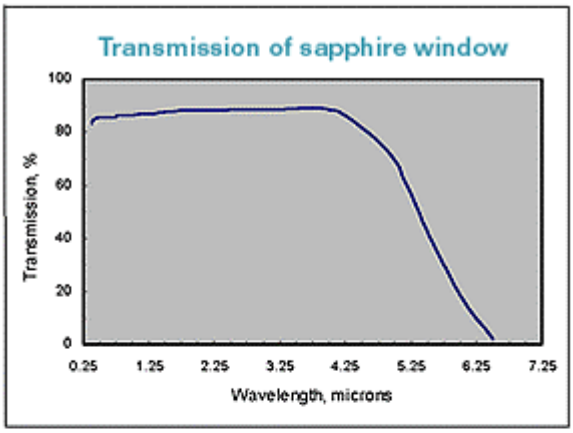
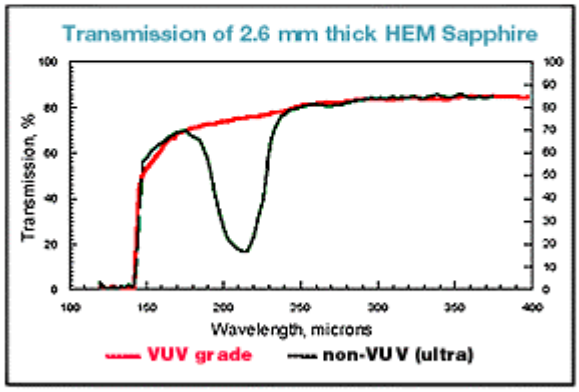
# Sapphire : Optical Properties

Sapphire is the leading material for highly sophisticated optical applications that require reliability, strength and a wide range of light transmittance. Sapphire transmits light over a broad wavelength range spanning from 0.15 to 5 microns. This unique ability to transmit over a broad range combined with its mechanical strength makes sapphire the material of choice for many space and military applications.




*Transmission spectra show performance of sapphire windows over a wide spectral range.*

*The top curve is infrared performance of an uncoated 3-mm-thick HEM sapphire window.*

*The bottom curve (solid line) is a 2.5-mm-thick VUV HEM sapphire window; it lacks the strong peak at 205 nm found in standard sapphire material (dotted line).*

The most important optical properties of large sapphire windows are the optical transmission and low transmitted wavefront distortion. The transmitted wavefront distortion is evaluated by measuring the homogeneity of the refractive index of sapphire. Data show that the homogeneity for all grades of HEM sapphire is in the 0.1PPM range. The fact that lattice distortion has little effect on transmitted wavefront allows fabrication of large sapphire windows (up to 14 inches) in production mode at low cost.

Sapphire exhibits the unique capability of having a broad transmission range and high optical transmission: from the vacuum ultra violet to the infrared spectrum. It is recognized as a highly important optical material because it combines high transmission with outstanding mechanical-strength properties at high and low temperatures. Moreover, sapphire has excellent abrasion resistance and low dn/dt and wavefront distortion. The availability of HEM sapphire in large sizes with low scatter has made it ideal for the most stringent optical applications, such as high power laser windows. The HEM VUV (vacuum ultra violet) grade of sapphire combines high purity with extremely low defect density; the resulting material transmits light at the 205 nm range where standard sapphire material absorbs the light. The VUV grade of sapphire is especially resistant to solarization and damage from radiation or high-power-density beams.

For imaging optics it is desirable for the refractive index of an optical material to have a low dependence on temperature. Because of its low dn/dt, a temperature gradient across a window will not cause image blur and foresight error. The United States National Bureau of Standards has extensively researched the index of refraction of sapphire. Recently a model was developed by Thomas, *et al.* at the Advanced Physics Laboratory to predict dn/dt from 0.7 to 5 microns.