

## Sapphire properties

Synthetic Sapphire is SINGLE CRYSTAL. Synthetic Sapphire features high hardness, high strength, scratch resistance, high temperature resistance, purity, chemical durability and superior radiation stability. Due to its exceptional properties, Sapphire is the only material available to solve complex engineering design problems.

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## Sapphire Orientation

Single crystal Sapphire is a hexagonal structure crystalline material. The orientation of sapphire window may affect its performance of such as: mechanical, optical, thermal, and birefringence.

“Orientation” refers to the angle of sapphire crystal from its optical axis, also known as C-axis. Sapphire windows are available in C, R, A, and M plane and random orientations.

- The most common orientation is perpendicular to the face of sapphire window, referred to as “C-plane” sapphire window or “Zero-degree” sapphire window. The primary reason is that sapphire is naturally slightly Birefringent in all the other axis, while C-cut sapphire can eliminate the inherent birefringent properties of the crystal. C-cut sapphire is also the strongest and most mechanically symmetric orientation. C-plane sapphire window is ideal for optical applications.
- Random plane sapphire window is the least expensive and is generally specified for non-critical optical or mechanical applications. When cut in a ‘random’ orientation, it means that the internal structure of the crystal planes can be in any direction, and is birefringent.
- A plane sapphire window has a uniform dielectric constant and highly insulating characteristic, making it a perfect choice for semiconductor applications. A plane orientation also provides the hardest type of sapphire material. A plane sapphire window features more scratch resistant than c-plane sapphire window

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## Sapphire Windows Applications

- Due to its exceptional properties of high hardness, high strength, scratch resistance, high temperature resistance, chemical durability and excellent transmission bandwidths from UV to mid IR, Sapphire window is widely used for protecting cameras, detectors, and sensors.

- Extremely high melt temperature (2030°C), Sapphire provides the capability to withstand extremely high temperatures, which make Sapphire window is prefer choice for high heat applications such as viewing windows on furnaces and high-temperature equipment.
- Sapphire windows can withstand the extreme speed and transmit infrared light for observation. This makes sapphire window suitable for Electro-Optics Systems Windows of defense and Aerospace applications.
- Sapphire provides a wide bandwidth of transmission (0.2-5µm) and is much stronger than other optical materials. Sapphire is often designed for transparent domes and underwater windows. The high strength and high-pressure resistance of sapphire window provides an effective barrier to external sources of damage. Sapphire window is the ideal choice for high-pressure applications in underwater surveillance vehicles.
- Sapphire is second only to diamond in terms of strength, and provides high scratch resistance and durability. Sapphire window can be exposed to extreme environments such as sand and particulates with minimal impact on the performance or the clarity of the window. This makes sapphire windows widely used for premium devices such as scanner windows, aerospace windows, inspection windows, watch face and gun sights.
- Sapphire is very chemically stable. It is very corrosion resistant and is not damaged by most bases or acids such as hydrochloric acid, sulfuric acid, or nitric acid. Sapphire window is able to withstand long exposures to plasmas and excimer lamps.
- Sapphire window is designed for the protection of high-strength lamps as well as flash lights, due to its low thermal expansion rate and excellent Scratch resistant. Sapphire window can be taken to 1950C with no change to its shape and minimal reduction to mechanical performance.
- Sapphire window can withstand high-power laser radiation makes it an ideal material for laser optics. Its excellent optical quality ensures minimal loss and distortion in laser systems.
- Sapphire window is well-suited for many military applications. Due to its excellent resistance to impact and abrasions, Sapphire window is used as a protective layer of transparent shielding in place of conventional vehicle glass. The superior mechanical and optical properties of sapphire transparent armor help defend against the higher threat levels that combat vehicles endure, providing superior ballistic performance, enhanced night vision effectiveness and increased durability in challenging environments. Sapphire window performs well in sandy desert conditions and resists etching that typically occurs in the glass as a result of rocket launches. These properties

provide a significant improvement in visibility for the operators of the vehicle. Sapphire window delivers high level solution of safety, durability and visibility to meet the military demanding performance requirements.

- Combined with excellent properties of optical clarity, chemically inert, scratch resistance, and biocompatibility, sapphire window is ideally suited for a diverse range of medical applications, such as medical imaging, medical lasers, biochemical analysis, spectroscopy, dental instruments, and endoscopes. Sapphire window is also used in surgical robotics to enhance the precision, accuracy, safety, and efficiency.
- Sapphire window excels in harsh environments, withstanding immense pressure, low temperatures, and corrosive seawater. Its exceptional strength and clarity enable the remote and high-powered camera inspections for oil and gas industry.

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#### HYT Sapphire Optics Capability

HYT Sapphire Optics is leading manufacturer of sapphire windows. With more than 20s year diverse experience, Our state-of-the-art factory have the capability of developing precision customized sapphire windows manufactured to your project's specifications, including dimensions, orientations, surface accuracy and coating. Our achievable specifications for sapphire windows are: diameter up to 500 mm, length up to 700mm, thickness as thin as 80 microns, surface accuracy to  $1/10$  lambda ( $\lambda$  633 nm), surface quality to 10/5 scratch-dig, and parallelism less than 3 arc seconds, depending upon size and construction. These sapphire windows can also incorporate steps, tapers, beveled edges for sealing, and polished edges.