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PRESSURE-DEPENDENCE OF THE PHONON SPECTRUM OF Pb FROM TUNNELING MEASUREMENTS*

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The phonon spectrum of Pb has been obtained as a function of pressure from electron-tunneling data. The pressure-dependence of the electron–phonon coupling constant λ, and other parameters, shows that Pb tends towards weaker coupling with increasing pressure.

ELECTRON-tunneling measurements on Pb under approximately hydrostatic pressure make it possible to investigate the pressure-dependence of several microscopic parameters for this strong-coupling superconductor. We have previously published[1,2] information on the Grüneisen gamma and the gap ratio $2\Delta_0/kT_c$. Similar data have also been obtained by Zavaritskii *et al.*[3]

We present here results on $\alpha^2(\omega)F(\omega)$ – where $\alpha^2(\omega)$ is the energy-dependent electron–phonon interaction and $F(\omega)$ is the phonon density of states – and results on U_c, the Coulomb pseudopotential, both at zero pressure and at a pressure of 3445 bar. These results were obtained by inverting the gap equation, using the experimental tunneling density of states, $N_s(\omega)$, and the energy gap at the gap edge, Δ_0, as input-data.[4] From a knowledge of $\alpha^2(\omega)F(\omega)$ we can obtain several parameters, and their pressure-dependence, that are of interest in the theory of strong-coupling superconductors.

The experimental data used in this inversion were obtained from Pb-insulator-Al tunnel junctions at $T \simeq 2°$K, the Al being normal. Repetition of the measurement at 1.4°K showed no change in the tunneling data. The pressure data were taken at $P = 3445$ bar, generated in solid helium. The uncertainty in the applied pressure is approximately ± 6 per cent and this constitutes the major error in these measurements. Several other pressure runs were taken at pressures between 2300 and 3400 bar to establish reproducibility. The results at 3445 bar were taken for the inversion process, since they give a maximum effect. For more details of the pressure method see references 1 and 2.

In Fig. 1 the phonon spectrum $\alpha^2(\omega)F(\omega)$ is shown. The zero-pressure result is in good agreement with the data of McMillan and Rowell,[5] and Adler *et al.*[6] Under pressure the spectrum shifts to higher energies as expected. Grüneisen constants corresponding to the shift of the transverse and longitudinal phonon peaks were given in reference 1, the present method cannot improve on these estimates. For energies away from these peaks we cannot obtain Grüneisen constants, since the pressure-dependence of $\alpha^2(\omega)$ is not known. For this one has to await accurate determinations of $F(\omega)$ under pressure by inelastic neutron scattering.

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