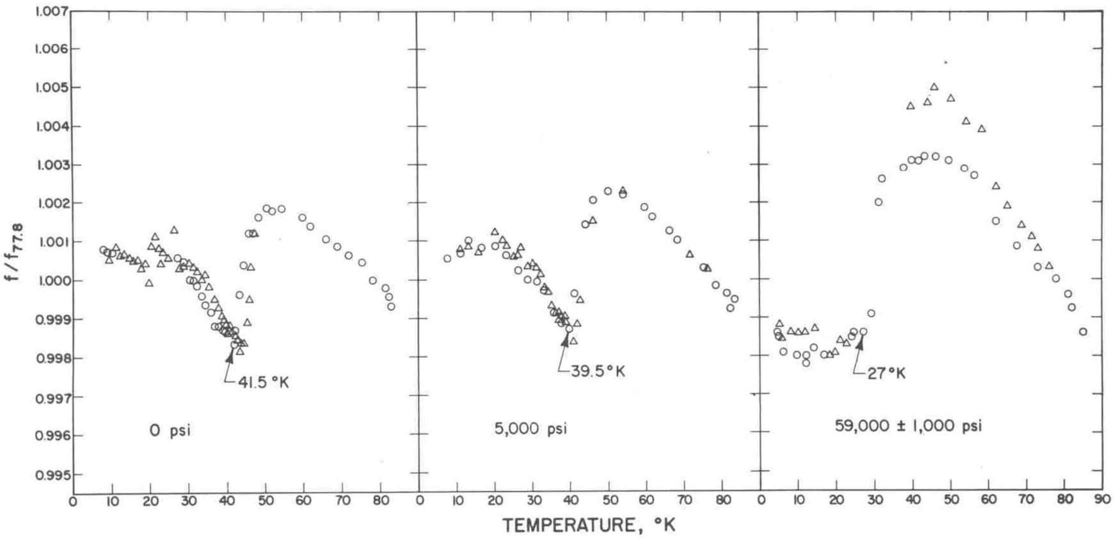

FIG. 3. Pressure effect on T_α as determined from basic C_{33} vs. temperature data. ($C_{33} = \rho V^2_{[001]}$)

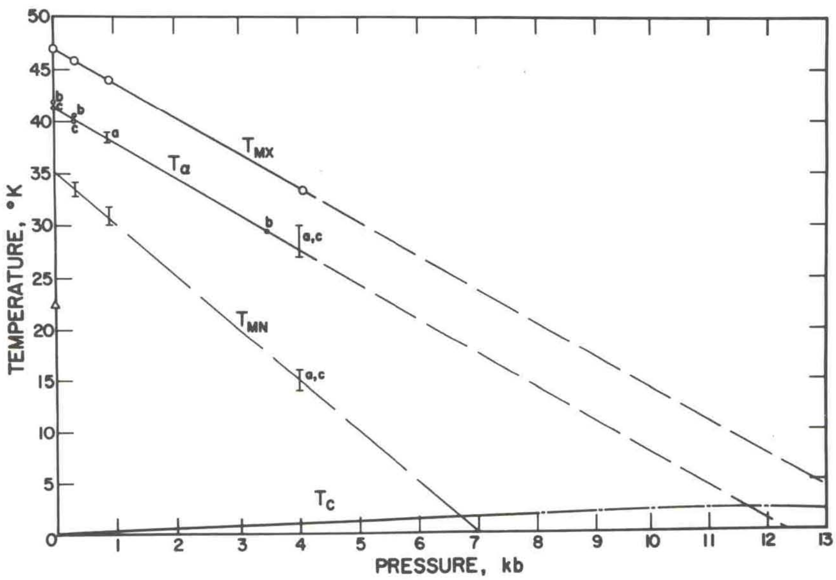

FIG. 4. Variations with hydrostatic pressure of T_α and the temperatures delineating the high acoustic attenuation for C_{11} mode in uranium. The T_c vs. pressure curve obtained from Reference 9 to 8 kbar and reference 7 at $p > 8$ kbar.

integral number of specimen waves, V = wave velocity, t = crystal thickness and the subscripted terms represent the basis data at 77.8°K. T_α is defined as the temperature at which there occurs an abrupt change in slope of the $f/f_{77.8}$ vs. T curves. For the [100] data, Fig. 1, T_α cannot be directly observed because of the very large acoustic attenuation that is associated with the softness of this mode near the phase transition. The decrease with pressure in T_α and the temperature of high attentuation is, however, clearly indicated, as is the reduction of the hysteresis effects[2] at $T < T_\alpha$. The data for the [010] direction, Fig. 2, clearly show T_α at two different hydrostatic pressures as well as at 1 bar or 0 psi. The [001] data, Fig. 3, show that unambiguous shift in T_α between 1 bar and 0.35 kbar (5,000 psi). At 4.07 kbar, however, there is a clear change in the character of the data for [001] so that T_α is less well defined.

The data for dT_α/dP are summarized in Fig. 4, where the indicated T_α marked a, b and c refer to [100], [010] and [001], respectively. The points (a) were obtained by interpolation of the [100] data. The decrease in T_α with increasing pressure is very near linear, with $dT_\alpha/dP = -3.4°K/kbar$. The lines marked T_{MX} and T_{MN} delineate the temperature range at a given pressure over which the longitudinal [100] mode signal is lost to attenuation and the pressure range at a given T that this mode velocity decreases with increasing pressure. Finally, the reported superconducting T_c vs. pressure data are reproduced from reference 9 and 7. We arrive at the conclusion that the maximum T_c occurs at or near the pressure at which $T_c = T_\alpha$. This is a rather different conclusion than is reached from a direct volume to valence relation. It is consistent, however, with the concept that $T_{c,\max}$ occurs when the electronic effects produced by cooling from T_α are completely reversed by ~ 10 kbar pressure or, similarly, ~ 10 kbar pressure is sufficient to retain the bulk superconducting α phase during cooling. It is not, however, necessarily inconsistent with an electron–phonon coupling model. The indications are that $T_{c,\max}$ occurs where $\omega_{[100]}$, the frequency for [100] longitudinal phonons, reaches a minimum value under hydrostatic pressure. In subsequent experiments we will attempt to measure the pressure dependence of the transverse mode velocities at 4°K and thereby estimate the changes in the whole phonon spectrum with pressure at superconducting temperatures.

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