

Thermal Conductivity of Solid Solutions of a Gd-S System in the Temperature Range 80 to 400 K

S.M. Luguev^{C,S} and N.V. Lugueva

*Institute of Physics, Dagestan Scientific Center, Russian Academy of Sciences, Makhachkala, Russia
luguev.if@mail.ru*

A study of the rare earth sulfides with the thorium phosphide structure is connected to the potential application of a number of these compounds as working elements of thermoelectric energy converters, for which the thermal conductivity is one of the most important characteristics. The present paper reports the results of an experimental investigation in the temperature range 80 to 400 K for the thermal conductivity coefficient of solid solution samples in the Gd-S system with the thorium phosphide structure in the homogeneous composition region. The measurements were carried out by a steady-state absolute technique. The investigated samples were prepared by melt crystallization and were large-grained polycrystals.

The investigation has shown that the thermal conductivity coefficient values of Gd-S system compounds are defined by a filling of the stoichiometric cation vacancies. In the investigated gadolinium sulfides, thermal transfer by lattice vibrations is a dominant mechanism of thermal conductivity. In gadolinium sesquisulfide, radiation heat transfer is also observed at temperatures higher than 200 K. The charge carriers' contribution to the heat transfer appears and increases as the cation vacancies are filling. The thermal resistance value is determined by phonon-phonon scattering processes and phonon scattering by defects (disordered localized cation vacancies). The temperature dependencies of the lattice thermal resistance have a kink in the 170 – 200 K range. The temperature of the kink shifts to a higher temperature range as the gadolinium concentration in the solid solution increases. The composition dependence of the thermal conductivity of the Gd-S system has a complicated character, which is determined by the change of phonon, electron and photon contributions to heat transfer, and also the influence of the change of the electron concentration, lattice defects and chemical bonds on these mechanisms.

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