INFLUENCE OF HIGH PRESSURE ON THE SPECIFIC HEAT OF AMORPHOUS POLYMERS

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It has been known for many years that the low temperature properties of amorphous solids below 1 K are dominated by the presence of tunneling states. This typical behavior can be described by the tunneling model [1]. However, above a few Kelvin the universal properties of glasses (plateau in the thermal conductivity; so-called boson peak) deviate from the predictions of the tunneling model. A successful description of these properties is given by the soft potential model [2,3] which is based on the idea that besides two level systems (TLS) there also exist quasiharmonic soft localized modes (SLM).
With our pressure-dependent measurements of the specific heat of glasses we wanted to study the influence of pressure on both kinds of low-energy excitations - TLS and SLM. Therefore, we investigated the specific heat c_p of Polycarbonate PC and Polystyrene PS at pressures up to p= 0.7 GPa in the temperature range 0.2 K < T < 80 K. The specific heat shows a visible influence of the pressure, specifically in the temperature range at and below the typical maximum of c_p / T^3 . With increased pressure, the temperature T_{max} of the c_p- maximum of PS and the temperature T_{min} of the c_p- minimum of PC are slightly shifted to higher values. This is an indication that the energy spectrum of the low-energy vibrations shifts to higher energies with increased pressure.
The influence of pressure on the TLS- and SLM-contributions to the specific heat is different. Above 1 K, the contribution of the SLM to c_p decreases with increasing pressure more than the Debye contribution to c_p. This behavior changes below 1 K, where the TLS is dominant. In this temperature range the contributions of TLS and of phonons decrease in the same ratio with increasing pressure.
The results are discussed in the framework of the tunneling model, the soft potential model and the experimentally observed narrowing of spectral holes in PS under hydrostatic pressure [4].

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