Type-I superconductivity in Ga-II phase of elemental Gallium

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The pressure induced superconductivity in Ga-II phase of elemental Gallium (the transition temperature $T_c$~6.45 K) was studied experimentally by means of muon-spin rotation. Experiments reveal that Ga-II is the type-I superconductor with the zero temperature thermodynamic critical field $B_c(0)=64.07(1)$ mT. The analysis of $B_c(T)$ data within the phenomenological $\alpha$-model, ref [1], allows to estimate $T_c=6.448(2)$ K, $\Delta=1.121(1)$ meV, and the coupling strengths $2\Delta/k_B T_c= 4.024(2)$ ($\Delta$ is the zero-temperature value of the superconducting energy gap).

Correlation between the thermodynamical critical field $B_c$ and the transition temperature $T_c$ (see Fig.1) and between the coupling strengths $2\Delta/k_B T_c$ and $B_c/T$ ($\gamma$ is the normal-state Sommerfeld specific heat coefficient) for various single metal superconductors and binary alloys were obtained. Both these correlations are well explained considering the phonon-mediated BCS type superconductivity and suggest, therefore, the similar type of the superconducting mechanism for Ga-II phase of elemental Gallium.

Figure 1. Correlation between the thermodynamical critical field $B_c$ and the transition temperature $T_c$ in single-element superconductors (after [2]). The various Ga phases are denoted by red starts.

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