

Experimental report

15/09/2024

Proposal: 6-05-1055

Council: 10/2022

Title: Fictive effects on the structure and optical properties of densified silica glass

Research area: Materials

This proposal is a new proposal

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Samples: SiO₂

Instrument	Requested days	Allocated days	From	To
D4	3	2	16/06/2023	18/06/2023

Abstract:

The optical transport properties of silica glass can be significantly improved by compressing the melt in a hot isostatic pressure (HIP) machine at high pressures and temperature. This improvement is directly related to the intrinsic properties of the network glass structure, as indicated by positron annihilation lifetime spectroscopy. We propose neutron diffraction experiments on five different silica glasses to explore the effect of (i) the fictive temperature T_f and (ii) the fictive pressure p_f on the network structure. The results will be combined with those from high-energy x-ray diffraction to construct realistic atomistic models by the molecular dynamics ζ reverse Monte Carlo method. The network structures will be thoroughly characterised using methods that include persistence homology and cavity volume analysis. The glass structures will be used to help interpret the results obtained from positron annihilation lifetime spectroscopy, and they will be related to the optical properties of the materials as characterised by Rayleigh scattering and refractive index experiments.

Fictive effects on the structure and optical properties of densified silica glass

The structure of five densified silica glasses was investigated by neutron diffraction. Figure 1 shows the measured total structure factors $F(q)$ in the region of the first-sharp diffraction peak and principal peak. Systematic changes to these structure factors are observed. The results are being combined with those from high-energy x-ray diffraction and other experimental methods to build realistic models of the associated glass networks.

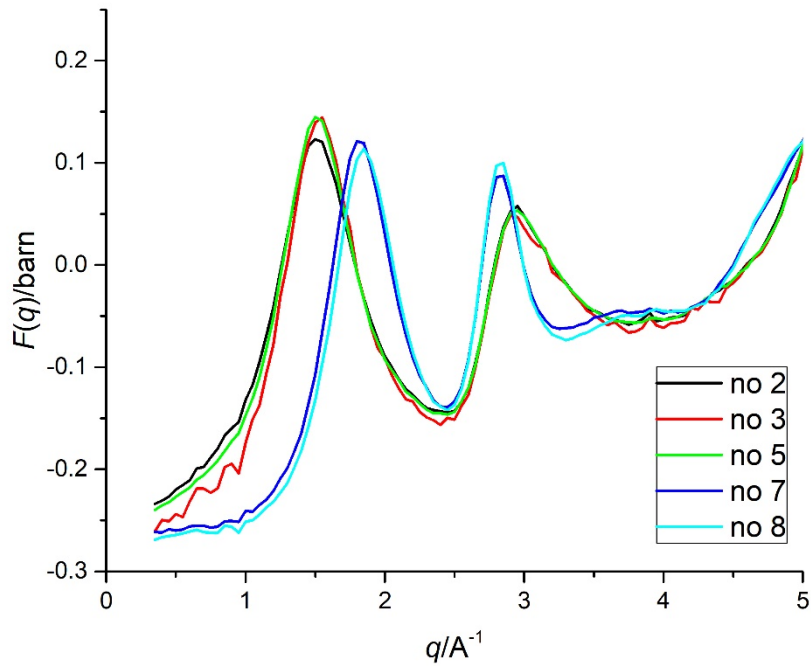


Fig. 1. The total structure factors $F(q)$ measured for silica glasses with different fictive temperatures and pressures. Sample 2: $T_f = 1364^\circ\text{C}$; Sample 3: 2073 K/0.75 GPa; Sample 5: 2073 K/0.2 GPa; Sample 7: $1300^\circ\text{C}/7.7$ GPa; Sample 8: $1100^\circ\text{C}/9.4$ GPa.