Grüneisen parameter of D-doped $Nb_{37}Ti_{63}$ at temperatures below 10 K

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Glasslike anomalies of low-temperature thermal properties were observed for the polycrystalline alloys $Nb_{37}Ti_{63}$ and $Nb_{37}Ti_{63}$ doped with deuterium. A giant heat release effect was found in $(Nb\text{-}Ti)_{92}D_8$ corresponding to a distribution parameter of $7.5 \cdot 10^{45}\,J^{-1}m^{-3}$ and a freezing temperature of 52 K. After rapid cooling of the sample a length relaxation, obeying a quadratic dependence on the starting temperature and a logarithmic time dependence [1], was measured. The results fit to the standard tunneling model assuming a temperature and time independent Grüneisen parameter $\tilde{A} = -2.5$. A constant Grüneisen parameter is compatible with a constant deformation potential $\gamma = \partial\Delta / 2\partial e$, but requires the derivative of the tunneling parameter λ with respect to a relative volume change *e,* to depend on the energy splitting *E* and tunneling splitting Δ_0 as $\partial\lambda / \partial e = \tilde{A}E^2 / \Delta_0^2$. For undoped $Nb_{37}Ti_{63}$ we could not detect a length relaxation and calculate a long-time Grüneisen parameter since it was below the sensitivity of our measurement.

We also measured the specific heat *c* and the thermal expansion α down to T = 0.3 K and determined for the tunneling systems of the deuterium doped sample a constant Grüneisen parameter $\tilde{A} = 3\alpha / \kappa_T c = -57$. This Grüneisen parameter differs considerably from the value derived from heat release and length relaxation, indicating that the assumption of a constant distribution function for the tunneling states does not hold for this material. From specific heat measurements we determined a distribution parameter of $4.3 \cdot 10^{45}\,J^{-1}m^{-3}$ for $Nb_{37}Ti_{63}$. The results indicate the generation of a different kind of TLS by the addition of deuterium, that are characterized by a different value of γ . For both systems the thermal expansion coefficient exhibits a negative linear temperature term in the superconducting state dominating below 1 K.

In order to decide weather a length relaxation also exists for other glasses like vitreous silica and polymers, the sensitivity of our dilatometer has to be increased.

[1] U. Escher, S. Abens, A. Gladun, C. Köckert, S. Sahling, M. Schneider, *Physica B* 284-288 (2000) 1159