Static and kinetic study of the structure of fused silica at high temperatures by infrared emission spectroscopy

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Abstract

Emissivity spectra of silica have been acquired in a wide range of temperature, i.e. from 4 K to more than 2500 K in static isothermal conditions, and from 2500 K to 500 K in kinetic free-cooling conditions. A fitting procedure allows extracting the temperature dependence of the dielectric function in the spectral range corresponding to lattice vibrations. Both sets of data are equivalent for a quantitative study of the structure of this model glass, despite the lower resolution and signal-to-noise ratio of the rapid-scan measurements. The results present clear changes around special temperatures, corresponding the $\alpha \rightarrow \beta$ transition temperature for crystalline quartz and the glass transition, with minor evolution at the effective melting temperature. Their signatures have been probed in a quantitative way through the analysis of the absorption bands related to the stretching motions of the silicate tetrahedra. The onsets of the new trends start at canonical values of the occupation ratios of the bands. This study serves to prove that rapid-scan infrared emission spectroscopy is a viable analytical technique for the study of materials in non-equilibrium conditions.

Keywords: fused silica, glass transition, infrared spectroscopy, infrared emissivity, dielectric function

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