Phase Diagram of Supercooled Selenium

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The speed of longitudinal sound waves at 7 and 22 MHz has been measured in liquid, supercooled, and amorphous selenium, including the region around the glass transition temperature, T_g (near 35 °C). In amorphous selenium the speed of shear waves at 7 MHz was also measured. The experiments were performed with high purity Se hermetically sealed in an evacuated quartz ampoule. Four temperature regions with strongly different relaxation times can be distinguished between room temperature and the melting point: (1) a stable (on the time scale of the experiments) glassy state below T_g, (2) a metastable glassy state above T_g, (3) a region of homogeneous crystal nucleation (“No man's land"), and (4) a region of regular supercooled liquid. Each region is marked by a change in the slope of the temperature dependence of the sound velocity. Near the glass transition temperature the velocities of longitudinal and transverse sound exhibit hysteresis with a step-like drop on heating and a more continuous rise on cooling. Possible molecular motions underlying the observed features will be discussed.