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Effect of High Pressure on the Energy Gap of Indium and Thallium Superconducting Films

By

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The effect of high pressure (up to 15000 atm) on the energy gap of In and Tl superconducting films was investigated by the tunnel effect on superconductor–barrier–superconductor systems. As directly found in the experiments, the In values $2\,\Delta/kT_c$ indicate a reduction of the electron–phonon interaction under pressure for this metal. In the range up to 8 kbar the value $2\,\Delta/kT_c$ for Tl remained constant within the experimental error and was found to be 3.64 ± 0.06.

Методом туннельного эффекта на системах сверхпроводник–барьер–сверхпроводник изучалось влияние высоких (до 15000 атм) давлений на энергетическую щель сверхпроводящих пленок In и Tl. Непосредственно найденные в экспериментах значения $2\,\Delta/kT_c$ для индия указывают на ослабление электрон-фононного взаимодействия под давлением для этого металла. Для таллия в области давлений до 8 катм в пределах погрешности эксперимента величина $2\,\Delta/kT_c$ оставалась постоянной и составляла $3{,}64 \pm 0{,}06$.

1. Introduction

The central part of microscopic theory of superconductivity [1] is the presence of an energy gap in the spectrum of elementary excitations:

$$\Delta = \frac{\hbar\,\omega}{\sinh\left(\frac{1}{N\,V}\right)}, \tag{1}$$

where ω and V are cut-off frequency and interaction strength, respectively, N is the state density on the Fermi surface. In this theory the energy gap is coupled with the critical temperature by the universal relation

$$\frac{2\,\Delta}{kT_c} = 3.528\,. \tag{2}$$

This value characterizes the electron–phonon interaction strength which differs for real superconductors from 3.528, reaching a maximum value of 4.6 for Hg [2].

It is interesting to investigate the influence of different factors on $2\,\Delta/kT_c$ for one crystal modification. In this respect high pressures as a method are of great perspective.