

# Investigation of the Optical Constants of Amorphous SiO<sub>2</sub> and Y-Cut Quartz from the Extreme to the Vacuum Ultraviolet Spectral Region

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## ABSTRACT

Fused silica (amorphous SiO<sub>2</sub>) and quartz crystal both feature ultra-low thermal expansion and exceptional transparency from the visible to the deep-ultraviolet. Quartz additionally offers strong piezoelectricity and pronounced birefringence, making both materials cornerstones of modern optics. Yet their optical properties in the extreme- and vacuum-ultraviolet (35–140 nm) remain largely unexplored because metrology in this spectral region is highly demanding; consequently, reliable optical constants of these two SiO<sub>2</sub> polymorphs are still scarce.

To fill this gap, we carried out the angle-resolved reflectometry of thermally grown amorphous SiO<sub>2</sub> and Y-cut  $\alpha$ -quartz from 36 nm to 140 nm at a synchrotron beamline. A transfer-matrix model, solved with Markov-chain Monte Carlo sampling, yielded  $n$  and  $k$  for the ordinary and extraordinary crystal axes together with their relative uncertainties. Two sharp resonances were resolved in quartz on each optic axis whereas amorphous SiO<sub>2</sub> displays only a single, broader resonance matching the feature on quartz's ordinary axis. The crystalline phase shows noticeably higher absorption at this wavelength, consistent with its greater oscillator strength. Although the materials are bulk-opaque below  $\approx 130$  nm, their complex refractive indices still govern reflection, scattering, and absorption in emerging EUV/VUV technologies.