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Thermal Transport Properties of the Heavy-Fermion Compound $YbRh_2(Si_{1-x}Ge_x)_2$

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Thermal conductivity κ and thermopower S measurements on high-purity single-crystalline samples of $YbRh_2(Si_{1-x}Ge_x)_2$ with $x = 0$ and $x = 0.05$ as well as of the non-magnetic reference material $LuRh_2Si_2$ in the temperature range between 2 K and 300 K are presented. In this temperature range the transition from incoherent to coherent Kondo scattering plays a major role in the transport and scattering processes within the heavy-fermion system. Furthermore, crystal electric field (CEF) excitations of the Yb^{3+} ions occurring in this region have to be taken into account. The resistivity ρ of $YbRh_2Si_2$ exhibits a pronounced maximum at $\approx$100 K and decreases strongly towards lower T due to coherence effects. The maximum in ρ is most likely attributed to crystal electric field effects, as neutron diffraction experiments have revealed the CEF levels to be situated at 200 K, 290 K and 500 K. The thermopower S of $YbRh_2Si_2$ shows a large negative maximum at 80 K that is assumed to be caused by an interplay of Kondo effect and CEF excitations. S of the reference compound is small compared to that of $YbRh_2Si_2$ and shows the behavior of a simple metal. The thermal conductivity κ of $YbRh_2Si_2$ is distinctly reduced compared to that of $LuRh_2Si_2$. Assuming that phonon contributions are negligible below 20 K, κ of $YbRh_2Si_2$ cannot be reproduced by the Wiedemann-Franz law.

Keywords : heavy fermion, thermal transport, crystal electric field