Biophotonics
Optical Solutions for Life Science, Fluorescence and Medical Applications
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 Optics Balzers 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 Optics Balzers at the forefront of markets in the photonics industry such as Biophotonics, Lighting & Projection, Sensors & Imaging, Laser, Space & Defence, and Industrial Applications.

With its acquisition of mso jena Mikroschichtoptik GmbH in Jena, Germany, Optics Balzers is expanding its competencies and manufacturing technologies into a unique portfolio, generating added value for customers.

Optics Balzers Jena, formerly mso jena, was founded in 1998 as a spin-off from the Fraunhofer Institute for Applied Optics Jena. The use and further development of state-of-the-art coating technologies, and the close connection to industry and research institutions in the Jena optics cluster were key factors for its successful development. Optics Balzers Jena is focused on the development and manufacturing of high-performance interference filters for various applications.

Optics Balzers’ 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 Optics Balzers as a trusted, reliable, and innovative partner.
Biophotonics Solutions

Our optical components guide, reflect, select and alter light for life science, fluorescence and medical applications.

The use of light for diagnostics and therapy in life science applications has been steadily expanded over recent years. Depending on wavelength and power, light can be an appropriate tool for the non-destructive examination of living samples or for the manipulation of tissue in laser surgery. It can be used to image the basic elements of life as well as to detect single molecules or proteins. The manifold use of light requires sophisticated methods for controlling the light propagation path and its spectral composition. Optical coatings are widely used for both purposes and play a key role for the operation of optical instruments. Based on its long-standing experience and development work, Optics Balzers produces a wide range of innovative coatings and coated optical components. We aim to work closely with biophotonics engineers to further advance the efficiency of optical methods in life science applications.

Biochips
Optics Balzers provides BioChip substrates for a broad application range both in fluorescence as well as label-free detection platforms. Our products include low defect glass substrates with customized metal or dielectric coatings as well as photolithographic patterning in the micro and nanometer range.

Fluorescence Detection
The detection of fluorescence light is a powerful and widely used method for the investigation of biological samples. Its sensitivity and selectivity to particular substances and cell constituents are highly dependent on the performance of the optical filters and beamsplitters in the light path. Precise adjustment of the spectral characteristics to the fluorescent dye and measurement set-up, steep transitions from high blocking to high transmission, broadband high-level blocking, and long-term stability of these optical components are key factors for reliable and conclusive measurement results. Optics Balzers provides customized high-performance filters and filter sets for high-quality fluorescence microscopes and other fluorescence detection instruments.
Medical Technology
Light processing and safety are crucial in applications where human health or life is impacted. Precision optical components of the highest quality utilized in medical equipment enable the development of new and innovative solutions. Optics Balzers’ safety filters for ophthalmologic surgery stand out by narrowband blocking of the laser wavelength and optimized color rendering. Cold, blocking, and conversion filters effectively remove damaging ultraviolet and unwanted infrared radiation, while ensuring maximum visible light transmission. Such filters are indispensable for ensuring homogeneous, cool, and accurate illumination in operating rooms or at the dentist.

Endoscopes
Endoscopes require optical components with durable and robust anti-reflection coatings or other functional coatings. Optics Balzers provides various types of coating with reliable performance even on very small lenses.

High-performance fluorescence microscopy is enabled by sophisticated interference filters
Optical Coatings & Components

The core competencies of Optics Balzers are designing and manufacturing of high precision dielectric and metal thin film optical coatings and integrating them into sophisticated optical components. Optics Balzers’ coatings and components are characterized by excellent spectral performance, low defect density 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.

Planar Wave Guides (PWG)
Planar waveguides (PWG) consist of sub-micron diffractive grating structures and high refractive index waveguides used as biochip substrates. Optics Balzers manufactures gratings with high uniformity across extended areas up to 5 inches, as well as coatings for waveguides that comply with low defect standards and biocompatibility. Support for customer specific design with optimized coupling and wave-guiding can also be provided.

BrightSlide™ D – Fluorescence Enhancing Slide
Fluorescence systems (e.g. microscopes) are today widely used in the life science research. For many applications an increased sensitivity compared to existing glass slides is required. The BrightSlide™ technology uses a proprietary dielectric coating to significantly enhance the signal intensity of fluorescent molecules from the surface. It can be read out with almost any system that illuminates and detects from the top. The technology makes use of only optical principles and substitutes conventional glass substrates.

WIOS – a Multi-Channel Optical Detection Platform
For analytics, high-throughput screening, assay development, environmental monitoring, and related fields, label-free optical detection technologies enable direct characterization of biomolecular interactions for a wide range of applications. The Wavelength Interrogated Optical Sensing (WIOS) technology allows for highly sensitive and robust label-free measurements in real-time, for single channel measurements and arrays. As a turn-key supplier, Optics Balzers provides high quality glass-based WIOS BioChip substrates for reliable and stable measurements.

The WIOS technology was jointly developed together with CSEM (Centre Suisse d’Electronique et de Microtechnique).
Fluorescence Filter Sets
Optics Balzers fluorescence filter sets include excitation and emission filters (band-pass, short-pass or long-pass) as well as a dichroic beam splitter. Cut-on and cut-off wavelengths of the filters are optimized for the excitation light source and for the fluorescent dye. The filter performance is realized by all-dielectric hard coatings deposited onto a single substrate. Because absorbing glasses and filter mounts are not needed, there is a high flexibility for the filter dimensions in compact optical set-ups.

Steep Edge Bandpass Filters
Optics Balzers bandpass filters excel by steep transition between blockband, passband, and high-passband transmittance (> 95%). Our sophisticated filter designs are optimized according to the requirements of the application. Typically, the filters provide broadband blocking (> OD5) from the UV to the NIR range. Even in the case of narrow bandpass filters (e.g. FWHM 2 nm), the filters combine high-passband transmittance with a deep broadband blocking level.

Low-Loss Dichroic Beamsplitters
Optics Balzers' dichroic beamsplitters separate the incoming light in a highly reflected and transmitted part. The transition zone can be reduced to approx. 3% of the transition wavelength for random polarized light. The all-dielectric interference filters are deposited by plasma-assisted processes and show extreme environmental stability. Filter dimension, spectral performance and angle of incidence can be customized. Shortpass and longpass beamsplitters are available.

Notch Filters
Notch filters allow blocking a specific wavelength of light (up to >OD6), while showing high transmittance for the remaining part of the spectrum. The bandwidth of the blockband can be as narrow as 10 nm in the VIS range. Multi-notch filters block up to 4 different wavelengths. Notch filters are composed of a complex multilayer stack deposited onto glass substrates. They can be designed for user defined blocking wavelength, blocking depth and angle of incidence.

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 hard-coated filters are long-term stable and available in flexible dimensions.
Optics Balzers' UV/IR-blockers effectively remove damaging ultraviolet and unwanted infrared radiation produced by broadband light sources. Filters are optimized for metal halide lamps and are particularly well suited for use in applications where high thermal loads exist.

Calflex™ – IR Blocking Filter
Some designs of medical lights require additional heat reduction. Optics Balzers' Calflex™ filters reflect infrared radiation while transmitting visible light and allowing differing emission behaviors of various light sources. Calflex™ filters allow maximum transmission in the visible waveband without changing the colorimetric characteristics of the light source.

Cold Mirrors
Cold mirrors reflect visible light and allow the transmission of infrared radiation. In general, these mirrors are used at an angle of incidence of 45°, thus reducing the temperature load of a light source by heat-light separation. Plane cold mirrors are an additional component of a high-performance heat management system.

Conversion Filters
Optics Balzers' conversion filters match the color temperature of a light source with individual requirements while maintaining good color rendition and high luminance. With conversion filters, customers can set their light sources to the right color temperature.
**Microoptics**
Optics Balzers offers a range of different anti-reflection coatings for microlenses and rod lenses for endoscope applications with dimensions down to 1 mm. Other functional coatings can also be provided.

**Gelot™ 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 microlenses down to 1 mm diameter.

**Patterned Chrome**
Full-surface and patterned chrome coatings on planar components are widely used in the optical industry. Optics Balzers puts its emphasis on high resolution, low defect patterns – optionally in combination with low defect functional coatings. With CrBlack™ coating, Optics Balzers also offers an optical black coating, characterized by high absorption and low reflection in the VIS range. Applications include background noise reduction in fluorescence sensors and precise alignment marks in correlative microscopy.

**ITO Coatings on Glass and Plastic Substrates**
Premium quality, full-surface, and patterned indium tin oxide (ITO) coatings are available as electrically conductive and optically transmissive thin films on glass and plastic substrates. The ITO layer may be supplemented with dielectric layers for index matching or for obtaining anti-reflective properties of the coating. Applications include radiation dose measurement and electron microscopy, where current induced by irradiation is measured or charge is drained to prevent the accumulation of electrostatic charge on the surface.

**TopFlex™ Hydrophobic Coatings**
Hydrophobic coating TopFlex™ is chemically resistant against water, oil and grease. This UV to IR transparent top-layer is easy to clean and also repellent to dirt. The coating exhibits a good adherence to the substrate and other coatings and is strongly resistant to various forms of cleaning processes.
Coating Plus: More Than Just Coating
Sophisticated optical thin film components and subsystems require additional process steps beyond coating

Most advanced thin film optical components require various additional process steps beyond dedicated coating processes to achieve their full functionality and performance in customer specific applications.

Biofunctional Coatings

Versatile Biofunctional Coatings
Biofunctional coatings are necessary for functionalizing surfaces for life science, fluorescence, and medical applications. Glass, metal oxides, ITO, and plastics can be treated in order to bind different kinds and variable amounts of macromolecules, tune specific cell adhesion, reduce nonspecific binding background, provide better signal-to-noise ratios and patterned surfaces with multiple functionalities.

Patterning

Optics Balzers 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 wide range of customer requirements for feature sizes and shapes.

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 biochip substrates and advanced microscopy slides.

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 Solutions

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 / Marking
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.

Subassembly

OEM Biochip Solutions
Optics Balzers offers customized optical subassemblies to meet its customers’ ever-increasing demands. We develop individual one-stop-shop solutions for and together with our customers and partners.

Wafer Dicing and Scribing
Economical production of thin film coating components often requires substrate wafer based processing. With advanced dicing and scribing capabilities, Optics Balzers manufactures thin film components to customer specific shapes and sizes with high precision.

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.
Bonding and Sealing

In various applications, thin film optical components need to be precision-mounted on other components such as sensors or sub-assemblies. Optics Balzers 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**

Light sensitive semiconductor devices require a packaging including a transparent glass lid. 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. Gelot™ is applied to the lid as a frame pattern with a clear aperture.

**Soldered Kovar Lids**

On top of the Gelot™ solderable coating an assembled glass-to-metal solution can be offered to satisfy stringent hermetic requirements. The soldered Kovar Lids are the first choice for demanding applications such as sensors in space or in the shortwave infrared range.
Applications
The field of Biophotonics is rapidly expanding, driven by development of breakthrough technologies for a broad range of applications.

- Diagnostics
- Bioanalytics
- Environmental Monitoring
- Crop, Feed and Food Analysis
- Fluorescence Microscopy
- Raman Spectroscopy
- Ophthalmology
- Endoscopy
- Dosimetry
- Emerging Applications

Fluorescence Microscopy
Applications

Raman Spectroscopy

Ophthalmologic Surgery
Biochips for Label-Free Detection

**Typical applications**
- Environmental monitoring
- Crop and food analyzing
- Life science
- Medicine

Biochips for Labeled Detection
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