Boundary and Phonon-Dislocation Scattering in Thermal Conductivity of HCP ^{4}He Crystals

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Investigations of thermal conductivity of perfect hcp ^{4}He crystals grown at different pressures from 25.5 to 185 atm (and different Debye temperatures Θ, accordingly) in long tubes with inner diameters D = 1-3 mm and subsequent computer simulations[1] of the proper phonon mean free path L_M had demonstrated possibility of observation of the well pronounced Knudsen minimum on L_M (T) curves (with relative depth $\Delta L/L \sim 0.15$) placed at reduced temperatures $T/\Theta \leq 0.02$ in the region of transition from Poiseuille to Knudsen flow of phonon gas in crystal under the condition $L_R \gg L_N$, $L_R \gg D$, where L_R is the phonon path due to any resistive scattering in bulk, L_N – due to normal phonon-phonon scattering, and D is the sample diameter. From further studies of thermal conductivity of weakly bent crystals and processes of recovery of the bent samples[2] it followed that scattering of phonons on freshly introduced dislocations was up to 10^3 times higher than that predicted by the theory. It could be attributed either to the flutter effect or to scattering of phonons on high mobile kinks propagating along the dislocations as it was proposed recently[3] for the inelastic electron-dislocation scattering in bent metal crystals.

[1]L.P. Mezhov-Deglin, Fizika Tverdogo Tela (Solid State Physics), **22**, 1748 (1980).
[2]A . A . Levchenko, and L.P. Mezhov-Deglin, JETP **86**, 2128, (1984).
[3]L.P. Mezhov-Deglin, S.I. Mukhin, submitted to LTP.