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Low-temperature thermopower and Nernst effect of the strongly correlated semimetal CeNiSn

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Heavy-electron semimetals have been claimed promising for thermomagnetic applications due to the anticipated large Nernst coefficients and the enhanced effective mass of the charge carriers. We present low-temperature thermoelectric power and Nernst effect measurements on the orthorhombic CeNiSn. Single crystals of highest available purity have been studied between 1.5K and 40K in different heat current-field configuration.

CeNiSn is classified as Kondo semimetal which exhibits a pseudo-gap opening at around 10K. At low temperatures residual states within the gap are revealed by transport and thermodynamic measurements. The Hall effect indicates the decrease of the charge carriers below the gap temperature. In this temperature range also the thermopower is found to change rapidly. Negative values are found for the configuration with the heat current along b. In field, the minimum shifts to lower T whereas the absolute values increase. Only at high fields the closing of the gap due to the field is observed. Furthermore, the influence of sample misalignment and transverse signals in the presence of a field are analyzed. The presented data are first reliable results which take into account the large Nernst coefficient at low temperatures. Results of different samples with the same configuration support exact orientation and alignment of the samples.

The field-dependent thermopower is discussed in terms of a Zeeman split energy gap at the Fermi energy. A similar analysis was to the specific heat results.

The Nernst effect exceeds values of 100μV/K at high fields of 7T. These large values correspond to a low charge-carrier concentration. CeNiSn allows for a study of the Nernst effect without concomitant ordering. The results will be compared to simple approaches. However, due to multiband effects those approximations are not sufficient to explain the temperature and field dependence of the Nernst effect of CeNiSn. More realistic theoretical models which take into account the gap structure as well as the multiband nature are desirable to understand the Nernst effect of strongly correlated semimetals and semiconductors. The large values of the Nernst effect of CeNiSn show that systems with strong correlations might be candidates for application for thermomagnetic cooling devices. The thermomagnetic figure of merit $N^2\sigma T/\kappa$ reaches values of 0.05. However, it has to be noted that the thermal conductivity of these single crystals is large and degrades the figure of merit. Reducing the thermal conductivity by nanostructuring might yield high figures of merit.