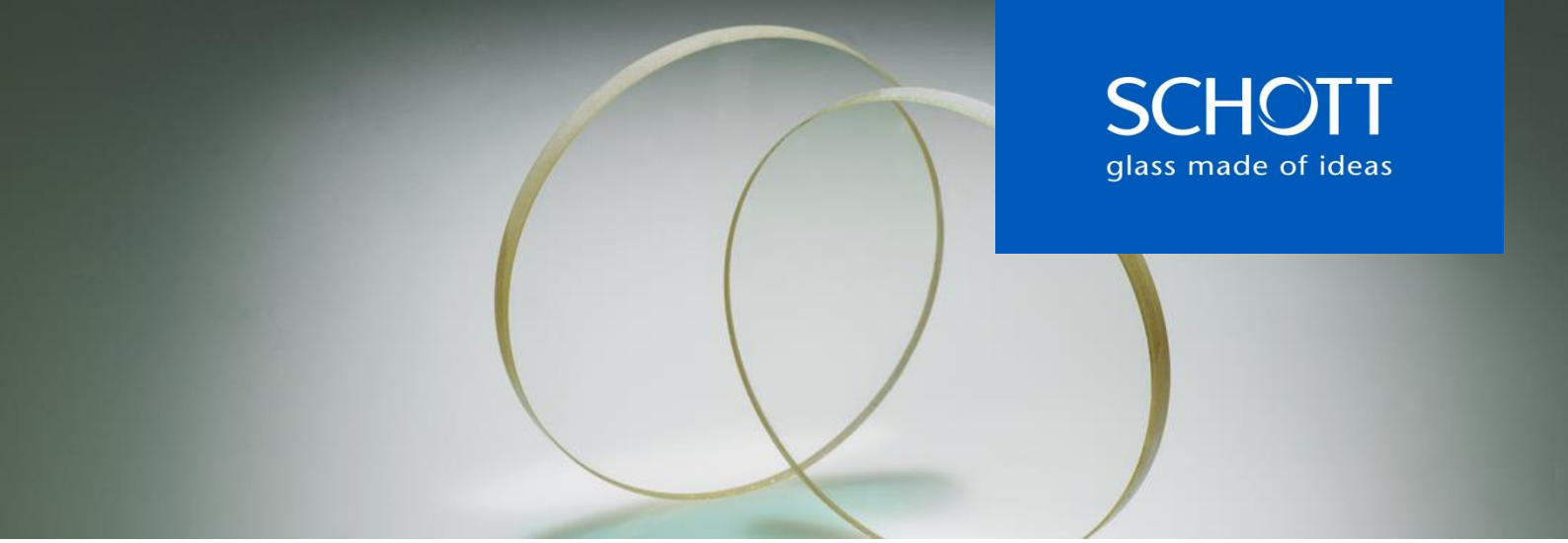


December 9, 2021

SCHOTT Infrared Materials

Protecting Sensitive Optical Devices in Harsh Environments

Introduction

SCHOTT Academy of Optics is a free, online seminar series designed to take your industry knowledge and expertise to new levels.

Throughout the series, you will learn from leading glass and material experts as they cover various topics pertaining to the optics industry.

Visit our website for more information or to register for an upcoming seminar: www.schott.com/academy-of-optics

A variety of commercial and defense applications rely on glass-like materials with IR transmission for optical components or as an IR window, which protects sensitive optical devices. Zinc sulfide (ZnS) is often used for these applications because of its optical performance and robustness against harsh environments. Newly developed multi-band scratch resistant anti-reflection coatings are helping ZnS stand up to even harsher conditions without sacrificing spectral quality.

1. Where and how are IR glasses used?

Regular (FLIR) grade ZnS is a polycrystalline optical material with high optical performance, especially in the long wave IR region (8-12 µm). The material's high fracture strength and hardness make it ideal for harsh environments, including rain and particle erosion. ZnS also tends to cost less than other materials with comparable properties.

ZnS combined with scratch-resistant coatings is used in a variety of defense applications to protect sensitive equipment from a harsh environment. For example, ZnS windows can protect visible cameras, laser rangefinders, fire control systems, and IR cameras. They are also used to safeguard a military tank's periscope, which has a CCD for daytime use and a long-wavelength IR camera for night vision.

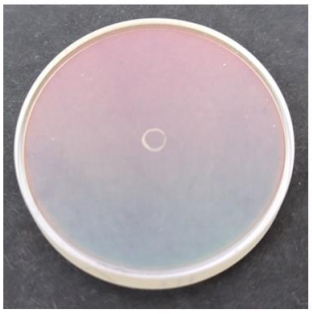
In many cases, protecting visible-wavelength and IR equipment on a military vehicle requires different types of glass, which means that two parts must be replaced if damage occurs. SCHOTT developed one ZnS material and a single kind of coating that can be used to protect all these sensitive systems. This allows just one spare-part to be kept on hand and allows easier and faster repairs in the field. We also figured out the best way to polish and prepare the material to achieve the highest durability.

2. Optimizing the coatings

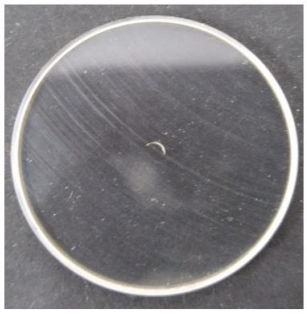
When optimizing a coating to withstand harsh environmental conditions, it is important to understand that the coating's refractive index is proportional to its density, which is, in turn, linked to hardness. While an anti-reflection coating requires a very low refractive index to perform well, abrasion resistance is determined by the coating's hardness. This makes is necessary to find a way to balance spectral performance with scratch resistance for each application.

One way to balance these requirements is to coat the inside surface of the protective window — such as the side facing the camera, or optics inside a protective housing — with a high-efficiency antireflection coating. Because these optics aren't exposed to the environment, they can have non-scratch resistant coatings. The portion that is exposed to the environment will then receive a scratch-resistant coating.

At SCHOTT, all the scratch-resistant coatings we use undergo a battery of tests to ensure they do not degrade under harsh conditions. This includes lateral tests such as severe abrasion, where the coating must remain scratch free after a certain number of strikes across the surface, and the wiper test, which is based on a military standard that specifies the wiper pressure and water/sand mixture to which coatings are exposed. Because no commercial setup was available for the windshield wiper test, SCHOTT defined and developed a testing setup. This test can now be performed with no waiting time.



No scratch visible!
Mark on back side due to part removal



Uncoated sample shows clearly scratch marks over the whole surface

Figure 1: Pictures of samples after performing the windshield-wiper test. Image on the left is a coated piece. Image on the right in uncoated ZnS. The circular mark in the center is on the backside and comes from removal of the part from the setup.

Impact resistance is assessed using blowing dust and blowing sand tests, the most extreme tests performed on coatings. For the blowing dust test, samples are exposed to a defined concentration of dust and a specified wind speed for six hours at two different temperatures. Durability in blowing sand is tested in a similar way but with different sized particles. The coatings are also tested against salt, fog, and humidity.

3. Multiband performance

SCHOTT's new multiband coatings allow ZnS's transmission to be adjusted for specific applications while maintaining or even boosting durability. The coatings have an average transmission in the visual (450 - 750 nm) range of more than 92 percent and more than 85 percent for 8000 to 11,500 nm. Additional bandwidth combinations are available for both scratch resistant antireflection and standard antireflection coatings. ZnS windows can be made in circular shapes with diameters up to 200 mm and rectangular sizes up to 170 x 167 mm.

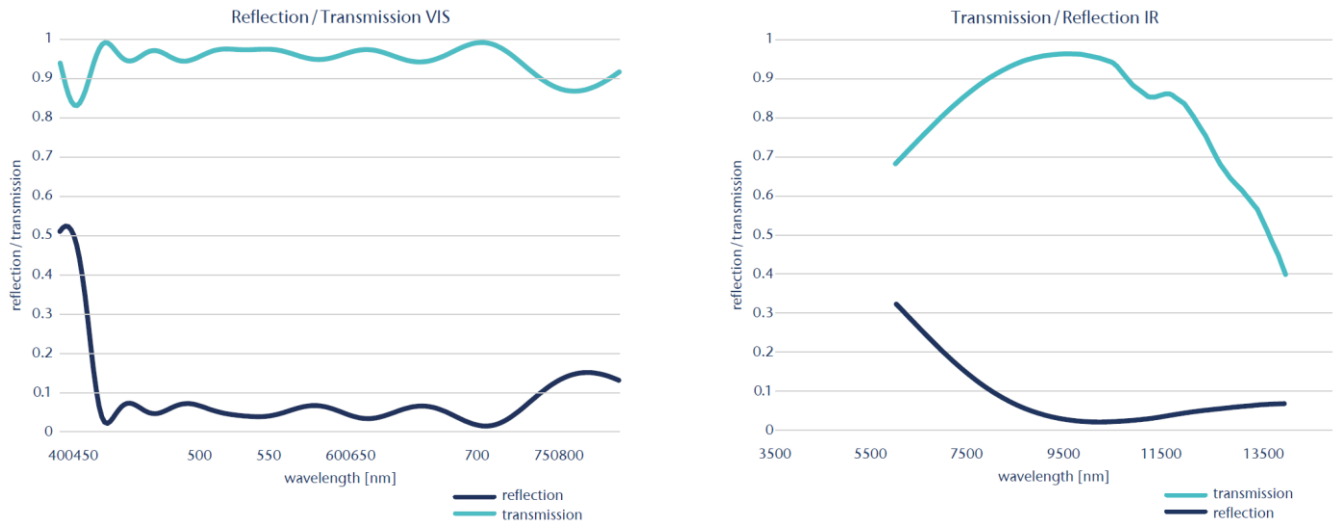


Figure 2: Transmission and reflection curves of a scratch resistant 2-band AR coating (VIS+LWIR).

We also offer other coatings, such as LUXADUR coatings. These coatings were originally developed as visible-wavelength coatings for the watch industry but have been extended to the mid-IR. They are used in windshields, train lights, and military applications. In addition to coatings, SCHOTT also performs all polishing for optical components and can also assemble the components.

Want to learn more about AR coating?

Contact us to learn more about how scratch resistance can be used to protect your optical devices from harsh environments without compromising spectral performance.

You can also visit our website for more information and resources: www.schott.com/products/ir-materials.