Diss. ETH No. 6861

INFLUENCE OF SUPERCONDUCTIVITY AND MAGNETISM ON TRANSPORT PROPERTIES OF RARE EARTH RHODIUM BORIDE COMPOUNDS

A dissertation submitted to the
SWISS FEDERAL INSTITUTE OF TECHNOLOGY ZURICH

for the degree of
Doctor of Natural Sciences

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ADAG Administration & Druck AG

Zürich 1981

6 SUMMARY

We have measured the thermal conductivity and the electrical resistivity of $LuRh_4B_4$, $HoRh_4B_4$, $ErRh_4B_4$ and $SmRh_4B_4$ between 0.05 K and 50 K. The properties of these four compounds are characteristic for the whole series of the rare earth rhodium borides.

$LuRh_4B_4$ shows superconductivity. A detailed analysis shows that the lattice contributes about one third of the total thermal conductivity at the critical temperature T_c. The thermal conductivity in the superconducting state can be described with the theory of Bardeen, Rickayzen and Tewordt (BRT). From a fit to our data, the ratio of the energy gap to the superconducting critical temperature is found to be that of a weak coupling superconductor: $2\Delta(0)/k_BT_c = 3.5$.

$HoRh_4B_4$ orders ferromagnetically. The behaviour of the thermal conductivity and the electrical resistivity below the ordering temperature can be explained in terms of an enhanced mean free path due to the decrease of spin disorder scattering in the ferromagnetic phase.

The reentrant superconductor $ErRh_4B_4$ shows superconductivity and ferromagnetic order. The effect of the noninteracting localized magnetic moments of the Er^{3+} ions on the superconductivity is weak and the BRT theory may be applied. The thermal conductivity data show a gradual destruction of superconductivity over a temperature range of 0.5 K with the onset of magnetic order. Below 0.87 K, the thermal conductivity displays a linear temperature dependence indicating that the whole sample is in the normal state. The thermal hysteresis around 0.9 K found in other physical properties was confirmed by the thermal conductivity measurements.

Superconductivity and possibly antiferromagnetic ordering persists in $SmRh_4B_4$. In contrast to $ErRh_4B_4$, the localized magnetic moments of Sm^{3+} ions seem to have a strong influence on the thermal conductivity in the superconducting state. Our results can be interpreted in terms of the Ambegaokar and Griffin theory of the thermal conductivity in a superconductor containing magnetic impurities. In particular we derive a pairbreaking parameter which is consistent with the value deduced from the reduction of the superconducting critical temperature due to magnetic interactions. From the value of this parameter and following the Abrikosov and Gor'kov theory of magnetic impurities in superconductors we expect a gapless superconducting region for $T/T_c > 0.65$.