pressure has been explained[12] in terms of the fine structure of the d band in the Labbé-Friedel linear-chain model.[13] On the basis of this model, Schuster[14] calculated the pressure effect on C_s by taking into account the intrachain charge transfer through the overlap integral and the change of density of states $N(0)$ through the shift in Fermi energy under pressure. By choosing an unrealistically large $q_0 a$ (Slater coefficient times the interatomic distance) of 4.2, $\partial C_s/\partial P$ was made negative below ~100°K. Lattice stiffening under pressure at low temperature can be achieved from the above formulism with $q_0 a < 2.4$ which is a reasonable choice. However, the pressure-promoted lattice softening between 100 and 50°K[10] can still not be accounted for.

The simplicity of the Labbé-Friedel model in describing the anomalous properties of $A15$ lies partially in neglecting the interchain coupling and the interband charge transfer. The close distance between the Fermi level and the density-of-states peak makes the interchain coupling and interband charge transfer important under pressure because of the broadening of the narrow d band. Recently, using the Labbé-Friedel model, Ting and Ganguly[15] have calculated $\partial C_s/\partial P$ as a function of T by taking into consideration the charge transfer between the s and the d bands and obtained excellent agreement with our results on $\partial T_L/\partial P$ and those of Carcia and Barsch[10] on $(\partial C_s/\partial P)_T$.

Making use of the strong-coupling theory for superconductivity, where the electron spectrum plays only a minor role, Testardi[1,4,6] has tried to explain the pressure-enhanced T_c of cubic V_3Si in terms of a pressure-promoted soft phonon mode. The recent results of Larsen and Ruoff[11] showed a large negative value for $\partial C_s/\partial P$ of cubic V_3Si at low temperatures, demonstrating an increased mode softening under pressure. For a transforming V_3Si, however, no predictions on the pressure dependence of T_c or T_L based on sound-velocity measurements could be made because of complications arising from the domain structure in the transformed state. The conjecture has been made,[6] however, that a maximum in T_c would occur with the state of maximum lattice softness, i.e., when $T_L \to T_c$. This leads to the suggestion of opposite pressure effects on T_c and T_L for $T_L > T_c$. Figure 2 provides some support for it.

A more complete test would require measurements at higher pressure to see if T_c reaches a maximum when $T_L = T_c$ and then falls for a further reduction in T_L. Close examination of Smith's $T_c(P)$ results,[5] which were extended to 24 kbar, reveals a tendency of T_c to saturate above 22 kbar. However, further experiments are required to determine if this is indeed the suggested behavior or just the reflection of the difference in the pressure behavior between the cubic and the tetragonal phases.

It should also be noted that for cubic V_3Si, Larsen and Ruoff[11] have concluded from measurements of $\partial C_s/\partial P$ (< 0) that hydrostatic pressure would induce the structural transformation (i.e., $dT_L/dP > 0$ for the nontransforming V_3Si). Measurements at sufficiently high pressure (~25 kbar) to test this prediction have yet to be made.[16] Similar relations among T_c, T_L, and P were also observed in V-Ru $B2$ compounds[17] and $(Zr_x\text{-}Ta_{1-x})V_2$ Laves phase,[18] in spite of the fact that T_L is much higher than T_c and the strain saturates long before the temperature reaches T_c from above.[19]

In conclusion, we have for the first time directly determined the pressure effect on T_L of V_3Si. T_L was found to be suppressed by the application of hydrostatic pressure. An extrapolated critical pressure of 24 kbar was obtained for complete suppression of the lattice instability down to the superconducting state. The results can be explained in terms of the Labbé-Friedel model by taking into account the interband charge transfer under pressure, in agreement with the calculation of Ting and Ganguly. On the other hand, the pressure effects on T_L and T_c up to 22 kbar are consistent with the conjecture that T_c is enhanced by the pressure-induced lattice softness. However, crucial tests on this latter suggestion lie in further experiments extending to higher pressure.

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