VIII. PHYSICAL ACOUSTICS*

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A. ULTRASONIC ATTENUATION IN FUSED SILICA

Measurements of the ultrasonic attenuation in fused silica, for both transverse and longitudinal waves, were carried out over a frequency range of 200-1000 MHz using optical probing.[1,2] The reflection losses at the free surface and bonded-transducer surface of the sample were also evaluated. Although the losses in the former case were negligible, in the latter case we observed a resonance reflection loss in the peak acoustic intensity of as much as 3 dB, even with very inefficient transducers.

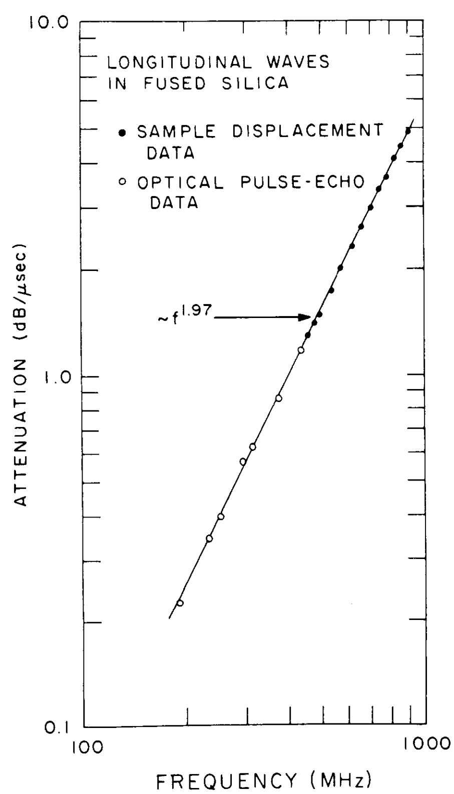

Fig. VIII-1.
Ultrasonic attenuation as a function of frequency for longitudinal waves in fused silica at 25.0°C.

For the lower portion of our frequency range of measurement, for which the ultrasonic attenuation in a single pass of the sample is not substantial, a modified pulse-echo technique was used. The light-sound interaction region was positioned midway between the two ends of the sample. Only the attenuation values between the adjacent pairs of echoes that included a free-surface reflection were used; this enabled us to eliminate the relatively large losses at the transducer-medium interface. At the higher frequencies, the attenuation was measured by displacing the light-sound interaction

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region an accurately measured distance along the acoustic-wave propagation direction, thereby obtaining the spatial decay of acoustic intensity.

The composite results for longitudinal waves, with both measurement techniques used, are shown in Fig. VIII-1. The estimated over-all accuracy is ±0.05 dB/μsec. Figure VIII-2 shows the same results for transverse waves. In both cases, the frequency dependence of the attenuation is very nearly a square law. This is consistent

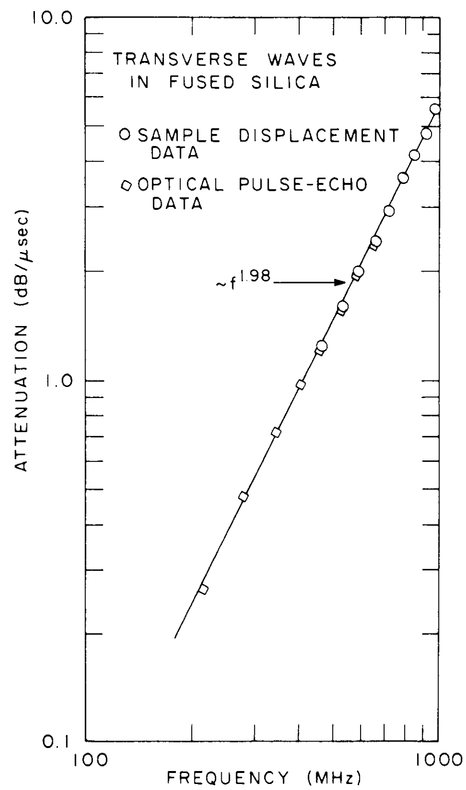

Fig. VIII-2. Ultrasonic attenuation as a function of frequency for transverse waves in fused silica at 25.0°C.

with the hypothesis of a thermally activated relaxation process,[3] with a room-temperature relaxation frequency much greater than our measurement frequencies.

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References

1. M. G. Cohen and E. I. Gordon, Bell System Tech. J. 44, 693 (1965).
2. C. Krischer, Appl. Phys. Letters 13, 310 (1968).
3. O. L. Anderson and H. E. Bommel, J. Am. Ceram. Soc. 38, 125 (1955).