



MATERION

// BALZERS OPTICS

Defense

Optical Solutions for Defense 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 Westford / United States

Defense Solutions & Applications

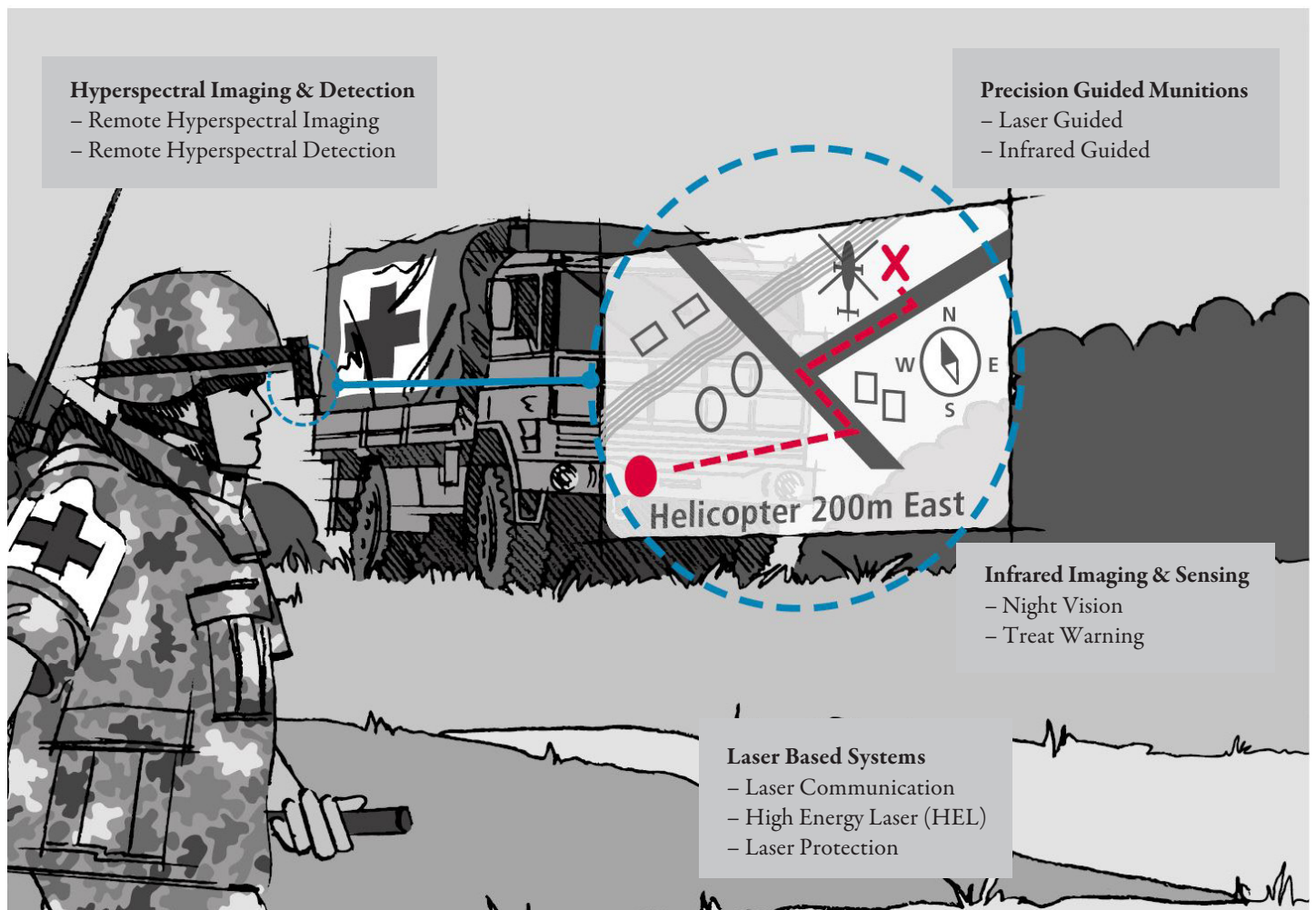
Our optical components are made for filtering, selection and sensing of light in defense-based applications.

Materion Balzers Optics has over 40 years of experience in the design and manufacturing of coated components for a number of different defense related applications that include Hyperspectral imaging, optically guided munitions, thermal imaging, high energy laser and laser communication.

From the Ultraviolet through the long wave infrared parts of the spectrum, Materion Optics Balzers has delivered solutions for the most demanding defense related applications. Precision optical coatings are at the core of our capability, and we are capable of manufacturing custom, complex, high layer count designs with cutting edge performance. The types of coatings include band pass filters, long and short pass filters, beam splitters, rejection filters and high-performance reflective coatings.

In addition to our coatings, we offer unique differentiated value-added solutions, such as our multi-spectral filter arrays. Filter arrays have been manufactured with over 100 distinct channels and can be provided as a butch block assembly or as a patterned monolithic component. We offer solderable metallization and solder assembly services for attaching filters to housings and sensor packages. We also offer specialty precision prism assemblies.

At Materion Balzers Optics, our engineers and project managers are familiar with the planning and execution of custom solutions for the defense industry.





Hyperspectral Imaging & Detection

Space qualified optical components for precision wavelength selections

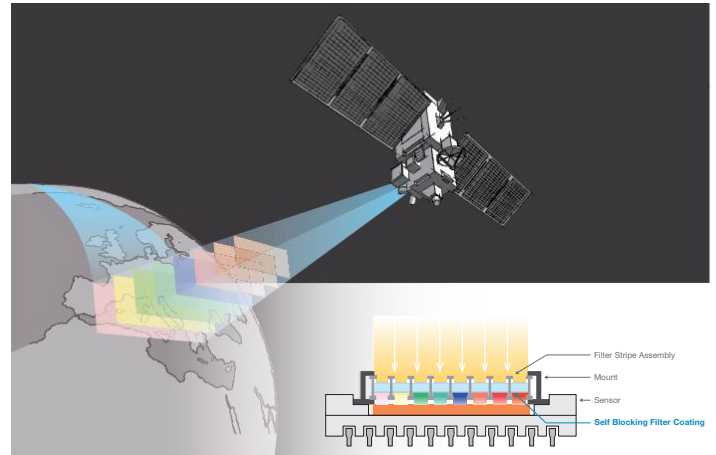


Remote Hyperspectral Imaging and Detection

Situational awareness is a key source of strategic advantage in modern warfare. The ability to “see” the enemy with advanced imaging and sensing technologies is key in today’s military. This capability is provided across many platforms including space-based satellites, piloted aircraft, and unmanned Aerial vehicles. Remote hyperspectral technologies perform a number of different battlefield missions including:

- Intelligence, Surveillance & Reconnaissance
- Launch Detection
- Missile Tracking
- Weather

The key to hyperspectral sensors is wavelength discrimination. By separating out different wavelengths of light across the electromagnetic spectrum, signals can be analyzed, and unique information can be determined. Materion Balzers Optics is the leading provider of optical filter arrays that are used to precisely discriminate wavelengths. This technology has been developed and perfected over 30 years with a strong legacy in many space and airborne based systems. Our filter array technology provides for low cross talk between channels, unique custom designs that include monolithic and butcher block type constructions, and high filter counts of over 100 individual channels. We have the capability to operate across the spectrum from UV through the long wave infrared. All our coatings and assemblies are fully space qualified. Used in conjunction with our high performance, enhanced mirrors, Materion Balzers Optics offers industry leading technology for hyperspectral imaging and sensing payloads..



Space and Aircraft based Hyperspectral Spectral Imaging

Precision Guided Munitions

Defense qualified optical components for Laser and Infrared Guided Munitions



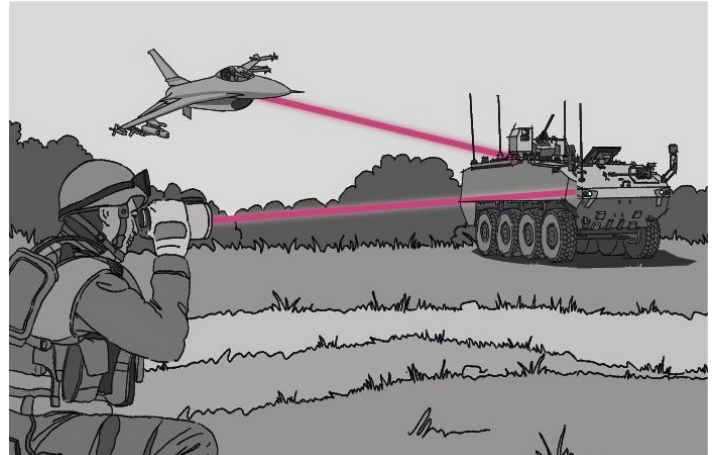
Today's smart munitions use active guidance systems to engage their targets with the goal of causing less collateral damage and increasing lethality. Reliable components for these systems are crucial for the warfighter, Materion Balzers Optics has a long legacy of providing highly reliable, precision optics for both laser guided and Infrared guided systems.

Laser Guided

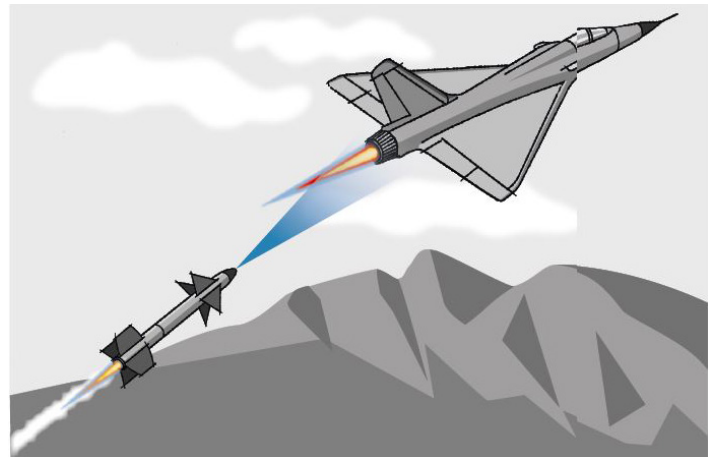
These types of weapons are guided to their targets using lasers, typically in the near infrared part of the spectrum. A soldier on the ground, or an aviator in an aircraft, paints the target with a LASER beam. The smart weapon senses the laser signal and is guided to the target. Materion Balzers Optics provide specialized filters in the NIR that are designed for a wide field of view and have very little wavelength shift over large angles. Hundreds of thousands of these filters have been produced and are currently in use on several key weapon systems.

Infrared Guided

Also known as electro-optically guided weapons, this type of guidance uses an infrared seeker that homes in on its targets thermal signature. They make use of a sensor that detects wavelengths in the mid wave and long wave infrared range of the electro-magnetic spectrum. Materion Balzers Optics has many years of experience manufacturing coatings in the mid wave and long wave, including both filters and mirrors. Our filters have precise wavelength placement, steep edges and high out of band blocking. Our mirrors have high reflectance and are highly durable. Our Infrared coatings can be found on many deployed systems.



Laser Guided Munitions



Infrared Guided Munitions

Infrared Imaging & Sensing

Custom optical components in the Infrared Wavelengths



The Infrared region of the electro-magnetic spectrum contains wavelengths that are longer than that of visible light, but shorter than microwaves. The infrared spectral band begins with waves that are just longer than those of red light, the longest waves in the visible spectrum, so IR is invisible to the human eye. These wavelengths while invisible to the eye, can provide a wealth of information beyond what we can see.

Night Vision

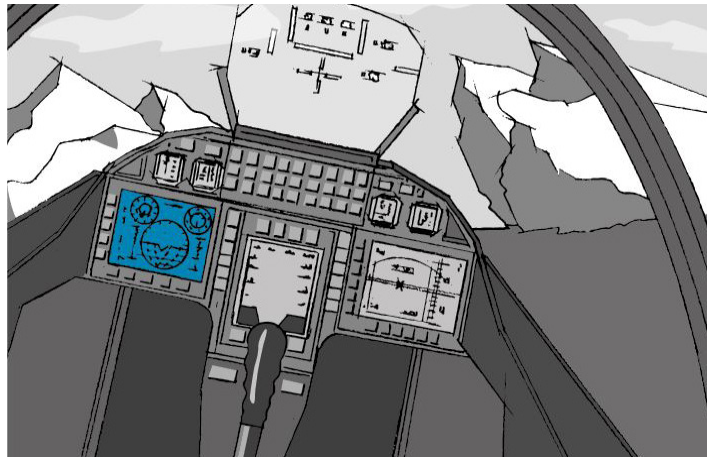
- Critical warfighting advantage being able to see at night
- Sensing in the long wave 8-12um wavelength range
- Thermal weapons sights for soldiers
- Thermal sight for armored vehicles
- Aircraft mounted sensors
- Support products for both cooled and un-cooled sensor types
- Materion has been providing coatings in the long wave for over 20 years
- Variety of filter types including Anti-reflection, long pass, edge, beam splitters and precision narrow band filters
- Capability out to 30um
- Highly durable
- Tightly toleranced
- We can also do solderable metal coatings and soldered assemblies.

Threat Warning

- Aircraft based threat detection
- Detecting incoming missiles and other threats
- Situational awareness
- Typically mid-wave sensors operating in the 3-5um range
- Cooled sensor types
- We provide filters and multiple channel filter arrays



Thermal Imaging



Threat Warning Detection

Laser Based Systems

High performance optics for Laser applications



As Lasers become smaller, more powerful, and more transportable, they are also becoming more practical for use in defense related applications. From portable Laser communication terminals to high energy lasers that can shoot down drones and incoming missiles, Lasers in the military have a strong future. Materion Balzers Optics provides cutting edge optical components for these key Laser applications.

Laser Communication

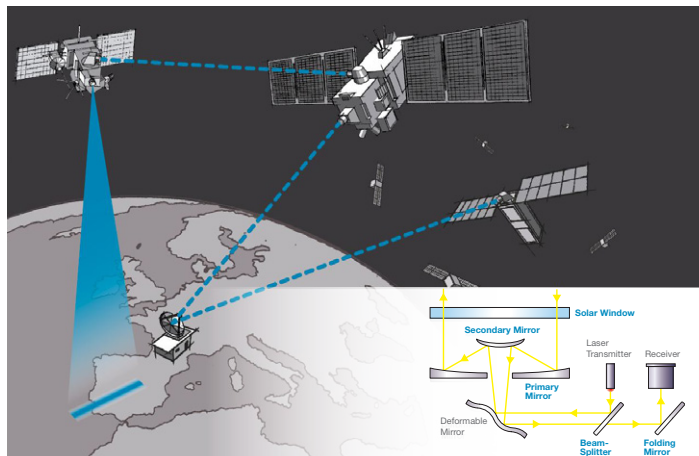
The ability to quickly and securely collect, process and transmit data, and the information derived from that data, is critical for command-and-control operations. With the proliferation of sensors, the amount of data has increased exponentially. Free space optical communication, or laser communication, allows for faster. Data can be transmitted 1000 times faster than radio, and 100 times faster than the fastest internet connection, allowing for transfer of large amounts of data. It also provides for more secure communications. Optics are critically important system components. Materion Optics Balzers provides precision narrow band filters for use within the common telecommunication bands, as well as highly reflective mirrors and beam splitters.

High Energy Laser (HEL)

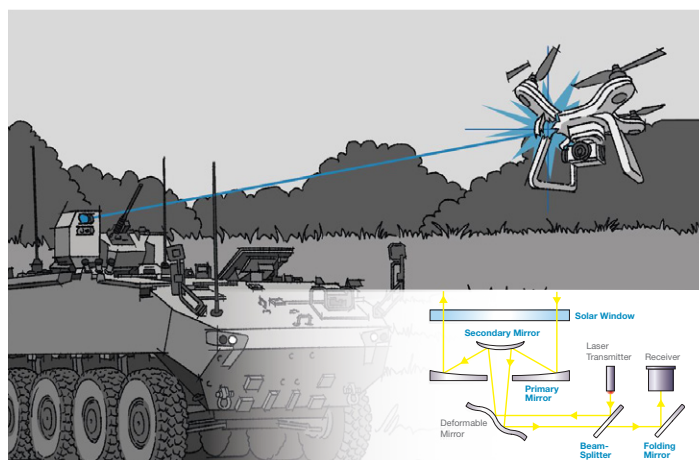
Militaries around the world are working to develop directed energy weapons, in particular high energy lasers. As they become smaller, transportable, and yet more powerful, the applications become endless. Just some of these applications include shooting down incoming missiles and defending against drones. The benefits of such weapons are their cost effectiveness per shot and the fact that they become endless magazines that do not need to be replenished. The optics used in HEL systems must withstand very high energies, with LDT's as high as 100 KW. Optical coatings must be very high performance with very low levels of defects. Materion Optics Balzers manufactures extreme performance coatings for mirrors, beam splitters and other critical components and has been supporting development efforts for many years.

Laser Protection

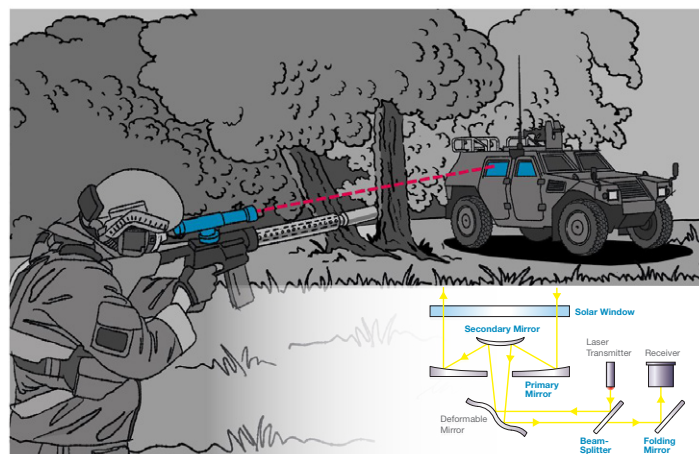
- Lasers can be used to blind both people and sensors.
- Becoming a bigger threat to aircraft, artillery vehicles and soldiers
- Soldiers and pilots have threat to their eye safety.
- Sensors can be "blinded" with lasers and make them ineffective.
- Protective measures are needed.
- Protective coatings for optical sensors, sighting systems, and soldier eye protection
- We provide laser rejection filters that can reject multiple laser lines.
- Unique rugate filter technology.



Laser Communication



High Energy Laser



Laser Protection

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.



Hyperspectral
Imaging & Sensing

Precision
Guided Munitions

Infrared Imaging
& Sensing

Laser Based
System

| | Hyperspectral Imaging & Sensing | Precision Guided Munitions | Infrared Imaging & Sensing | Laser Based System |
|--|------------------------------------|-------------------------------|-------------------------------|-----------------------|
| Alflex™ | x | | | x |
| Beamsplitters | x | x | x | x |
| Diflex™ Broadband Dielectric Mirrors | x | | | x |
| Enhanced Mirrors | | | | x |
| Gelot™ Solderable Coatings | | x | x | |
| Goldflex™ | x | | | x |
| Iralin™ – Duolin™ – Supertriolin™ | | | | x |
| Laser Beamsteering Mirrors | | | | x |
| Laser Rejection Filters | | | | x |
| Laser Scanning Mirrors | | | | x |
| Linear Variable Filters | x | | | |
| Low angle shift NIR Filters | x | | | |
| Mid wave and Long wave IR Filters | x | x | x | |
| Multispectral filter arrays | x | | | |
| Narrow Bandpass Filters in the VIS and NIR range | x | x | | x |
| NIR, IR Blocking Filters | x | | | |
| Silflex™ Coating | | x | | |
| Solder Assemblies | | x | x | |
| Ultra Short Pulse Mirrors | | | | x |
| VIS, NIR and SWIR Bandpass Filters | x | x | | |
| Wafer Level Coatings | | x | | |

Optical Coatings & Components



Laser Scanning Mirrors



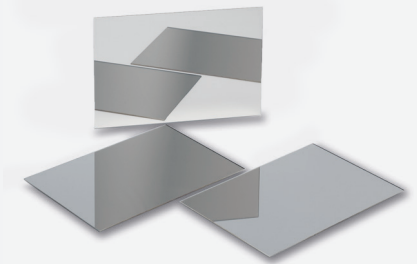
Materion Balzers Optics offers a large variety of customer specific laser scanning mirrors as they are applied for example in mirror galvanometer scanner units. High reflectivity $R \geq 99.5\%$ for 1064 nm for a customized large range of angles of incidence e.g. from 22° to 57° allows this coating to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



Diflex™ Broadband Dielectric Mirrors



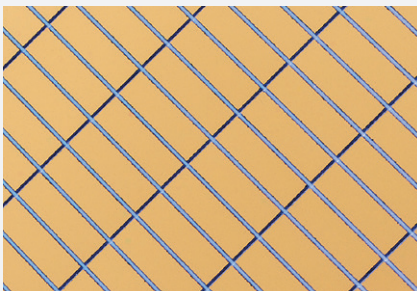
Materion Balzers Optics provides the best choice of broadband high reflectivity mirrors. Diflex™ mirrors are characterized by extreme reflectivity, low scattering and a wide acceptance range for the angle of incidence. The consistent and high reflectivity for any polarization covers the wavelength range 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.



Laser Beamsteering Mirrors



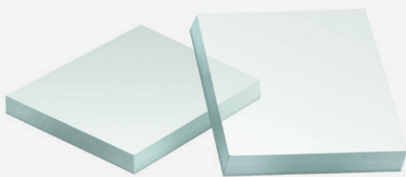
Materion Balzers Optics designs and produces flat mirrors for use in all mirror applications. Their features are excellent quality, impressive flatness, low scattering and they are easy to use over a wide range of angles and wavelengths because of their consistent reflectivity. Dielectric coated mirrors 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.



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.

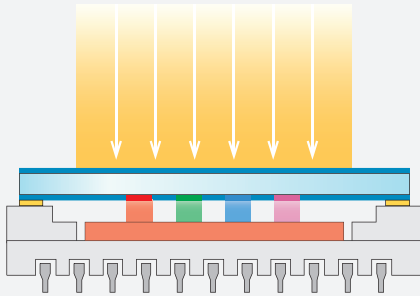


Beamsplitters



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.

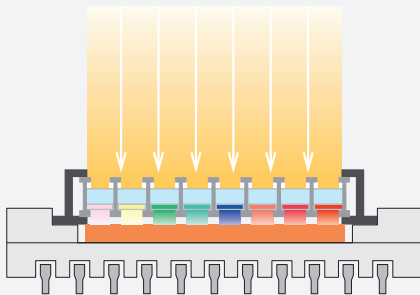
Optical Coatings & Components



Multispectral filter arrays



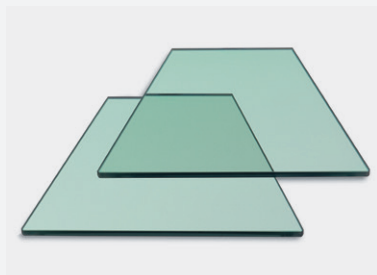
Multispectral image sensors require cover glass lids with integrated color selective dichroic filters. Materion Balzers Optics provides patterned color filters for selective spectral filtering on different zones of the cover glass lids. Such dichroic filters may include R/G/B, NIR and PAN Filters or 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



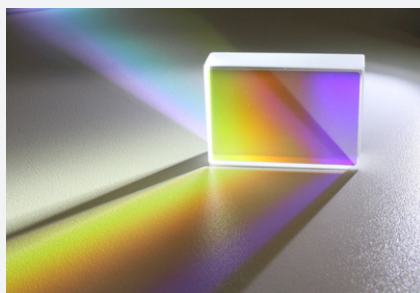
VIS, NIR and SWIR bandpass filters with standard or self-blocking filter design for spectral sensing and imaging combine wide blocking and high passband transmittance. They feature extreme stability in terrestrial and space environments and are customized for Si, InGaAs or HgCdTe sensor applications.



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).

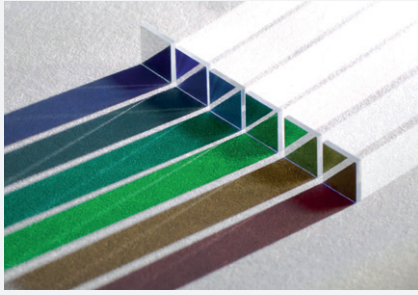


Linear Variable Filters



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.

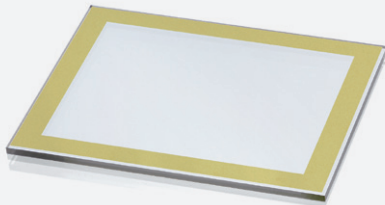
LVFs components are applied as wavelength selectors, order sorting filters in grating based systems or in purely filter based spectrometers.



Narrow Bandpass Filters in the VIS and NIR range



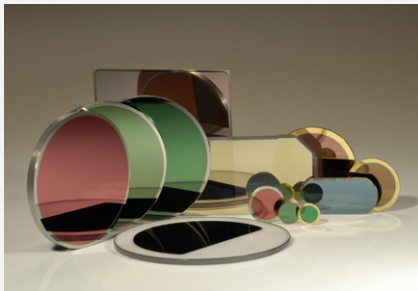
Materion Balzers Optics narrow bandpass filters are characterized by high passband transmittance, accurate center wavelength, and steep filter edges between pass- and blockband, and broadband blocking range. With typical passband width between 2 and 20 nm, and a blocking depth of OD5 the filters provide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



Gelot™ Solderable Coatings



Gelot™ is a solderable gold-based multilayer coating that can be applied to glass, fused silica, sapphire and crystals, as well as to ceramics and similar materials. Gelot™ is used in various bonding and sealing applications with optical glass components such as micro-lenses, or to provide electrical contact on conductive coatings such as Indium Tin Oxide (ITO).



Mid-Wave Infrared Filters



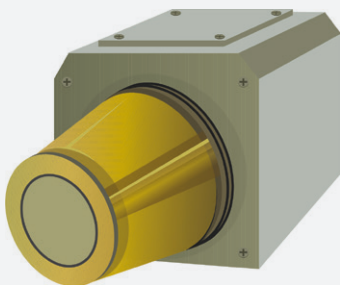
Materion Balzers Optics is a leader in MWIR filters used for a wide variety of applications. We offer a number of narrowband filters for measurement of various gases and vapors by non-dispersive infrared spectroscopy. We also offer narrow and wideband filters used for measurement of temperature and flame detection. For MWIR cameras, a window can be coated with an antireflective coating on one face and a longpass filter on the other face.



Long-Wave Infrared Filters



Materion Balzers Optics manufactures leading LWIR filters for temperature measurement and thermal imaging, offering engineered transmission and reflection between 8 and 14 μm . Our LWIR windows can be coated with antireflective and longpass filters, suitable for LWIR cameras. These filters are metallized for hermetic solder assembly and can be supplied soldered into Kovar frames or conical housings. We also provide $\text{\O} 200$ mm Si window cavity wafers for bonding onto microbolometer ROIC wafers. Additionally, narrow bandpass filters with a bandwidth to center wavelength ratio as low as 1% are available for LWIR applications.



Solder Assemblies



Materion Balzers Optics can supply infrared windows hermetically soldered into metal housings. These window housing assemblies are suitable for soldering or welding onto the customer's cooled infrared detector. Materion can manufacture the infrared window with AR or filter coatings, metallize the window for solder assembly, and then solder the window into metal housing. The integrity of the solder joint is rigorously measured by X-ray, helium leak checking and environmental testing.

CoatingPlus™: More Than Just Coating

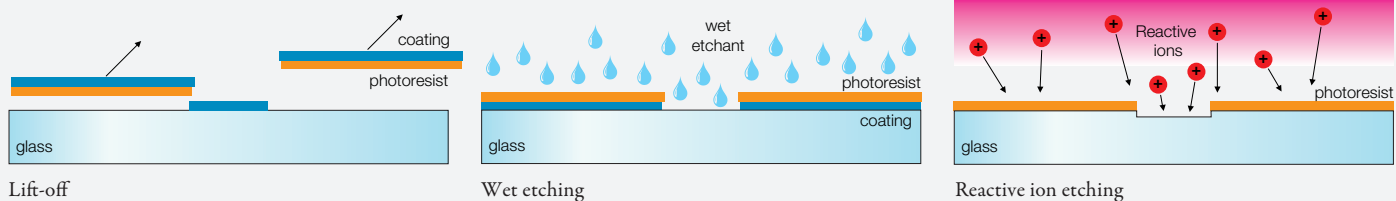
Sophisticated optical thin-film components and subsystems require additional process steps beyond coating.

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.

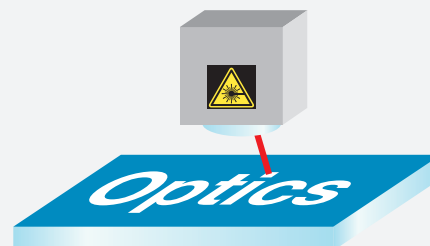


Marking

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.

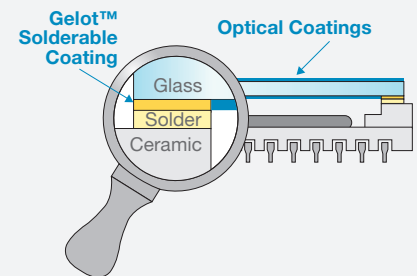


Bonding and Sealing

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.

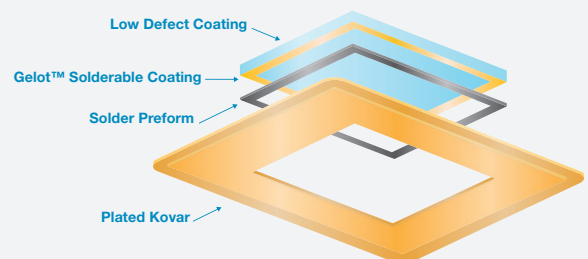
Gelot™ Solderable Coatings

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

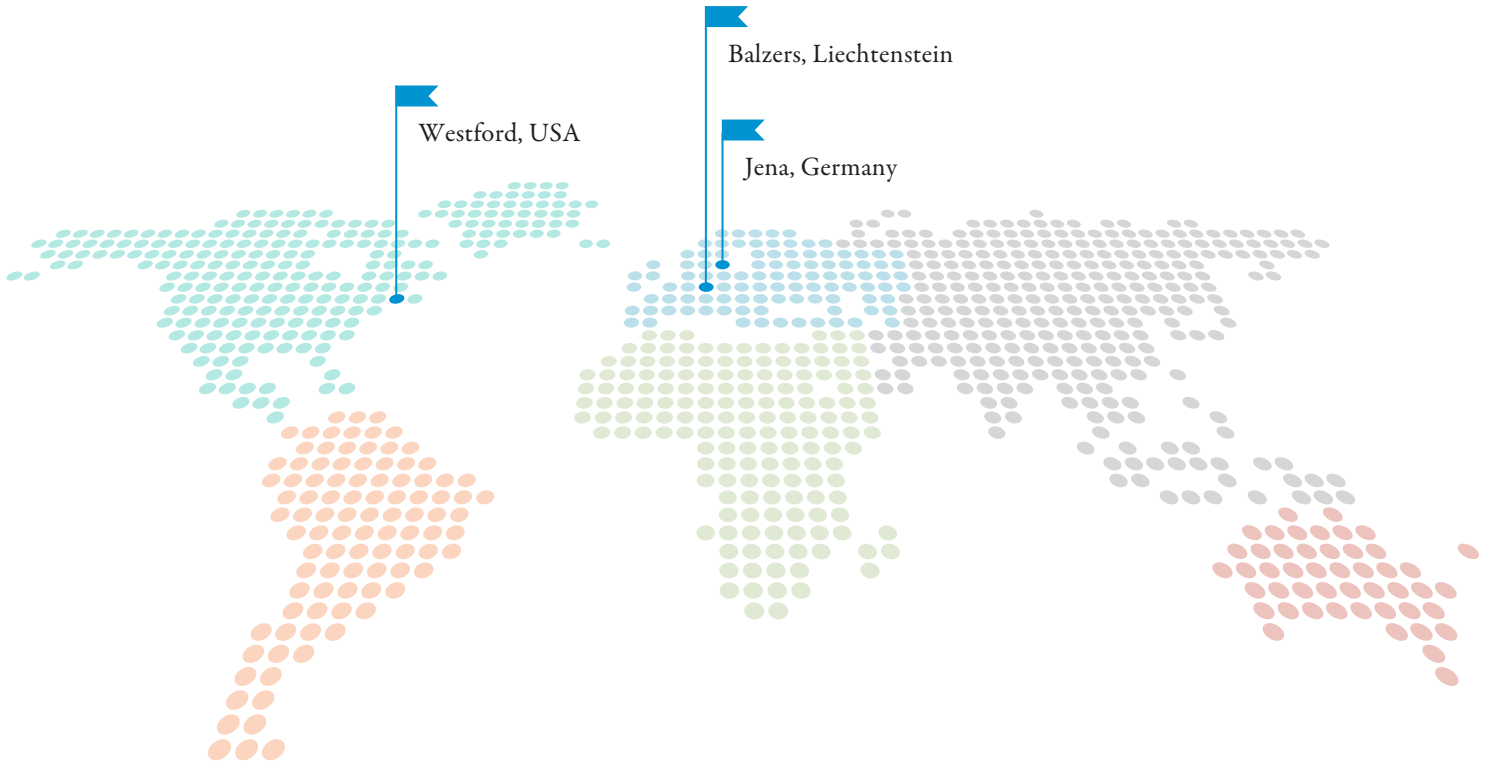
On top of the Gelot™ solderable coating an assembled glass-to-metal solution can be offered for stringent hermetic requirements. The soldered Kovar Lids are the choice for demanding applications such as sensors in space or in the shortwave infrared range.



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.





Production Balzers

Optics Balzers AG
Liechtenstein
T +423 388 9200

Production Jena

Optics Balzers Jena GmbH
Germany
T +49 3641 3529 30

Production Westford

Materion Precision Optics
United States
T +1 978 692 7513



materionbalzersoptics.com