

## Single crystal quartz cultured for optical use

### Optical quality objectives

The present optical quality objectives for an alpha quartz single crystal are:

- (a) Freedom from twins
- (b) Freedom from inclusions
- (c) Optical homogeneity
- (d) High transmittance over the widest possible transparency range.

Alpha quartz transparency limits are believed to be set by the vacuum ultraviolet cutoff at about 0.149 microns (attributed to the electronic band absorption) and by the strong absorptions (attributed to lattice vibrations) from about 4 microns to about 80 microns, beyond which quartz crystal again becomes transparent.

### Natural quartz

For many years all the quartz crystals used for optical purposes were of natural origin. Natural quartz is, of

course, an extremely variable material. Efforts have been made at the mines, (mainly in Brazil) and by the exporters and importers, to inspect the natural crystals in illuminated oilbaths for all visible imperfections (principally optical twins, inclusions and colour), and to classify the crystals – optical-grade being the highest.

Selected optical-grade natural quartz has found use in optical instruments such as spectrophotometers where its wide range of transparency endows the instrument with a correspondingly wide range of utility. The best natural crystals yield transmittance curves which are higher than 75% from about .210 to about 2, 7 microns. Fig. 1 shows three curves taken from differing natural quartz specimens. The impairments of transmittance at the extremes of the possible range, i.e., from .149 to .210 microns, and from 2.7 to about 4.0 microns, are generally attributed to residual amounts of various impurities in the material; that is, the highest transmittance material is believed to have highest overall purity.

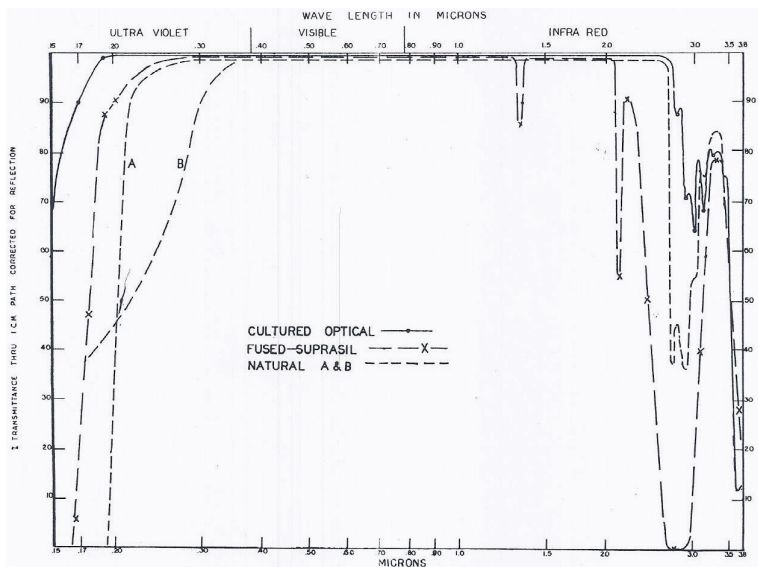


Figure 1 - Transmittance curves for cultured, fused, and natural quartz. Percent transmittance through 1 cm. paths corrected for reflection.

\*Cultured quartz is an outgrowth of a research and development program sponsored by the U. S. Army Signal Corps in the United States since 1946.

1 Transmittance for purposes of this discussion is the percent of light transmitted through a 1cm path of material with full corrections made for reflections. Actual % transmissions through samples will be lower by 5 to 10% due to reflection losses.