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MOLECULAR MOTIONS IN THE PLASTIC CRYSTAL: SUCCINONITRILE

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ing temperature. This means that the average shear-phonon lifetime is increasing towards the melting temperature. This unusual behavior which is reminiscent of other plastic crystals (such as pivalic acid⁴⁴) still remains to be explained.

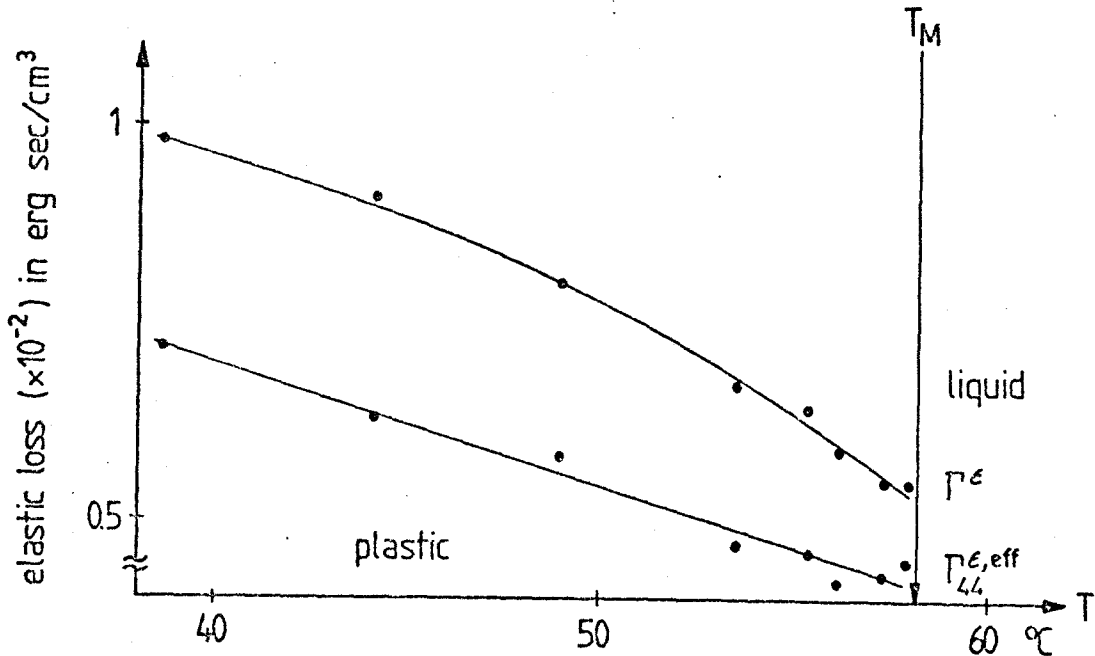


Fig. 23 The elastic loss of the shear phonon close to the melting temperature, for $\Gamma^\epsilon = 2\rho\gamma_p/q^2$ and $\Gamma_{44}^{\epsilon, \text{eff}} = \Gamma^\epsilon - (\Gamma_{44}^{\alpha\epsilon})^2/\Gamma_{44}^\alpha$ the "dressed" elastic loss.

V. SUMMARY AND CONCLUSIONS

The measurements of the AC-Kerr susceptibility and of the orientational anisotropy indicate that these two quantities show a remarkable pretransitional behavior on the approach of the plastic-solid and plastic-liquid transition points. It was shown that the measured non-linear susceptibility tensor can be understood as a tensorial polarizability correlation function.

A qualitative interpretation of this correlation function leads to the following results. Throughout the plastic phase the AC-Kerr susceptibility is a measure of the short-range orientational molecular ordering. As the temperature is lowered towards the plastic-solid phase transition molecular segments become correlated over longer distances. The considerable decrease of the orientational anisotropy near the melting point found by the AC-Kerr effect and confirmed by light-scattering experiments suggests that as the temperature is raised the orientational correlation of the molecules become more and more isotropic until melting occurs. However, this observed pre-transitional effect should not be interpreted as causing the melting. It should be noted that melting of succinonitrile is a clear first-order transition as indicated by refractive-index measurements across the melting transition²⁴. The loss in the anisotropy of orientational correlation is not reflected by the curvature of the refractive index below the melting point.

By means of light-scattering experiments information about the dynamics of the molecular reorientation was obtained. Two reorientational relaxation times have been determined. These times correspond to an isomeric and a quarter-turn relaxation of the "trans"-molecules. Combinations of these two relaxation processes permit a description of any hindered rotational motion of the molecules within their thirty-six equilibrium positions.

The shear-phonon contribution to the depolarized light-scattering spec-

trum is strongly dependent on the crystal orientation and shows a typical resonance line-shape for certain crystal directions. The spectra were explained by a coupling between shear-phonons and molecular reorientations. A hydrodynamic description of this coupling served to calculate the depolarized light-scattering spectrum in terms of phenomenological coupling constants. The latter have been determined by fits to the experimental light-scattering data. The static coupling turns out to be practically constant throughout the temperature range of the experiment, whereas the dissipative part of the coupling decreases towards the melting temperature.

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