LiDAR – Sensing Your Vision

Why Glass Solutions Play a Key Role in Improving LiDAR Sensor

Boris Eichhorn – Senior Manager New Ventures

Introduction to SCHOTT

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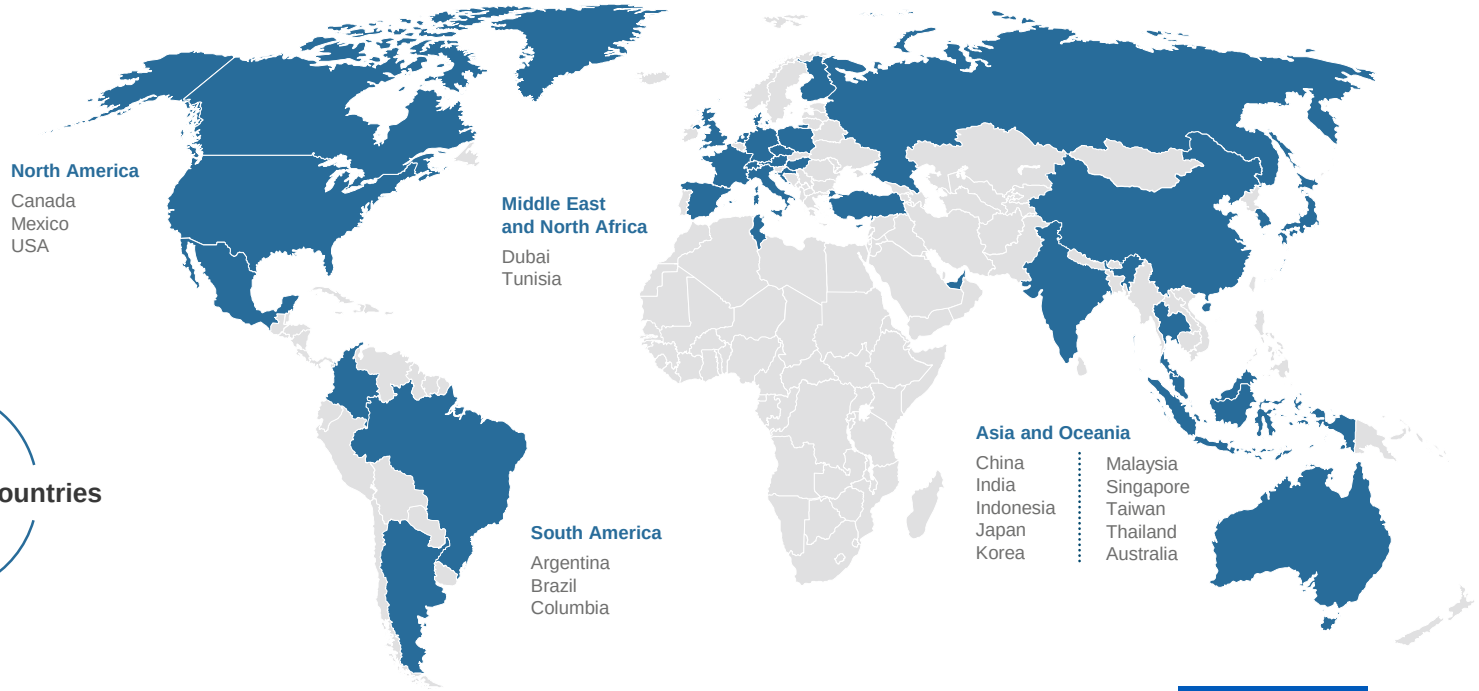
SCHOTT worldwide presence – 42 production sites / 26 sales offices

Europe

Austria
Croatia
Czech Republic
Denmark
Finland
France
Germany
Great Britain
Russian Federation
Spain
Switzerland
Turkey



in **34** countries

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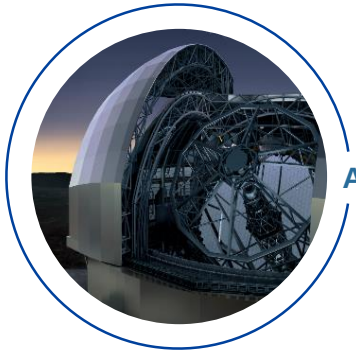
Broad product portfolio for many industries

Home Appliances

Life Sciences



Astronomy

Pharma

Electronics

Automotive

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Glass solutions from SCHOTT can improve your LiDAR sensor

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Glass and glass-to-metal sealed components protect **LiDAR** sensors, while maintaining a high optical performance

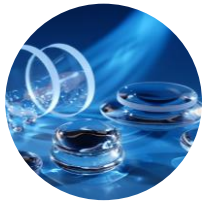
LiDAR components incl. MEMS mirrors and high-power lasers require protection from humidity and atmospheric influences, while offering superior performance.

Protective windows, optical path components and hermetic packages from SCHOTT address these challenges.

Protective window

Protective glass windows in different shapes

Anti-reflective and hard coating



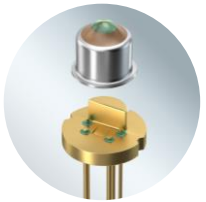
Optical path

Optical glass

Filters

Mirrors/ Beam splitters

Aspherical Lenses



Hermetic packaging

Highly reliable encapsulation for:

Laser diodes

Photo diodes

MEMS mirrors

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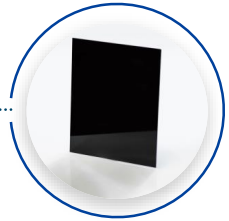
High-quality **protective windows** are needed to withstand harsh conditions

Challenges

- The LiDAR sensor has to reliably function at a high level to provide a continuous situational picture.
- LiDAR systems need protection from rain, temperature fluctuations and impacts from gravel, rocks, and other debris.
- Protective windows must feature high transmission that allows near infrared (NIR) to pass through, while attenuating visible ambient light.

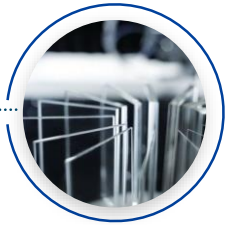
The advantages of **protective windows** made out of glass lie in a longer life-time and a higher optical reliability

RG Filter glasses



- **High NIR transmittance and strong absorption** in the visible range
- **Different thicknesses available** 0.3 mm to 6 mm
- **Available** for **905nm** and **1.550nm**
- **Thermal toughening** to increase strength

BOROFLOAT® 33



- Outstanding **thermal resistance**
- Exceptionally **high transparency**
- High **chemically durability**
- Excellent **mechanical strength**

AR Coatings

- AR Coating with a **hardness close to Sapphire**
- Outstanding scratch resistance, **ensuring long term performance**
- Excellent **coating adhesion to surface**
- Applied and proven **for defense and watch applications**
- **High visible** transmission

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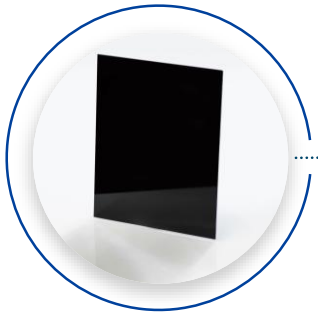
The advantages of **protective windows** made out of glass lie in a longer life-time and a higher optical reliability



Glass Advantages	Explanation	Impact on: Optical Reliability	Impact on: Life-time
Scratch Resistance	**Polymer with lower scratch resistance due to:** • Debris/ particles in atmosphere • Sand behind LiDAR-windscreen wipers • Mechanical cleaning of protective window	✓	✓
Environmental Stability	**Polymer with less environmental stability e.g.:** • Brown coloring due to UV radiation • Atmospheric deposit leads to surface roughness • Water diffusion leads to corrosion & malfunction	✓	✓
Adhesion of Coatings	**Polymer with quicker delamination of coatings e.g.:** • Anti-reflective coating • Hydrophobic coating • Heating layers	✓	✓
Service Costs	**Replacement cost impact** due to shorter exchange cycles for polymer windows compared to glass		✓

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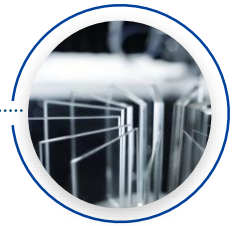
Filters, substrates and lenses – high performance for the **optical path**

Challenges

- In the optical path of a LiDAR system, the precision of the interacting components is key because the laser beam cannot afford any single photon loss.
- LiDAR sensors must deliver long lasting good image quality regardless of temperature differences or aggressive climate conditions.
- High transmission and a thermalized lens system design are commonly considered.
- LiDAR sensors require superior overall imaging quality, while being compact and lightweight.

Filters, substrates and lenses – high performance for the **optical path**

BOROFLOAT® 33



- Outstanding **thermal resistance**
- Exceptionally **high transparency**
- High **chemically durability**
- Excellent **mechanical strength**

D263® T eco

- Very **high transparency across a wide range**
- Suited for **chemical toughening**
- **Wide range of thicknesses** without need of polishing
- **Ideal substrate** for any type of optical filters

MEMpax®

- **Precise match** in thermal expansion with Si
- Suited for **anodic bonding**
- Exceptionally **high transparency**
- Excellent **thermal and mechanical resistance**
- **Optimal coating** substrate for both reflective and anti reflective coatings
- No **surface or subsurface** damages

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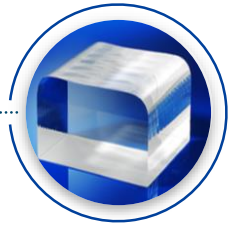
Filters, substrates and lenses – high performance for the **optical path**

Filter Substrates

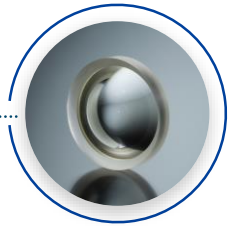
- Absorption filter – **independent on angle of incidence**
- Steep cut-on wavelength enables **excellent S/N ratio**
- Cut-on wavelength **custom made**
- Good **polishing capability**
- **RoHS and REACH** compliant

Optical Glass



- **More than 99%[1] internal transmittance** at 905 and 1530 nm
  [1] thickness of 10 mm assumed
- **High refractive** index glass
- **Low or negative dn/dT or very high dn/dT** for temperature compensation
- **Low CTE** < 6 ppm/K
- Good **chemical resistance**
- Precision **moldable glasses**

Aspherical Lenses



- Custom designed products at **competitive prices**
- From single piece for **prototype to series production** levels
- Available in **high transmission optical glass** and **fused silica materials**
- Coating: All lenses can be coated **to specific custom designs**
- **Master the entire value chain** from raw glass to aspherical coated lenses

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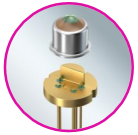
Hermetic packages protect and power LiDAR sensors to withstand harsh conditions



Challenges

- Laser diodes, photo diodes and MEMS mirrors must be protected against internal condensation and harsh external elements of the driving environment in all types of LiDAR sensor devices.
- Professional support and consulting is needed when it comes to product size, shape, materials, technology, and all-round R&D support as well as solutions optimized for competitive, high-volume manufacturing.

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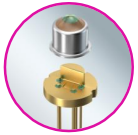
Hermetic packages protect and power LiDAR sensors to withstand harsh conditions

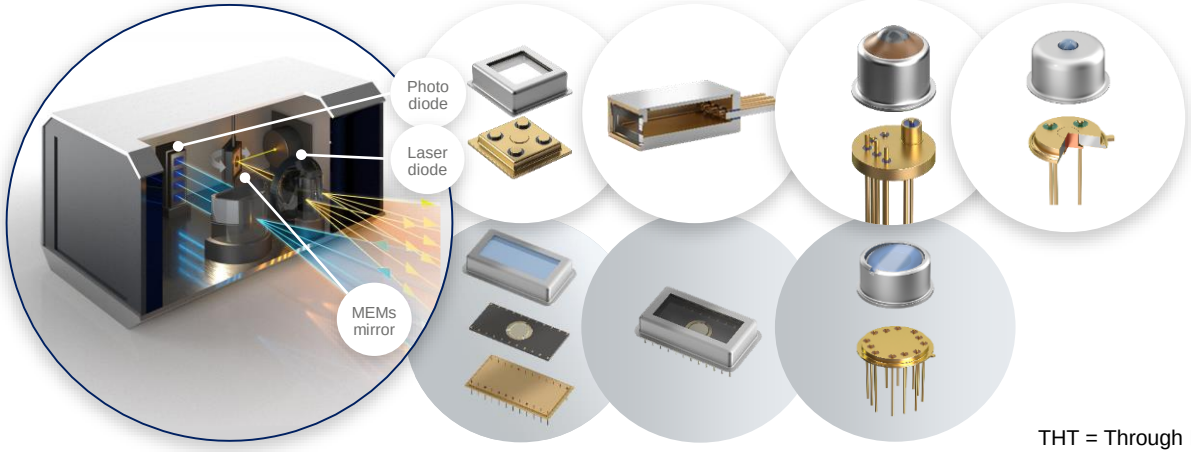


Robust packages
- Air tightness: < 1x10^{-8} mbar l/s to protect against harsh automotive conditions (dust, moisture)
- THT is robust against vibration
- Inert material and plating system against corrosion

Improved performance
- Package can be designed to have vacuum to improves MEMs sweeping angle, response time, and reduce power consumption
- Excellent heat dissipation improves laser efficiency and maintains the wavelength

Excellent heat dissipation
- TEC design to cool high power lasers and control constant wavelength
- Cu as heatsink to quickly dissipate heat load from laser to package

High optical precision
- Metal cap with special glass and advanced optical design
- Angled window, AR coating to minimize reflection
- Near Infrared (NIR) filter and other coating options



Custom-made or off-the-shelf
- Product size, shape
- THT, SMD style
- I/O numbers
- Coating materials, etc.

THT = Through Hole Technology
TEC = Thermal Electrical Cooler
SMD = Surface Mount Device

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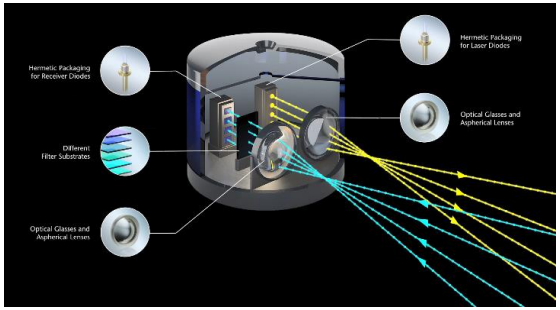
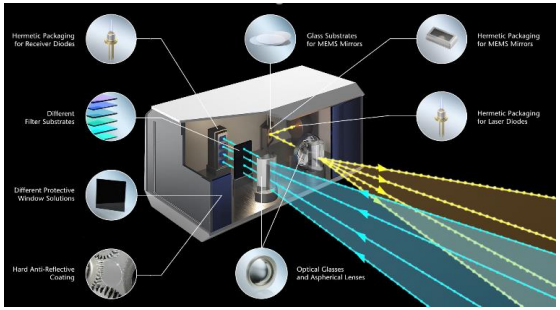
Please check out our LiDAR microsite

SCHOTT’s value proposition for different LiDAR technologies

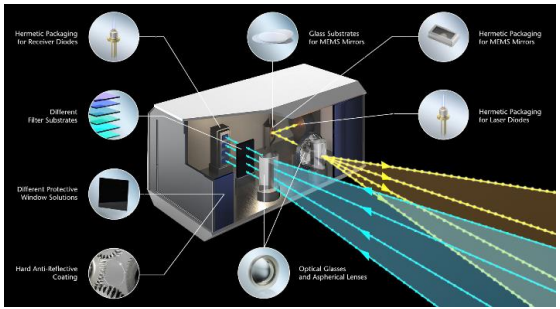
360° mechanical LiDAR



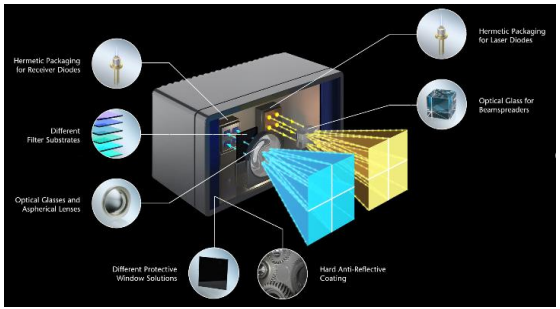
MEMS LiDAR



Mirror-mechanical LiDAR



Flash LiDAR



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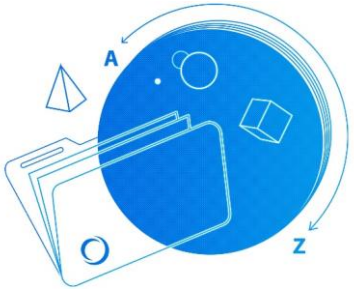
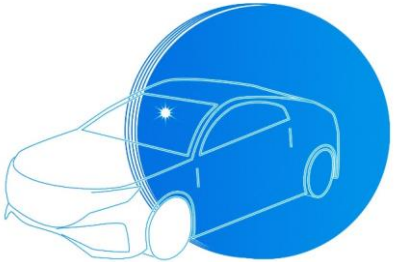
SCHOTT offers the broadest glass solution portfolio for LiDAR sensors on the market. All from one source.



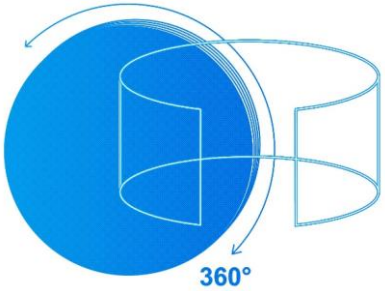
OUR OFFER

The broadest glass solutions portfolio on the market. All from one source.



OUR DRIVE

With our passion to innovate we tailor solutions for your visions.



OUR MINDSET

We are proactive consultants. A partner that offers a holistic approach.

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Please visit our Microsite & our Opportunity Lab!

https://microsites.schott.com/us-lidar/english/

https://www.us.schott.com/innovation/opportunity-lab-contact/

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