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Thermoelectric properties of the $CeCu_4Ag$ compound

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Abstract – The thermoelectric properties, i.e. the electrical resistivity (ρ), thermopower (S) and thermal conductivity (κ) are discussed for the $CeCu_4Ag$ compound. The sample was prepared by induction melting of the constituent elements under an argon atmosphere. The electrical resistivity shows a Kondo-like logarithmic increase up to a maximum at T = 75 K. Thermopower is positive over the whole temperature range and below T_{max} = 25 K falls rapidly. The total thermal conductivity increases with the increasing temperature.

The studies of the electrical resistivity, thermal conductivity and thermopower for the $CeCu_4Ag$ compound are reported. The temperature variation of the electrical resistivity of $CeCu_4Ag$ is shown in Fig. 1. It amounts to about 190 μΩcm at room temperature, rises with decreasing temperature up to 210 μΩcm near 75 K, where $\rho(T)$ forms a broad maximum, and then rapidly drops down. A negative temperature coefficient of the resistivity, accompanied by an enhanced negative value of the paramagnetic Curie temperature is the characteristic feature of Kondo systems, frequently found amidst Ce-based intermetallics.

The behaviour of the thermopower of the Ce- and Yb-based intermetallic compounds often differs from the case of the ordinary metals and their alloys. Instead of the magnitude of several μV/K, the $S(T)$ of compounds with unstable f-electron shells may attain a giant value, i.e., of the order of a hundred μV/K. Furthermore, in addition to the diffusion mechanism that appears as a linear temperature dependence term in the $S(T)$ function, there are other contributions, for instance those related to the Kondo effect, crystalline electric field or scattering of conduction electrons on a narrow f-band. The temperature dependence of the thermopower for $CeCu_4Ag$ is displayed in Fig. 2. It is visible that as temperature decreases from room temperature the value of S increases, reaching a relatively high value of 50 μV/K at T_{max} = 25 K. The thermopower of $CeCu_4Ag$ is positive over the whole temperature range and below T_{max} falls rapidly. This fact is in contrast to the mixed valence compound $YbNi_{0.8}Al_{4.2}$ [1], for which $S(T)$ was reported to be negative. The opposite sign of the $S(T)$ of the Ce- and Yb-based compounds reflects the electron-hole symmetry of the $4f^1$(Ce).

The thermal conductivity κ increases with increasing temperature. The lattice thermal conductivity and electronic thermal conductivity are similar not only in their magnitudes but also in the overall temperature changes. The lattice contribution of $CeCu_4Ag$ is dominant below 150K. According to the definition of the thermoelectric figure of merit $ZT=S^2T/\rho\kappa$, a thermoelectric material should possess high S, with low ρ and thermal conductivity κ. For $CeCu_4Ag$ ZT is equal to 0.03 at T = 25 K.

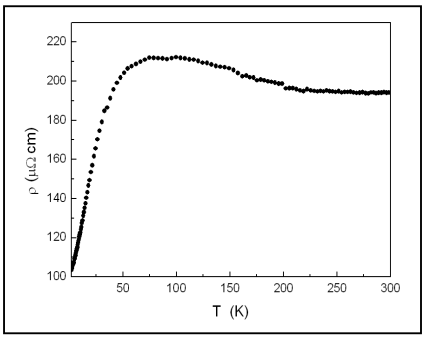

Figure 1: Temperature dependence of the electrical resistivity of $CeCu_4Ag$.

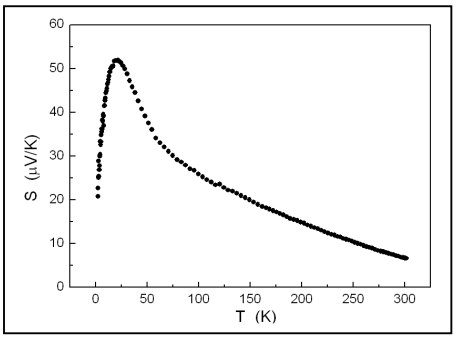

Figure 2: Thermopower of $CeCu_4Ag$ measured as a function of temperature.

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References

[1] V.H.Tran, W. Miiller, A. Kowalczyk, T. Toliński, G. Chełkowska, Journal of Physics: Condens. Matter 18 (2006) 10353-10363.