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Ultrasonic investigations of silicate glasses between room temperature and the glass transition range

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Abstract

Elastic moduli and internal friction are important indications which characterise the mechanical properties of solids and their relaxation behaviour. They can be determined in homogeneous isotropic glasses and melts by ultrasonic wave propagation and attenuation. In this paper longitudinal and transversal ultrasonic wave velocities and the attenuation coefficient of silicate glasses are measured as a function of temperature between room temperature and approx. 70 K above Tg by means of the impulse echo overlap method. The compositions of the investigated glasses are 16 R_2O × 10 CaO × 74 SiO_2 (with R = Na, K, Cs), 26 Na_2O × 74 SiO_2 (in mole-%) and the DGG standard glass I. The decrease of the elastic moduli with increasing temperature up to T_g is generally relatively small. Above T_g this decrease is much stronger. Attenuation maxima of the ultrasonic waves below and around T_g correspond to two relaxation processes. These agree with the alterations of the slopes of the moduli-temperature curves. The activation energies of the two relaxation processes are calculated from the present results in connection with low-frequency data of the damping of mechanical oscillations from literature.