

Laser, Space & Defence

Optical Solutions for Laser, Space and Defence Applications



Enabling Innovative Optical Solutions

Innovation is part of our tradition

It was at the suggestion of the ruling Prince Franz Josef II of Liechtenstein that Dr. Max Auwärter – in cooperation with Emil G. Bührle – founded the company Balzers in the village of Balzers, in the Principality of Liechtenstein, in 1946. At that time the technology of vacuum deposition was still in its early stages. With very few exceptions, high vacuum systems were being used only in research laboratories.

Due to the lack of commercially available high vacuum equipment, Balzers had to design and build most of the required vacuum components, equipment and systems necessary for the development of its novel and proprietary thin-film coating processes.

Today Materion Balzers Optics is a globally recognized leader in customized optical thin-film coatings and components for the photonics industry. The company possesses a broad and in-depth know-how in optical thin-film coating processes, complemented by sophisticated patterning, glass bonding and sealing, and further processing capabilities necessary for producing optical thin-film coated components up to optical subassemblies. Highly experienced and skilled development and engineering teams closely collaborate with customers to develop innovative solutions meeting their specific requirements. The combination of these capabilities and skills places Materion Balzers Optics at the forefront of markets in the photonics industry such as Automotive, Biophotonics, Laser, Space & Defence, Lighting & Projection, Industrial Applications, and Sensors & Imaging.

Materion Balzers Optics' continuous innovation, quality improvements, additions of expertise and production sites in Liechtenstein and the EU, will continue to support customers' novel product development efforts with Materion Balzers Optics as a trusted, reliable, and innovative partner.



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

Laser Solutions & Applications

Our optical components designed for scanning, steering and reflecting of laser beam light in high-end applications.

- **High-End Laser**
- **Security & Safety**

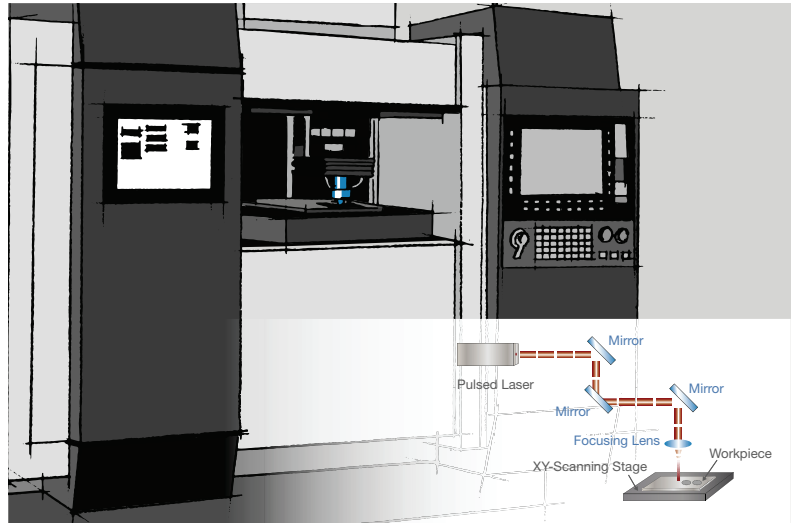
For the wide-ranging field of laser applications, Materion Balzers Optics offers products with outstanding optical properties as well as excellent characteristics with regard to stability.

Besides the employment of state-of-the-art technologies through Ion Assisted Deposition (IAD) and Ion Beam Sputtering (IBS), complex coating systems can be manufactured by innovative Magnetron Sputter Technologies (PARMS). For that, both oxidic and metallic materials can be used.

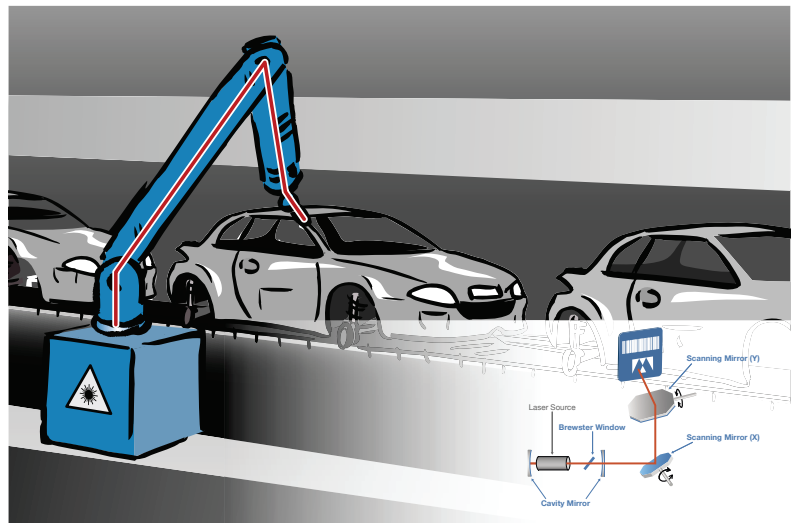
The product range includes coatings for highly and most reflective mirrors. Applied in resonators, not only our coating, but our substrates as well meet the highest requirements. Whether used as highly reflective mirror or as optics for beam steering, our laser components are characterized by an excellent damage threshold (LIDT).

Broadband coatings with a consistent absolute reflection >99 % over the entire wavelength range between 320 and 2000 nm also represent a standard for customer substrates. On the basis of qualified technologies, beamsplitters, Brewster windows, pump lenses and a wide range of additional optical components as well as toll coating of customers' substrates, components and crystals e.g. with the solderable coating "Gelot™" can be offered.

As a competent partner for laser based technologies "Chirped Mirrors" with a defined Group Delay Dispersion and optical components for ultra short pulsed laser systems, used in the range from nano- to femto-second pulses are completing the portfolio.



Laser Machine



Laser Scanning

Space Solutions & Applications

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

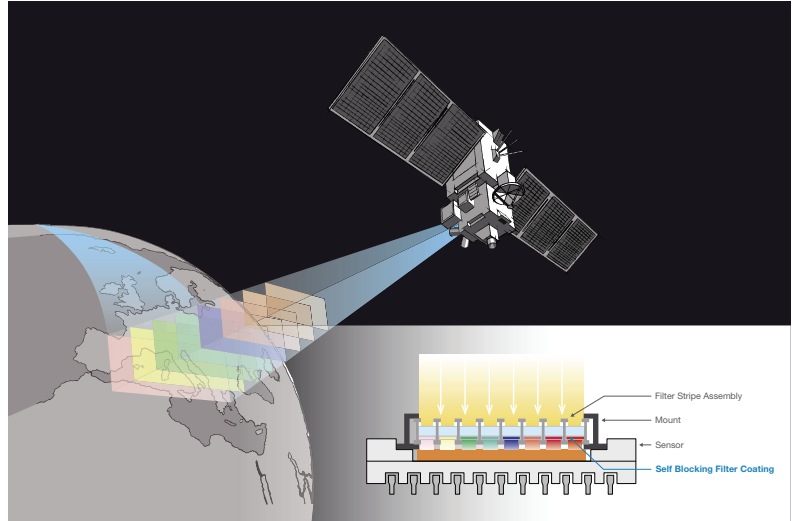
- Space
- Astronomy

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.

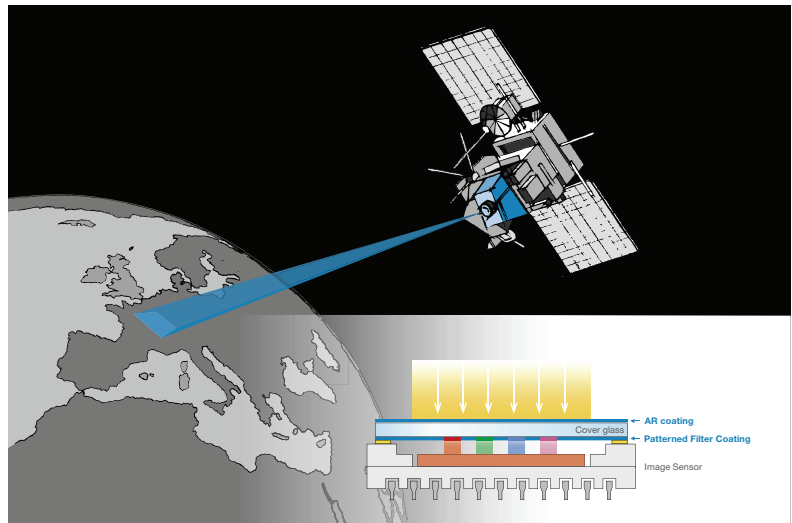
Optical multi-spectral remote sensing of the earth from air and space uses various spectral bands in the VIS and NIR (VNIR) region and several channels in the Short-wave Infrared (SWIR) to determine diverse bio-geophysical variables. Key requirement for these products is extreme reliability under harsh 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. In addition, Materion Balzers Optics also delivers dichroic splitter devices, located in back-focal path of telescopes, telescope relay lenses and redirection mirrors and laser windows.

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



Remote Multi-Spectral Imaging from Space



Meteorological Satellite

Defence Solutions & Applications

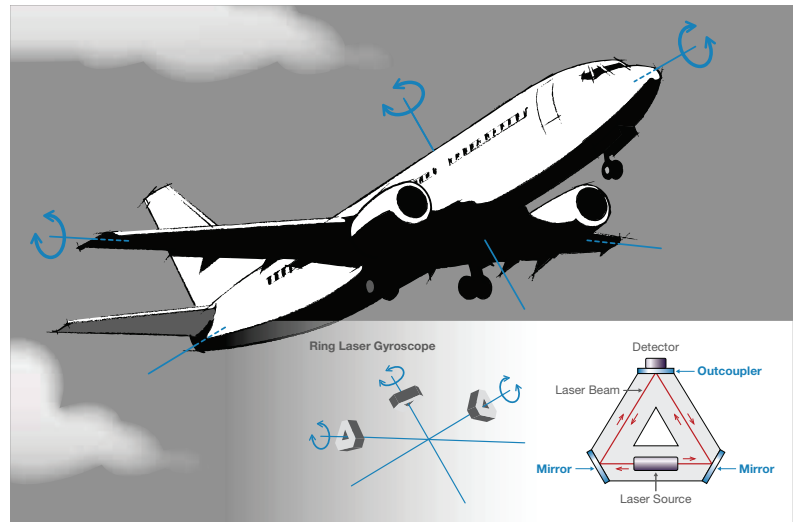
Our optical components and coatings are made to guide light, to reflect and to alter light and also to protect optical components.

- Defence
- Security

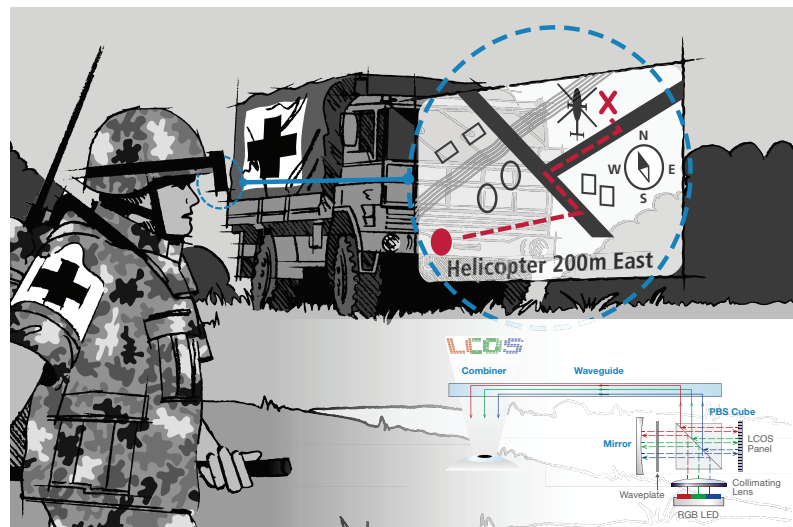
For optical components in the field of Defence, besides a large number of specific technical parameters, especially high requirements regarding the optical performance and quality have to be fulfilled, too. Thus, those components with their special material properties rank among the demanding challenges. Due to the successful implementation of a sophisticated optical design, in combination with many years of experience in processing optical components, our products are qualified for a multitude of most different applications.

Based on a vast number of technologies developed by Materion Balzers Optics, optical components like filters, prisms, mirrors and combiners – to mention only a few – are specially processed and furnished with their respective functional coating design. Among these technologies are the specially developed solutions, like ITO-coating, which ensure an electrical conductivity. Gelot™ facilitates the solderable connection of system components – not only on glass substrates. For emerging Near-Eye Display applications, we also have established glass processing and assembly technology tailored to the fabrication of planar waveguides and cascaded combiners. The products and technologies are, in close cooperation with the customer, optimally adapted to the respective application.

The flexible manufacturing structure and the complex expertise in the field of thin-film technology make Materion Balzers Optics a reliable partner for the successful realization of project development.



Ring Laser Gyroscope

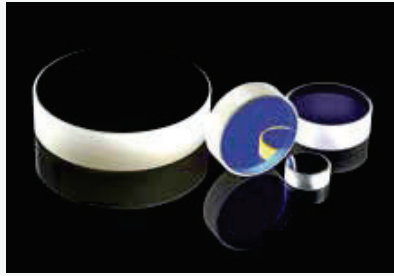


Near Eye

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.

				
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Laser Mirrors

The product program for Laser mirrors includes standard components as well as customized laser beamsteering mirrors. Based on high performance technologies like IBS manufactured coating, we are able to supply high reflective mirrors. The reflectivity is greater than 99.9 % from 0° to 45° at 1064 nm for all polarizations. This coating technology produces significantly more dense coating with lower defects. In fact, low defect mirror surfaces reduce scattering and absorption which increases the laser damage thresholds significantly.



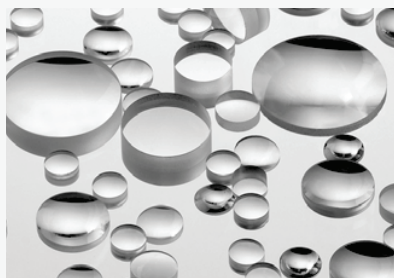
Brewster Windows

Brewster windows are designed to operate at an angle of incident. They transmit linearly polarized light in the p-plane and reflect about 50 % of the s-plane component. Usually they are uncoated. Coated Brewster windows enhance the reflectance of the s-polarization component but they reduce the power. These windows are ideal for producing linearly polarized light within laser cavities. Special machining processes with extra qualified substrate material allows us to provide optical components with the special Brewster characteristics in customized dimensions and with high volumes.



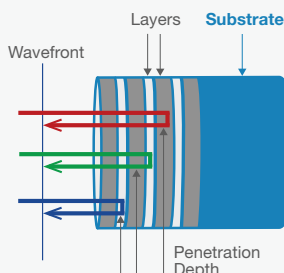
Laser Beamsteering Mirrors

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.



Ultra Short Pulse Mirrors

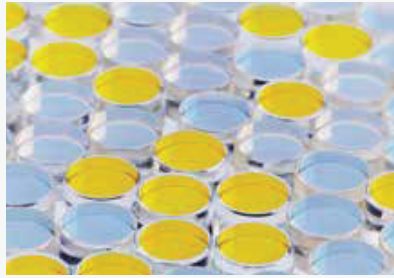
Mirrors for ultra short pulse laser are available for several wavelengths in the VIS and NIR range. These components are used in numerous applications such as ultra precision material processing, spectroscopy and telecommunication. Femtosecond pulse are generated by Ti:Sapphire lasers, solid state lasers or on the basis of rare earth metal doped crystals. The design and development of our laser mirrors are driven by these technologies. The production by magnetron sputtering technologies offers furthermore a high level laser damage threshold values (e.g. for 1064nm 70J/cm²@10ns and for 532nm 20J@10ns).



Chirped Mirrors for GDD

Pulse reflection at a dielectric mirror leads to a broadening from the pulses and the reflected signal is modified. Different wavelengths pass the coating layers with different speed and the pulse itself is e.g. delayed. Also the pulse energy is infected by this phenomenon. Which leads to a reduced energy level. To overcome these effect, dispersion controlled mirrors can be designed. Our coating design is precise adapted to the required spectral performance and sets available in customized configurations.





Cavity Mirrors

The cavity (or resonator) mirrors are high reflecting (HR) or output coupling (OC) mirrors for gas or solid state lasers resonators. Combined they generate the necessary feedback for the stimulated emission of the lasing wavelength. The HR mirror has a reflectivity close to 100% for the Laser wavelength and high transmission for the pump light wavelength, while the output coupling mirror reflects the Laser beam to a certain level. Cavity mirrors can be planar or concave/convex mirrors made of N-BK7 or fused silica. The coating technology is chosen according to the requirements. Ion Beam Sputtering (IBS) can be applied if necessary.



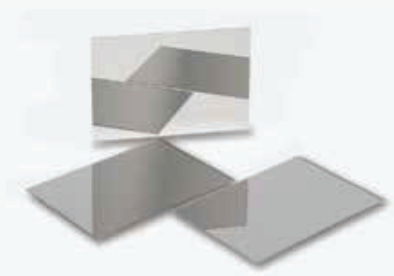
Laser Scanning Mirrors

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.



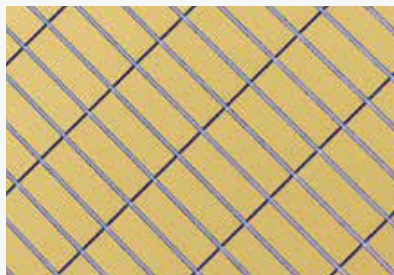
Diflex™ Broadband Dielectric Mirrors

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™ – Supertriolin™

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. **Supertriolin™** 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.



Ring Laser Gyroscope Mirrors

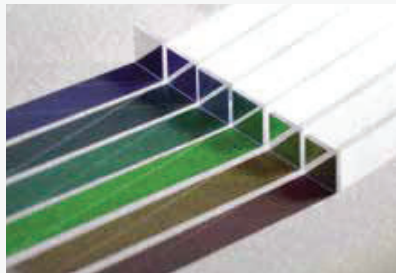
RLG (Ring Laser Gyroscope) require mirrors and outcoupling coatings with very low absorption and scattering loss, high resistance to plasma environment and long durability. Materion Balzers Optics provides such coatings done by Ion Beam Sputtering (IBS) with outstanding spectral performance and very low defect levels according to customer's specifications. IBS coatings find various applications where low loss and accurate performance is needed such as high finesse etalons.



Laser Safety Filters

In ophthalmology instruments, laser safety filters block the therapy laser with high optical density, while showing a high transmittance for the image of the patient's eye background. A sophisticated filter design with narrow blockband and balanced transmission level over the full visible range optimizes color rendering. The beamsplitter controls transmittance and reflectance for both therapy and target laser. The hard-coated filters are longterm stable and available in flexible dimensions.





Narrow Bandpass Filters in the VIS and NIR range



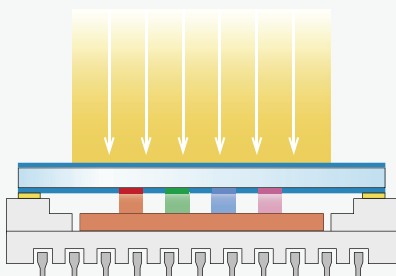
Materion Balzers Optics narrow bandpass filters are characterized by high passband transmittance, accurate center wavelength, and steep filter edges between pass- and blockband, and broadband blocking range. With typical passband width between 2 and 20 nm, and a blocking depth of OD5 the filters provide 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.



Waveguides and Combiners



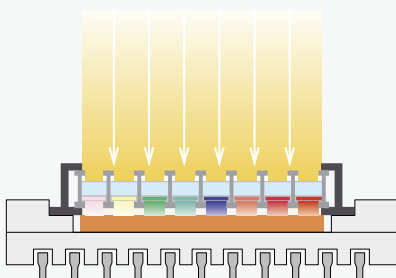
We understand the tight budget of lumens, weight and size, when it comes to Near-Eye Displays (NEDs). Furthermore, stray-light and ghosting are challenges imposed by system design trade-offs and increased by manufacturing limitations. Optics Balzers has established thin film coating and substrate manufacturing technology to break those limitations, because we have reinvented the entire process flow for thin film coated assemblies.



Patterned Dichroic Filters



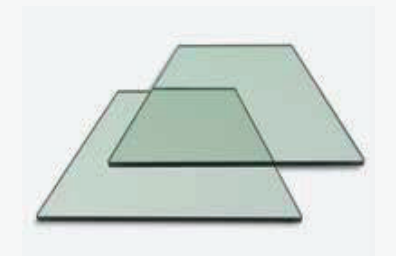
Multispectral image sensors require cover glass lids with integrated color selective dichroic filters. Materion Balzers Optics provides patterned color filters for selective spectral filtering on different zones of the cover glass lids. Such dichroic filters may include R/G/B, NIR and PAN Filters or monochrome UV or IR Filters. The individual filter zones may be masked with an opaque chrome layer containing alignment marks.



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).

Coating Plus: More Than Just Coating

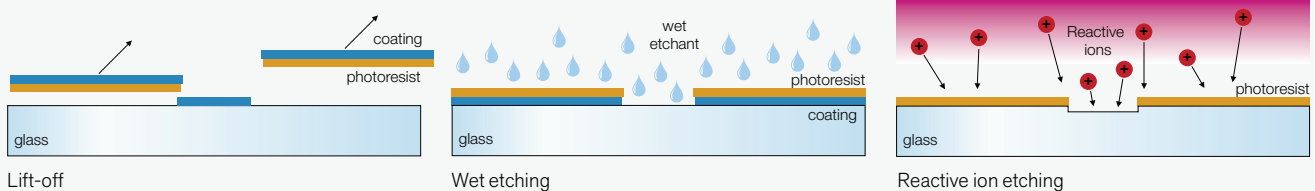
Sophisticated optical thin-film components and subsystems require additional process steps beyond coating.

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.

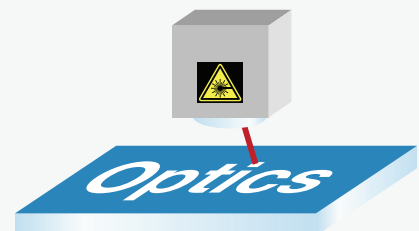


Marking

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.

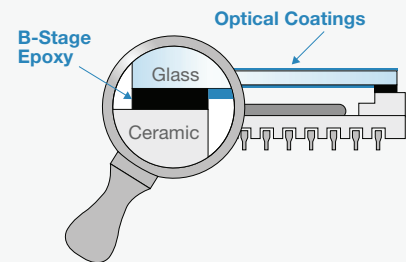


Bonding and Sealing

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.

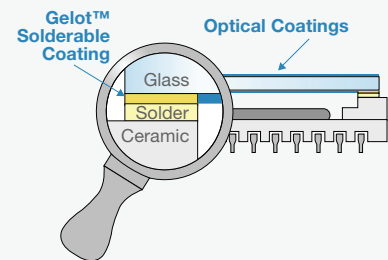
B-stage Epoxy

A B-stage epoxy frame on the lid facilitates the assembly process: The epoxy is provided in the dry state and is cured by simple tempering at 100°C – 130°C. The epoxy is applied to the lids in a way which allows for precise patterns and high cosmetic standards. Further adhesive solutions can be developed on customer's demand.



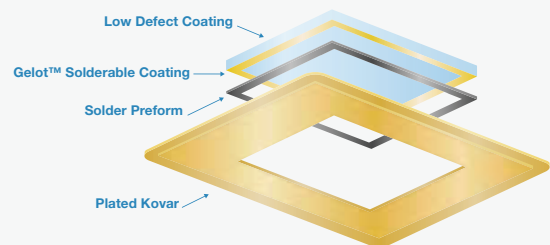
Gelot™ Solderable Coatings

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.



Coating Plus: More Than Just Coating

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

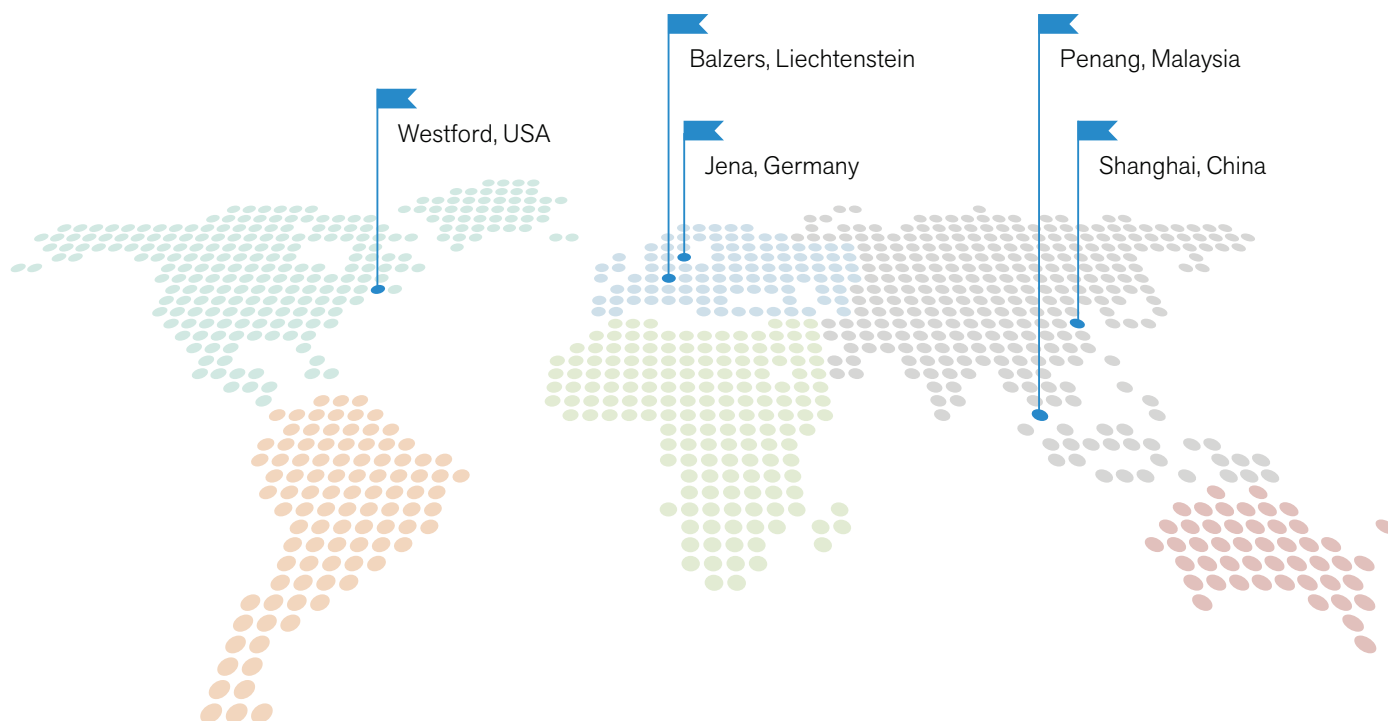
Customized packaging and shipping ensures top quality in surface protection and cleanliness during transportation and in subsequent process steps at the customer's site.

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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