Self-organizing disorder and low-temperature thermal conductivity of molecular crystals

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The goal of this study was to investigate experimentally the thermal conductivity of simple molecular systems, orientational glasses in the temperature region 2-150 K. The objects were molecular orientational glasses: ethanol (C_2H_5OH), freon 112 ($C_2F_2Cl_4$), freon 113 ($C_2Cl_3F_3$), cyanocyclohexane ($C_6H_{11}CN$), cyclohexanol ($C_6H_{11}OH$) and cyclohexene (C_6H_{10}). The data are analyzed in terms of the presence of several phonon scattering channels contributing to a resistive relaxation rate which apart from anharmonic Umklapp processes requires the implicit account of glassy dynamical features which are here handled in terms of the soft potential model. The analysis of the experimental results on the thermal conductivity of two types of glass - like molecular crystals (orientational glasses) shows that the temperature dependence of the thermal conductivity $\kappa(T)$ in these substances is similar to that of amorphous solids. The thermal conductivity can be described as a sum of two contributions $\kappa(T) = \kappa_I(T) + \kappa_{II}(T)$, where $\kappa_I(T)$ accounts for the heat transfer by long-living acoustic excitations, and $\kappa_{II}(T)$ stands for the heat transfer by delocalized vibrational excitations (diffusons). It is shown that the contribution $\kappa_I(T)$ can be described well by the universal curve in the soft potential model.

Section: OT - Other topics and model systems

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