ESRF	**Experiment title:** Investigation of acoustic localization in fused silica	**Experiment number:** HC-393
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Report:

The velocity c and linewidth Γ of acoustic phonons of fused silica ($v\text{-}SiO_2$) are known up to ~ 400 GHz. One has c ≅ constant and $\Gamma \propto \omega^2$ (Fig. 1). On the basis of thermal conductivity one expects a crossover jnto a phonon-Rayleigh-scattering regime, $\Gamma \propto \omega^4$ that terminates into $\Gamma \cong \omega$ at the Ioffe-Regel crossover, $\omega_{IR} \cong 1$ THz. Above ω_{IR} the excitations are believed to be non-propagative. The purpose of our investigation has been to study acoustic excitations in the Ioffe-Regel crossover region. The main outcome of our analysis is the position of ω_{IR} shown by the star in Fig. 1.

Fig. 2 shows Brillouin neutron scattering and X-ray results. The neutron results were obtained on IN5 at the ILL (see ILL experimental report). What one sees in Fig. 2a is a scattering-vector-dependent boson peak. It has been fitted with a spectral function which is suited to represent the phonon to Ioffe-Regel crossover and which was tested in details in Brillouin

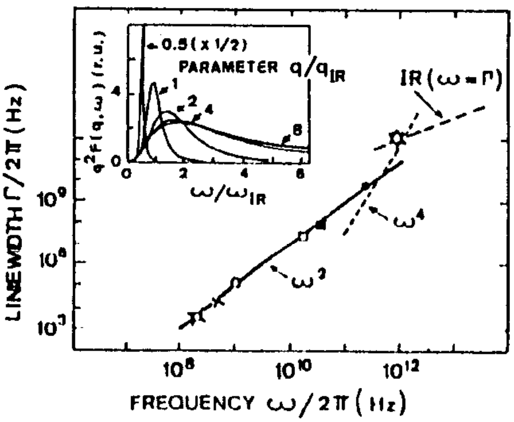

Figure 1. Linewidths vs. frequencies in $v\text{-}SiO_2$. The inset illustrates the lineshapes used in fitting in Fig. 2.

scattering from aerogels.[1] Fits depend only on ω_{IR}, on the intensities, and on a parameter describing the sharpness of the crossover for which a good value is $m = 2$. The spectral intensity is found to be approximately constant, which supports this approach. The ω_{IR}-value is that shown in Fig. 1, with a corresponding wave vector $q_{IR} \cong 1$ nm^{-1}.

The X-ray results were obtained in 11 shifts on BL21-ID16, in the unfocused configuration, at 17.8 KeV, with a resolution of 3.2 meV. What is shown in Fig. 2b is the difference between the signal at 300 K, and the properly scaled elastic signal measured at 20 K on the same sample. The background is also subtracted. One recognizes a weak but definite inelastic contribution. The solid lines represent the theoretical spectral function convoluted with the instrument response. It is calculated with the parameters found in the neutron experiment, and only the intensities have been adjusted. The overall χ^2 is ~ 0.5. The spectral intensities are approximately constant within the accuracy. There is only one fairly broad peak, that broadens with increasing q, and there are no propagating phonons following a linear dispersion which at $q = 4$ nm^{-1} would correspond to $\hbar\omega = 15$ meV. We conclude that $\hbar\omega_{IR} \cong 4$ meV and $q_{IR} \cong 1$ nm^{-1}. For q above q_{IR}, we expect that the excitations are non-propagative. More details are found in [2].

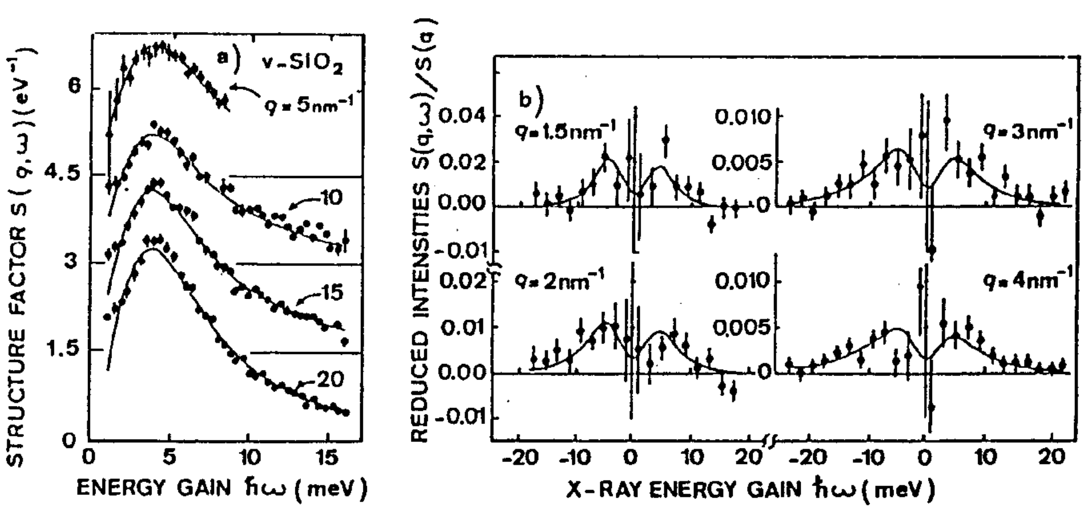

Figure 2. (a) Constant-q sections through the neutron inelastic structure factor on the energy gain side; (b) Inelastic X-ray scattering spectra.

References

[1] see, *e.g.*, E. Courtens and R. Vacher, in Nato ASI Proceedings, "Amorphous Insulators and Semiconductors", M. Thorpe and M. Mitkova, eds., Kluwer, Dordrecht, to be published in 1997.

[2] M. Foret, E. Courtens, R. Vacher, and J.-B. Suck, "Scattering investigation of acoustic localization in strong glasses", preprint, May 1996.