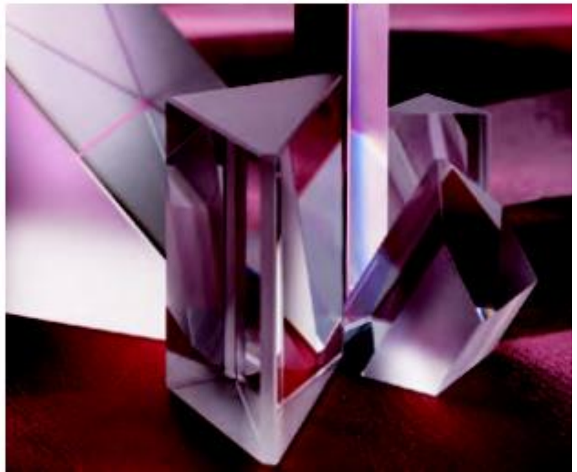

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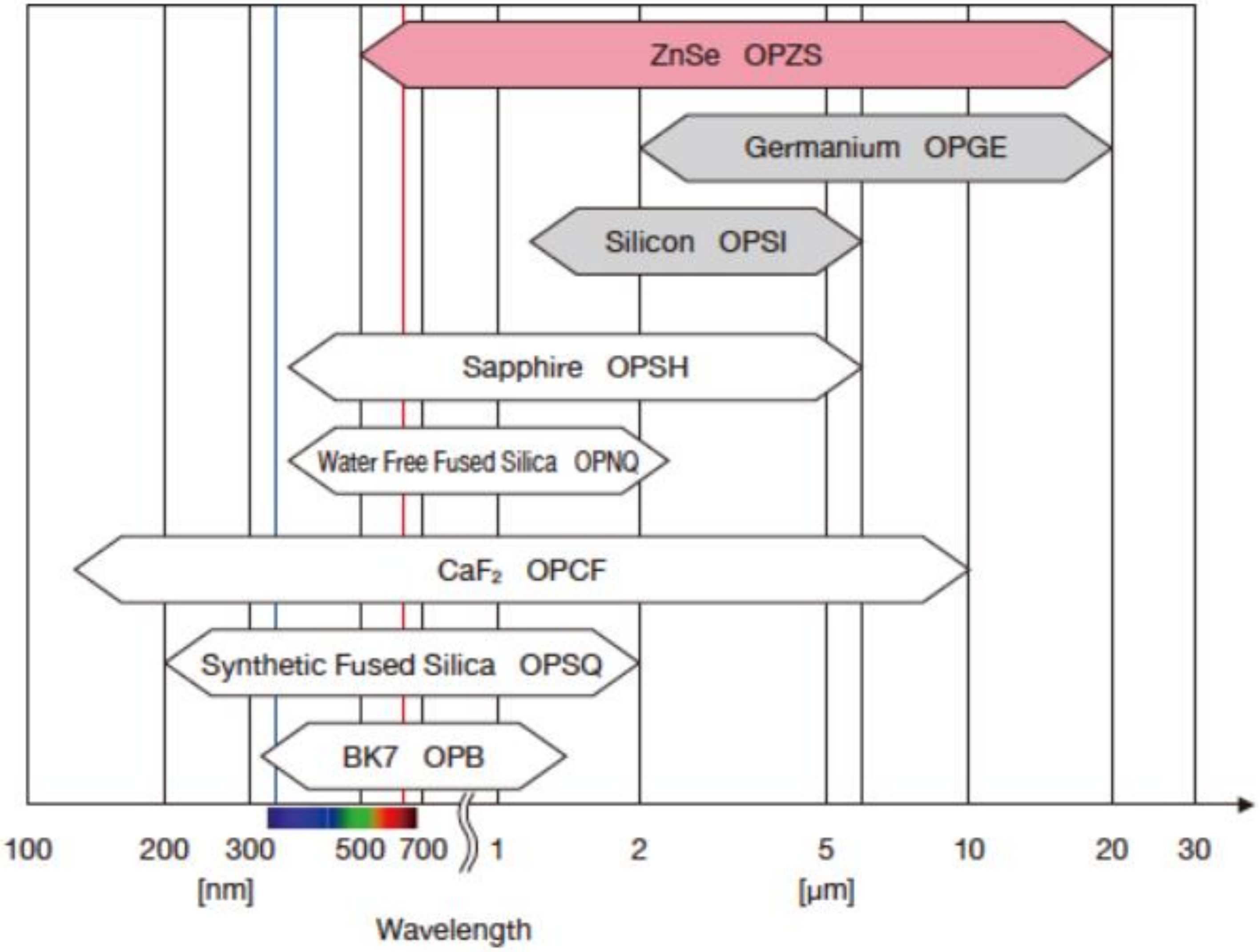


Optical Glass Specifications

Selecting a **glass material** is important since different glass types have different characteristics.

The **index of refraction** and **Abbe number** of a glass are typically used by designers as degrees of freedom when designing systems.

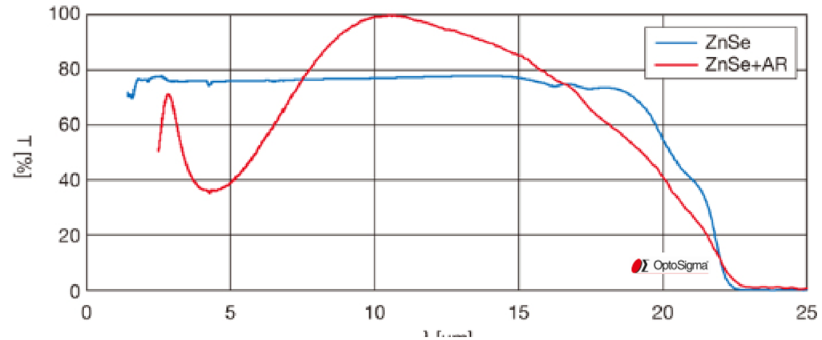
For instance, a higher index of refraction generally bends light more efficiently so there is less of a need of curvature in the lens. Spherical aberration is less present in lenses with higher indices of refraction, while light travels faster through materials with lower indices of refraction.
A high Abbe number generally gives less color dispersion and reduces color aberration.

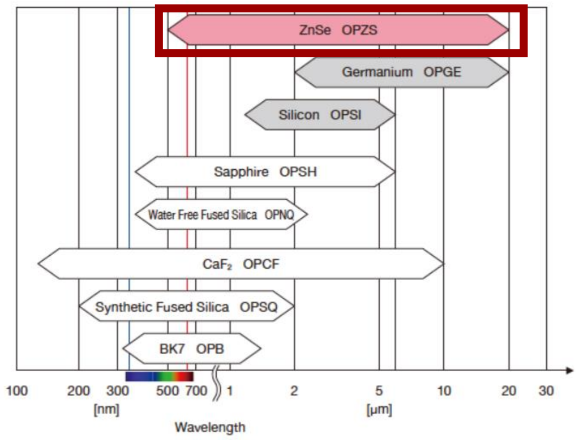
The **density** of a glass helps determine the weight of the optical assembly and, along with lens diameter, becomes critical for weight sensitive applications. When dealing with applications involving extreme temperatures and quick temperature differentials, a glass' **coefficient of expansion** also becomes a key factor.

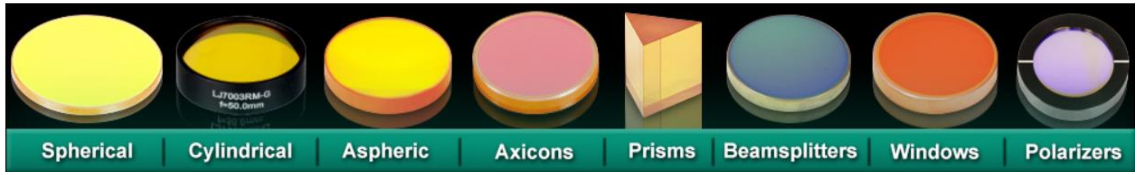
Many glass manufacturers offer the same material characteristics under different trade names and most have modified their products and processes to be ECO-friendly (free of lead and arsenic).

Zinc Selenide (ZnSe) / OPZS

- Commonly used in **optical systems that combine CO2 lasers, operating at 10.6 µm, with inexpensive HeNe alignment lasers**.
- Wide transmission band and low absorption in the red portion of the visible spectrum.
- Transparent from 600 nm - 16 µm and is **ideal for IR applications**.
- It is also commonly used in **thermal imaging systems**.
- Also transmits some visible light, unlike germanium and silicon, thereby allowing for **visual optical alignment**.
- **Quite soft and will scratch easily**.

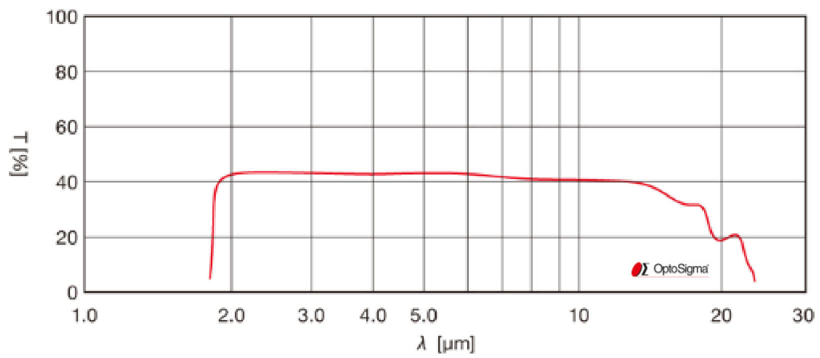


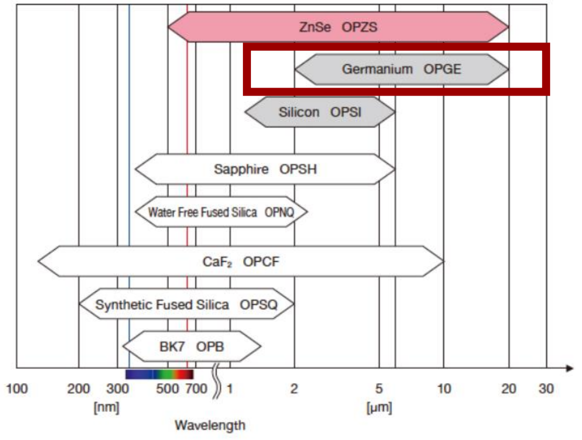




Germanium (Ge) / OPGE

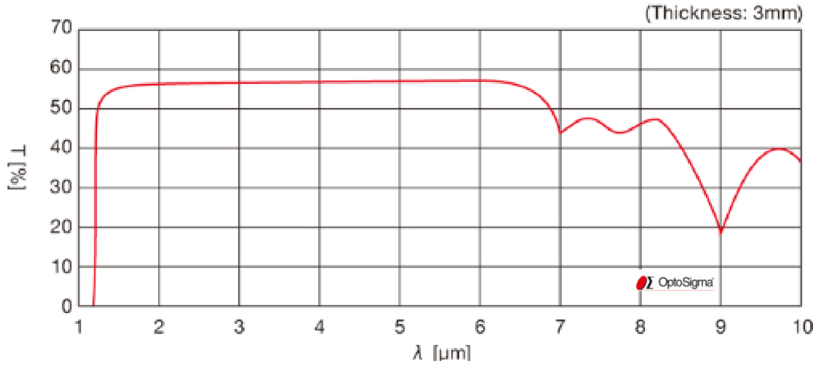
- Germanium (Ge) is well suited for **IR laser applications**.
- **Broad transmission** range (2.0 - 16 µm)
- **Opacity in the visible portion** of the spectrum,
- Ideal choice for **biomedical** and **military imaging** applications.
- In addition, Ge is inert to air, water, alkalis, and acids (except nitric acid).
- Germanium's **transmission properties are highly temperature sensitive**; in fact, the absorption becomes so large that germanium is **nearly opaque at 100 °C** and completely **non-transmissive at 200 °C**.

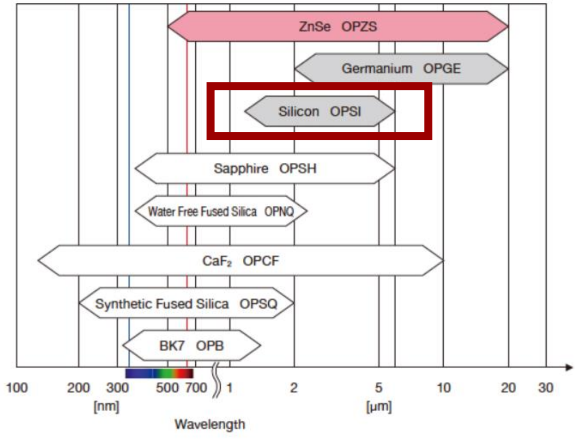




Silicon (Si) / OPSI

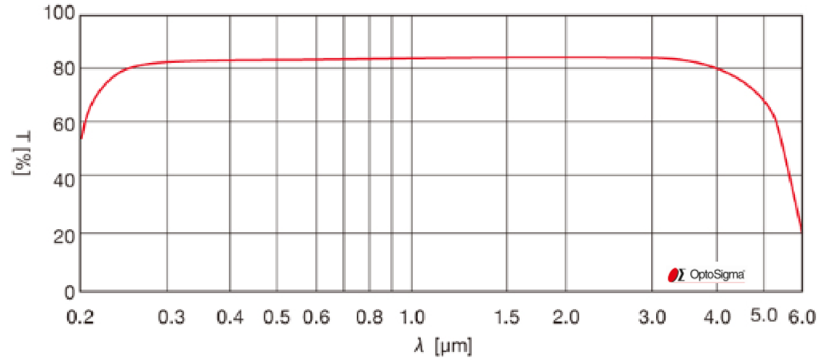
- Silicon (Si) lenses and windows are an ideal choice for applications using wavelengths in **the near-IR** range and parts of the **mid-IR** range.
- High thermal conductivity and low density, making it **suitable for laser mirrors**.
- Strong absorption band at 9 μm, it is **not suitable** for use **with CO_2 laser transmission applications**.
- Silicon optics are also particularly well suited for **imaging, biomedical, and military applications**.

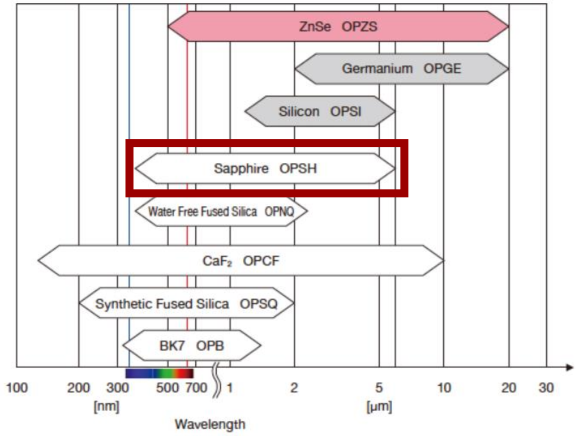




Sapphire / OPSH

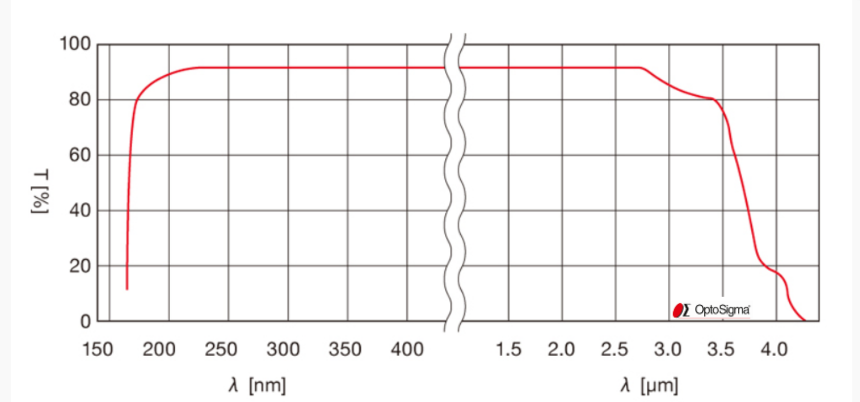
- Sapphire (Al2O3) has **exceptional surface hardness** and can only be scratched by a few materials other than itself.
- This hardness allows it to be made into **much thinner optics** than other substrates.
- Sapphire is chemically **inert and insoluble to water**, common acids, and alkalis for temperatures **up to 1,000 °C**.
- Sapphire is transparent in the **UV to the IR** (150 nm - 4.5 µm).
- It is commonly used in **IR laser systems** and has an ordinary refractive index of 1.754 and an extraordinary refractive index of 1.747 at 1.064 µm.

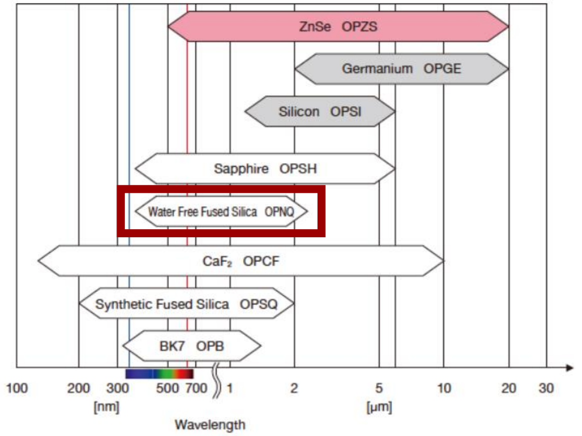




Water Free Fused Silica / OPNQ

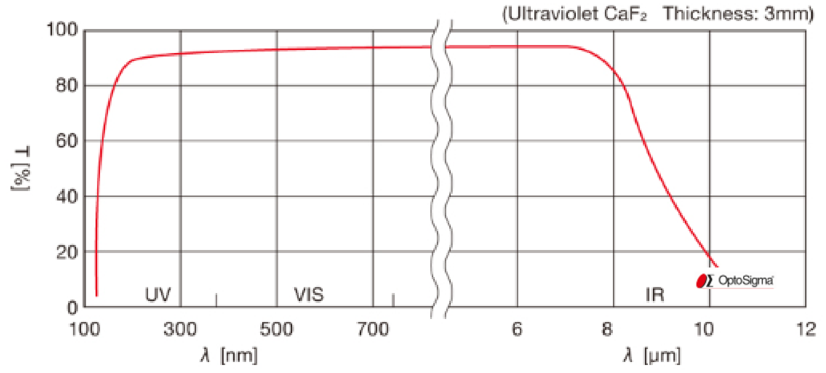
- A standard Fused silica window has hydroxyl absorption (OH radical group) at wavelength 1.4μm, 2.2μm, 2.7μm.
- Anhydrous synthetic quartz is a special material that **does not absorb water molecules** in the molecular glass; therefore there is no hydroxyl absorption at the IR region.
- The physical characteristics and optical properties of **none hydroxyl absorption at IR region** is the **only difference** from conventional synthetic quartz.
- The material is **physically robust** and provide higher stability and is recommend for use in vacuum and high pressure environments.

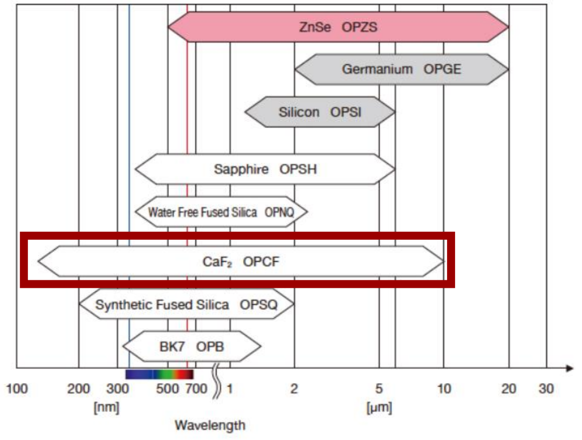




CaF2 / OPCF

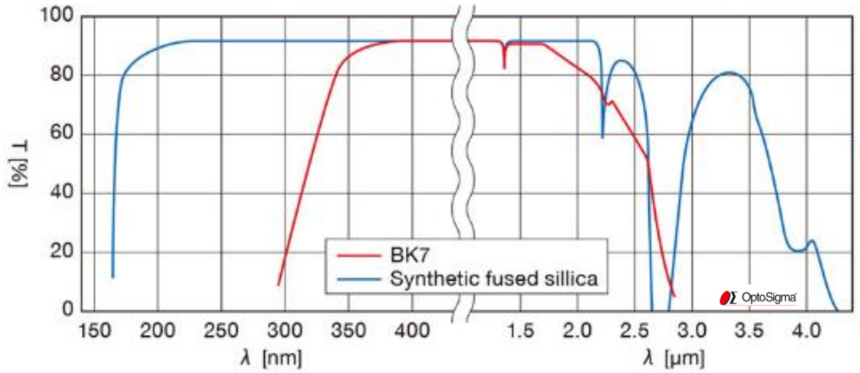
- Calcium Fluoride (CaF_2) is **transparent from the UV to the IR (180 nm - 8.0 µm).**
- It has a refractive index of 1.428 at 1.064 µm and is mechanically and environmentally stable.
- CaF_2 is ideal for any demanding applications where are beneficial :
- **high damage threshold**,
- **low fluorescence**,
- **and high homogeneity**.
- It is popular in **excimer laser applications** and frequently used **in spectroscopy and cooled thermal imaging**.

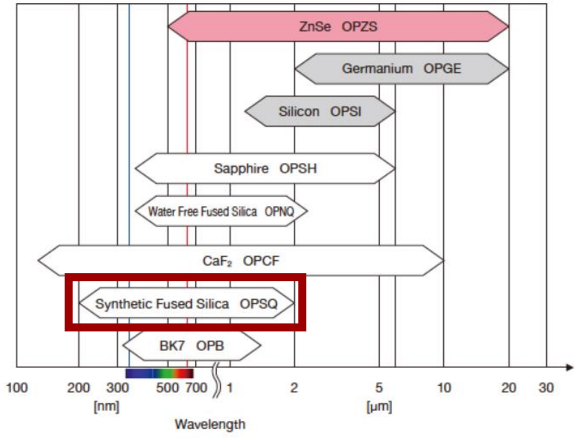




Synthetic Fused Silica / OPSQ

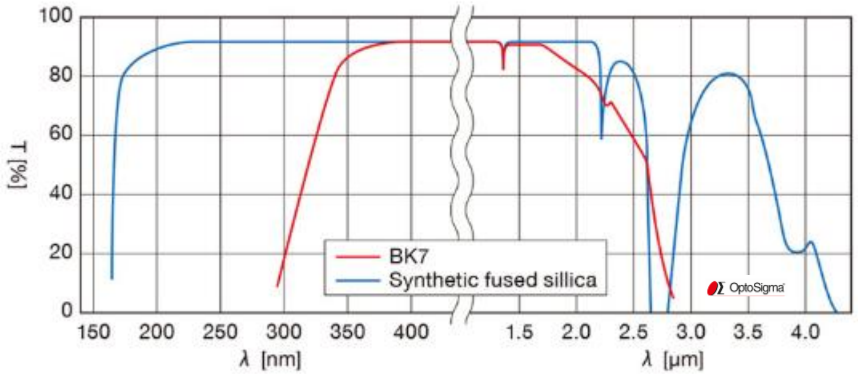
- Ideal for use in applications in the UV range that go beyond the transmission of N-BK7
- When compared to N-BK7, UV fused silica is transparent over a wider range of wavelengths (185 nm - 2.1 µm) and also offers a lower index of refraction as well as better homogeneity.
- It is **scratch resistant** and has a **low coefficient of thermal expansion**.
- UV fused silica exhibits **minimal fluorescence** when exposed to wavelengths longer than 290 nm.
- Its index of refraction is 1.458 at 587.6 nm.

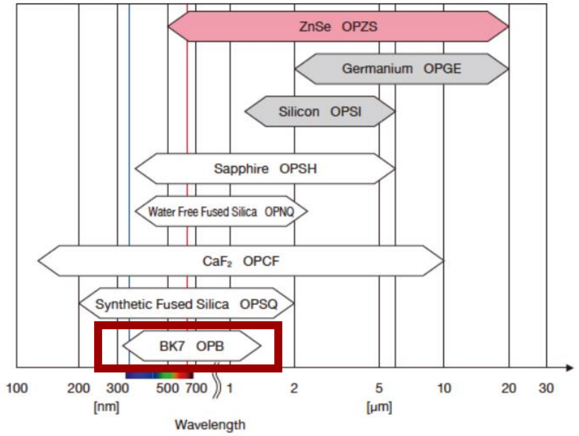


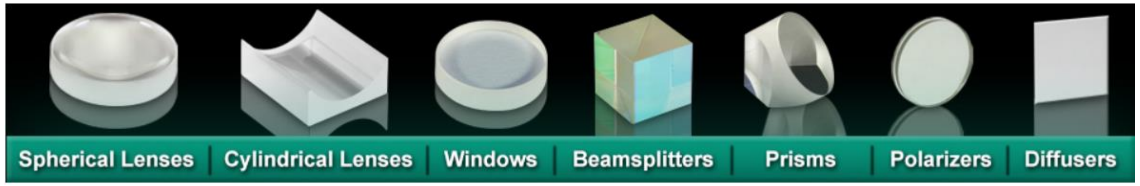


N-BK7 / OPB

- N-BK7 is a **RoHS-compliant borosilicate crown glass**.
- Excellent transmission in the visible and near IR portions of the spectrum (350 nm - 2.0 μm).
- N-BK7 is probably **the most common optical glass used in high-quality optical components**.
- Hard glass that can withstand a variety of physical and chemical stressors.
- It is **relatively scratch and chemical resistant**.
- It also has a low bubble and inclusion content, making it a **useful glass for precision lenses.**







Knoop hardness test & Hygroscopy

The **Knoop hardness test** /kəˈnuːp/ is a microhardness test – a test for mechanical hardness used particularly for very brittle materials or thin sheets, where only a small indentation may be made for testing purposes. A pyramidal diamond point is pressed into the polished surface of the test material with a known (often 100g) load, for a specified dwell time, and the resulting indentation is measured using a microscope.

Hygroscopy is the phenomenon of attracting and holding water molecules via either absorption or adsorption from the surrounding environment, which is usually at normal or room temperature. If water molecules become suspended among the substance's molecules, adsorbing substances can become physically changed, e.g., changing in volume, boiling point, viscosity or some other physical characteristic or property of the substance.

Abbe number

In optics and lens design, the **Abbe number**, also known as the **V-number** or **constringence** of a transparent material, is an approximate measure of the material's dispersion (change of refractive index versus wavelength), with high values of *V* indicating low dispersion. It is named after Ernst Abbe (1840–1905), the German physicist who defined it. The term V-number should not be confused with the normalized frequency in fibers.

The **index of refraction** refers to the ratio of the speed of light in a vacuum to the speed of light through a given material at a given wavelength, while **the Abbe number** of a material quantifies the amount of dispersion (variations in index) for a specific spectral range.