ABSTRACT CODE

Magnetic and electrical transport properties of UPdSb and UPd_2Sb

K. Gofryk and D. Kaczorowski

Institute of Low Temperature and Structure Research,
Polish Academy of Sciences, P. O. Box 1410, 50-950 Wrocław, Poland

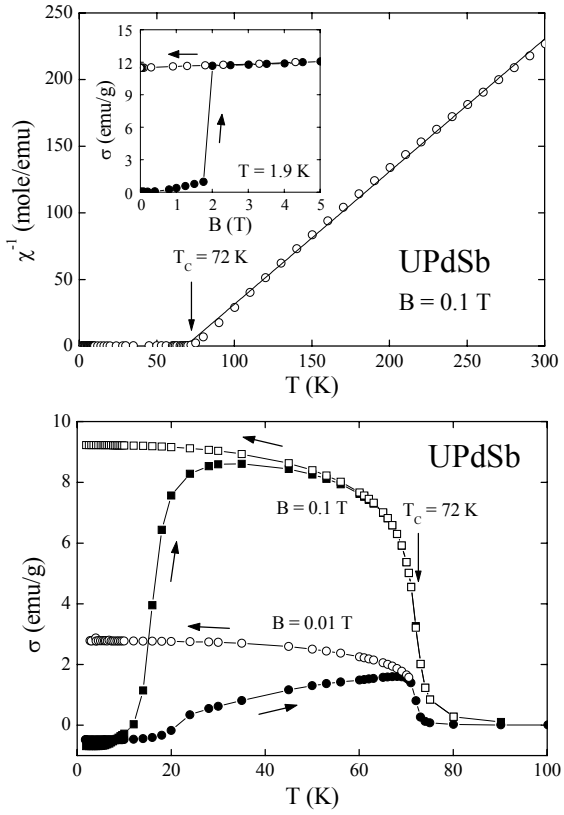
In the course of our systematic study of the magnetic, electrical and thermal behaviour in RPdSb and RPd_2Sb intermetallics, where R stands for an f-electron element, we have recently focused our attention on uranium-based materials. The equiatomic compound UPdSb has already been reported in the literature [1] but the information on its physical properties is quite limited. In turn, to the best of our knowledge, the constitution of UPd_2Sb is communicated here for the first time.

Polycrystalline samples of UPdSb and UPd_2Sb were synthesized by arc-melting the constituting elements in a titanium-gettered argon atmosphere. The buttons were remelted several times to ensure good homogeneity. The obtained alloys were proved by X-ray powder diffraction to be single phases. UPdSb crystallizes with the hexagonal $CaIn_2$-type structure, while UPd_2Sb adopts the $MnCu_2Al$-type crystal structure characteristic of Heusler phases.

Magnetic properties of the two compounds were studied in the temperature interval 1.7-300 K and in magnetic fields up to 5 T using a SQUID magnetometer. The electrical resistivity was measured from 4.2 to 300 K using a four-point dc technique.

In agreement with the literature data [1], UPdSb orders ferromagnetically at T_C = 72 K (see the figure). A pronounced irreversibility occurring in the magnetisation measured on heating and cooling the sample, negative $\sigma(T)$ signal seen at the lowest temperatures upon cooling the specimen in zero field, as well as a wide magnetisation loop with a sharp transition at a critical field of 1.8 T, all these features, being typical for narrow-wall ferromagnets, clearly manifest strongly anisotropic character of the magnetism in UPdSb. At 1.9 K the field-dependent magnetisation saturates at a value corresponding to the uranium magnetic moment of 1.0 μ_B. In the paramagnetic region the magnetic susceptibility follows the Curie-Weiss law with μ_{eff} = 2.84 μ_B and θ_p = 69 K.

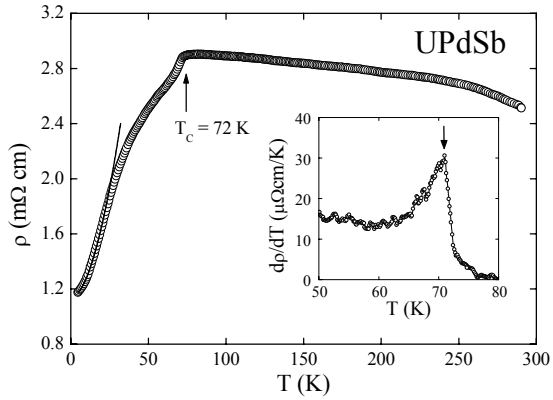
The electrical resistivity of UPdSb (see



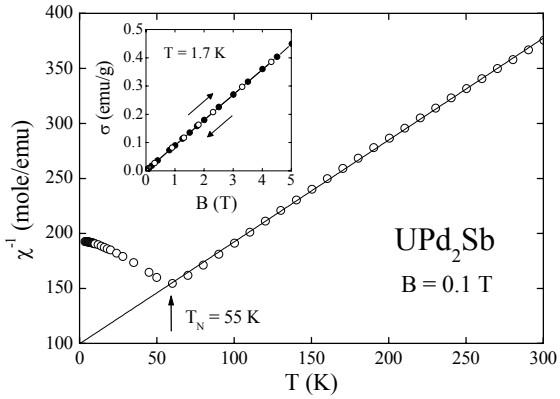
the figure) exhibits half-metalic behaviour of the type reported before for RNiSn (R = Ti, Zr, Hf) series [2]. The unusual properties of these latter systems were interpreted as being caused by the presence of narrow gaps in their electronic band structure near the Fermi energy [3], and similar scenario may hold for UPdSb. The magnetic phase transition manifests itself as a pronounced kink on the $\rho(T)$ curve and a sharp peak in the derivative $d\rho/dT$. Well below T_C, the

resistivity shows a T^2-behaviour (see the solid line), probably because of scattering of conduction electrons on ferromagnetic spin-wave excitations.

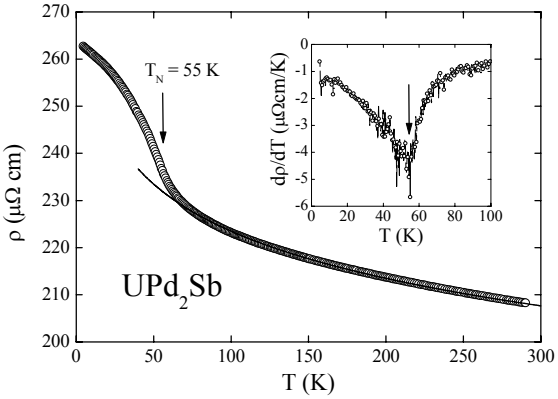
The novel compound UPd_2Sb is an antiferromagnet with the Néel temperature



T_N = 55 K (see the figure). In the paramagnetic region the susceptibility exhibits a Curie-Weiss behaviour with the parameters $\mu_{eff} = 2.94\ \mu_B$ and θ_p = -106 K.



Magnitude of the electrical resistivity of UPd_2Sb is typical of uranium intermetallics (see the figure). Interesting feature is a negative temperature coefficient in ρ(T) seen in the paramagnetic region. Above 60 K the resistivity is proportional to lnT (note the solid line), as expected for Kondo systems. The onset of magnetic ordering results in a distinct minimum in the dρ/dT vs. T dependence. Below T_N the resistivity starts to rise more quickly presumably due to



scattering of conduction electrons on boundaries of "magnetic" Brillouin zone.

It is worthwhile comparing the physical properties of UPd_2Sb to the behaviour of isostructural phases UPd_2Pb and $UPd_{1.85}Sn$. The plumbide was reported to be an antiferromagnetic (T_N = 35 K) low effective mass ($\gamma \approx 100$ mJ/molK^2) heavy-fermion compound [4], whereas the stannide was described as an antiferromagnet (T_N = 25 K) exhibiting enhanced specific heat (γ = 130 mJ/molK^2) and negative dρ/dT, yet probably not due to Kondo effect but rather because of crystallographic disorder [5]. In view of this assessment, one should be cautious when classifying UPd_2Sb as a new dense Kondo system. Apparently, further experiments are required to clarify the point. Interestingly, a regular non-magnetic non-superconducting heavy-fermion behaviour was observed for stoichiometric UPd_2Sn [6], which however crystallizes with an orthorhombic unit cell.

References:

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