Experimental evidences for two-gap superconductivity in MgB_2

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Abstract

It was experimentally observed for MgB_2 two jumps of the specific heat and two features of the thermal conductivity: the first at $T \approx T_c \approx 40K$ and the second at $T \approx 10 - 11K$. At $T \leq 11K$ the negative thermal expansion of MgB_2 was also observed. All anomalies at $T \approx 10 - 11K$ were explained by the presence in MgB_2 the second group of charge carriers and their Bose condensation.

Key words: specific heat; thermal expansion; MgB_2; superconductivity

Specific heat $C(T)$ and thermal conductivity $K(T)$ of MgB_2 were measured at temperatures $T = 5 - 45K$. The MgB_2 samples were obtained by the hot-pressure method. The single-phase material was synthesized. The density of the sintered MgB_2 was 97% from the ideal X-ray density. The quality of these samples was tested by measurements of electric, magnetic, and other properties. Meissner-effect was 44%. $C(T)$ and $K(T)$ were measured by the modulation calorimetric method [1]. The error was 0.3% for specific heat and 1% for thermal conductivity.

In the Fig.1 $C(T)/T$ is shown in the interval $T = 5 - 45K$. One can see two jumps: the first at $T \approx 38 - 40K$ and the second at $T \approx 10 - 11K$. These jumps $\Delta C/T$ are shown separately in the two insets. They were obtained by using Debay extrapolation from the nearest area above the jumps temperatures.

The dependence $K(T)$ also has two anomalous area: one at $T \approx 38 - 40K$ and another at $T \leq 10 - 11K$. In Fig.2 dependence $K(T)$ is shown at $T \approx 5 - 20K$.

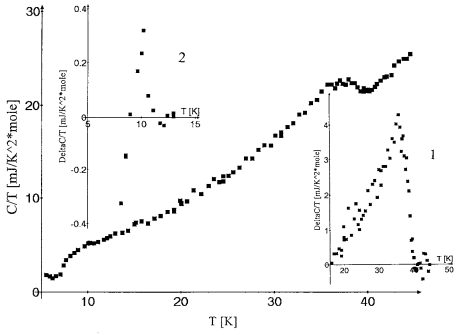

Fig. 1. The specific heat temperature dependence $C(T)/T$ of MgB_2. Inset 1: $\Delta C(T)/T$ at $T \approx 40K$; inset 2: $\Delta C(T)/T$ at $T \approx 10 - 11K$.

The obtained data can be explained by the existence of two groups of carriers in MgB_2 [2]. The superconducting transition at $T \approx 40K$ is connected with Bose condensation of the first group of the carriers. The anomalous jumps of $C(T)$ and $K(T)$ at $T \approx 10 - 11K$ are defined by the second group of the carriers. At the same $T \leq 11K$ the anomalous (negative) thermal expansion of MgB_2 was also observed [3].

The parameters of these two groups of the carri-

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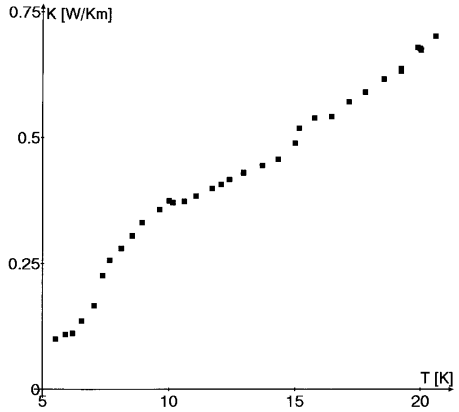

Fig. 2. The temperature dependence of the MgB_2 thermal conductivity at $T \leq 15K$.

ers were estimated from obtained experimental data. These data indicate on the existence of two-gap superconductivity in MgB_2.

Acknowledgements

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