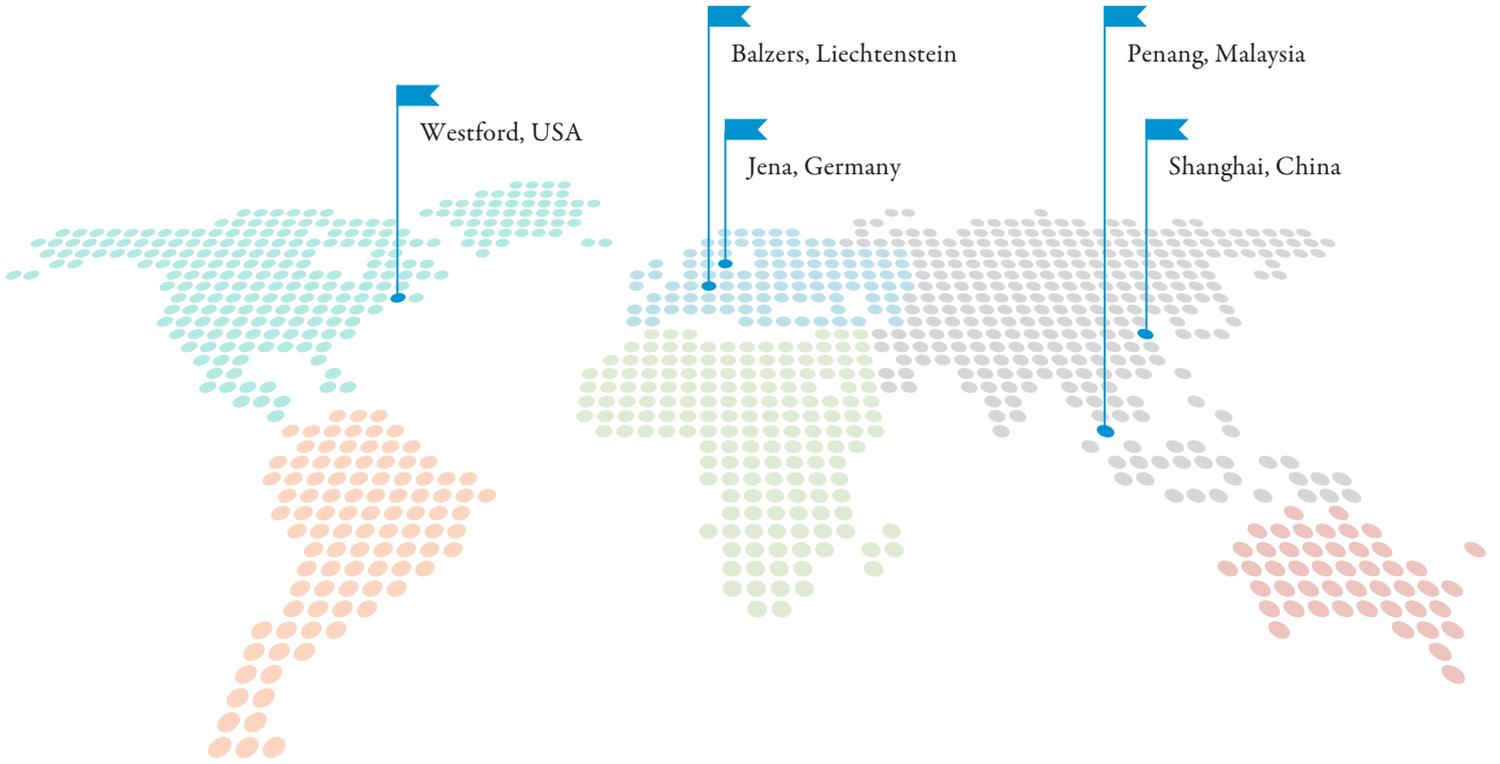
Customized packaging and shipping ensures top quality in surface protection and cleanliness during transportation and in subsequent process steps at the customer's site.

Development Partners

Materion Balzers Optics relies on strong partnerships. Therefore our competence centers in Liechtenstein and Germany count on the close cooperation with scientific institutes, universities, and colleges. Those partnerships allow our teams of engineers to develop innovative solutions, tailored to the individual requirements of our customers.

Project Management

Challenging projects with demanding product properties can be realized successfully only by high level organized and well educated project management teams. Therefore Materion Balzers Optics supports your product request with a dedicated project team, to bring your idea into a real success story. Close cooperation, a permanent exchange of information, and at last but not least, a company with tradition, are the basic elements for a strong long-term partnership.



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