SAPPHIRE REFERENCE TABLE

Synthetic sapphire is a single crystal form of corundum, aka, pure single crystal aluminum oxide, A12O3. The combination of its unique properties make sapphire a preferred material for extreme mechanical, chemical & optical applications. Unlike glass, sapphire cannot be molded. Sapphire can be grown into near net shapes such as tubes and rod, then ground and polished if necessary.

INDUSTRIES SERVED	**APPLICATIONS**
Aerospace	Windows, ball bearings, sensors
Medical	Dental tool tips, endoscopy, camera lens cover
Oil & Gas	Sight window without housing, gauges, diffusion plates
Military	Windows, viewports, sensors, range finders
Research	Containment tubes, cuvettes, lenses
Semiconductor	Plasma tubes, lamps, lasers
COMMON GRADES	**DESCRIPTION & COMMON APPLICATIONS**
	There are numerous sapphire growth methods & grades. Generally, the higher the grade the better the transmission in the UV and IR, and the less light scatter and lattice distortion. The best grades, in particular, UV grade will not solarize.
Verneuil	Original & simplest growth method, lowest cost, excellent for mechanical applications & situations where optical clarity is not critical. Good for lower quality watch crystals & observation ports.
EFG (Stepanov)	Edge defined growth method (to be exact, Edge-Defined Film-Fed Growth) for near net growth of tubes & large sheets. Better quality than Verneuil, but not as pure & defect free as Kyropoulos or CZ. Excellent for most window applications including scanner windows & viewports and lower cost than Kyropoulos & HEM.
Kyropoulos & CZ	Excellent optical properties, ideal method for most optical applications except long exposure high UV & extreme power threshold requirements. Also preferred for high purity applications like semiconductor, LED fabrication & high purity chemistry.
HEM	The best quality sapphire, but difficult to acquire & considerably more costly compared to other grades. Quality compared to Kyropoulos usually not significant enough to justify cost for most applications. Best for extreme power & UV applications & for when zero fluorescence &/or high power threshold is required.
ORIENTATION	**DEFINITION & COMMON APPLICATIONS**
C-Axis	Also known as the "optical axis". The only orientation that has almost zero birefringence for signals parallel to the C-axis. Used for optimal optical, mechanical, thermal & electrical performance. In a rod or tube the typical C-axis orientation is along its length, in a window perpendicular to the face.
Random	Parts are manufactured with no tracking of the crystal orientation. Lower cost & great for applications where orientation will not impact performance.
Other	90 Degree (to C-axis), M-Plane, A-Plane, R-Plane
	Click for Orientation Definitions & Drawing
PROPERTIES	**IMPORTANT PROPERTIES OF SAPPHIRE**
	Thermal, physical/mechanical, optical, electrical & chemical
	Click for Sapphire Properties Data Sheet
TRANSMISSION & OTHER CURVES	**DEFINITION**
	The overall transmission of sapphire is determined by purity. All quality sapphire materials transmit about the same in the visible wavelengths while higher purity creates better transmission in the UV and IR. For all optical materials, including sapphire, the thinner the material the deeper it transmits into the UV and IR.
	Click for Sapphire Optical & Thermal Properties Graph
	Click for Transparent Materials Transmissions Curves Graph
SURFACE FINISH	**DESCRIPTION**
Polished	Clear. Has little to no distortion & light scattering (depending on level of polishing). Ideal for optical applications, high purity semiconductor, chemical & vacuum processing.
Fine Ground	Frosted. Ground surface roughness can be fine tuned for diffuser & low stiction applications. Tends to have micro-cracks that can trap water, gas & other impurities.
As Grown	Clear but not mechanically polished. Some optical distortion due to growth process but no micro cracks. Excellent for high vacuum systems such as plasma chambers & chemical processing where purity is critical but optical clarity is not.
	Click for Surface Finish Photos
SURFACE QUALITY	**DEFINITION & RATING**
	The scratch-dig rating of surface quality is a qualitative rating based on comparing the actual surface to a scratch-dig standard. Pass or fail is somewhat subjective without clear dimensions to measure.
80-50	Commercial quality such as car windshield and commercial windows
60-40	Good polish, good for commercial lenses and optics. Good for optics where light scatter is not a problem.
40-20	Superior polish, good for higher performance optics and lower powered lasers. Reduced light scatter over 60-40
20-10	High Precision polish, extreme optics & good laser power threshold for medium powered lasers. Very little light scatter
10-5	Highest surface quality, highest laser power threshold and lowest vulnerability to solarization. Exceptional optics with near-zero light scatter
	Click for Quality Scratch-Dig Definitions
WHY SAPPHIRE?	
	One of the hardest materials available
	Superior IR & UV transmission compared to other optical materials
	Highly scratch & abradant resistant
	Highly chemical resistant
	Maximum temperature rating of almost 2000C
	Excellent dielectric & loss tangent performance
WHY RAYOTEK?	
	Onsite engineers & master optician
	25+ years of expertise in sapphire & exotic materials manufacturing
	ISO 9001:2008 Certified
	ITAR Registered
	State-of-the-art manufacturing equipment & measurement capabilities
	Cost saving overseas sourcing (for non-ITAR applications only)
	US Manufacturing at Rayotek's 30,000 SqFt facility + partnerships in the U.S., China, Europe & Russia
SAPPHIRE SERVICES	
	Annealing, Bonding/Fusing, Coating, Fire Polishing, Grinding, Laser Engraving, Machining & Screen Printing