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PHYSICA B

Effect of pressure on the electrical resistivity and magnetization of CeScGe

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Abstract

Measurement of the magnetization up to $H = 30$ T at 4.2 K, temperature dependence of magnetic susceptibility and effect of pressure on the electrical resistivity on CeScGe are presented. These results indicate that CeScGe is anti-ferromagnetic with $T_N = 46$ K. The Néel temperature T_N decreases with increasing pressure with the rate of $dT_N/dP = -0.56$ K/kbar.

Keywords: CeScGe; Pressure effect; Magnetization; Electrical resistivity

Recently, the physical properties of the new intermetallic compound CeScGe have been studied as a Kondo ferromagnetic compound by Canfield et al. [1]. The compound forms in the tetragonal La_2Sb structure (I4/mmm) with only one of the unique Ce sites, Ce2 site, occupied [1, 2]. Magnetic properties in the La_2Sb structure are sensitive to lattice strain or Ce site occupancy [2]. In Ce_2Sb , one of the Ce atoms in the inequivalent Ce1 and Ce2 sites is in the strong valence fluctuating state and the other local magnetic moment state, respectively. In this paper, we report the electrical resistivity of CeScGe in the temperature range between 5 and 300 K under high pressure up to 60 kbar and magnetization versus field to 30 T at $T = 4.2$ K to obtain the information on the electronic state of the Ce2 site in CeScGe.

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A polycrystalline sample was prepared by arc melting in an Ar gas atmosphere. The starting materials were 4N-Ce, 3N-Sc and 6N-Ge. The magnetization up to 30 T and magnetic susceptibility were measured with a 40 T hybrid magnetometer (Tsukuba Magnet Laboratories (TML)) and a SQUID magnetometer (Quantum Design), respectively. The resistivity measurement was carried out in the temperature range from 4.5 K to room temperature under hydrostatic pressure up to 60 kbar by standard four probe techniques. Details of the high-pressure apparatus have been described elsewhere [3, 4].

In Fig. 1 the magnetization curves for CeScGe are shown in the static field up to 30 T at 4.2 K. Two field-induced steps are observed near $H = 5$ T and 12 T. At $H = 30$ T, the magnetic moment for the Ce atom reaches $1.3 \mu_B$. These results indicate that CeScGe should be antiferromagnetic at

Fig. 1. Isothermal magnetization as a function of magnetic field for CeScGe at 5 K.

Fig. 2. Normal and inverse magnetic susceptibility of CeScGe.

Fig. 3. Temperature-dependent electrical resistivity ρ of CeScGe for various pressures. The inset shows pressure dependence of the Néel temperature in CeScGe.

$T = 4.2$ K, contrary to previous report on the appearance of ferromagnetism [1]. Fig. 2 show normal and inverse magnetic susceptibilities of CeScGe. At low temperature, the susceptibility has three anomalies magnetic–magnetic (T_1 and T_2) and antiferromagnetic–paramagnetic (T_N) transitions. The inverse susceptibility does not follow a simple Curie–Weiss law. This result suggests that χ is given by a constant term plus a Curie–Weiss term, as found previously in Ce₂Sb and in CeScGe; the Ge site (Ce1 site of Ce₂Sb) may be occupied by a small amount of Ce.

The electrical resistivity is shown in Fig. 3. At ambient pressure, the resistivity of CeScGe shows an anomaly at 46 K, which corresponds to T_N . At $P = 60$ kbar, a shoulder appears near 80 K (T_{MAX}) similar to typical Kondo materials. Therefore, the Kondo temperature may increase with pressure and this has been observed in many other typical Kondo compounds. In the inset of Fig. 3, we have plotted the pressure dependence of the antiferromagnetic transition temperature T_N . T_N

decreases linearly with increasing pressure with the rate of $dT_N/dP = -0.56$ K/kbar, which is the same order of magnitude as in other Kondo compounds having a Ce³⁺ atom [5].

In conclusion, we found that CeScGe is an antiferromagnetic compound in which T_N decreases with increasing pressure at the rate of $dT_N/dP = -0.56$ K/kbar.

References

- [1] P.C. Canfield, J.D. Thompson and Z. Fisk, *J. Appl. Phys.* 70 (1991) 5992.
- [2] A. Oyamada, A. Isobe, H. Kitazawa, A. Ochiai, T. Suzuki and T. Kasuya, *J. Phys. Soc. Japan* 62 (1993) 1750.
- [3] G. Oomi, T. Kiyama and Y. Uwatoko, *Jpn. J. Appl. Phys.* 32 (1993) 349.
- [4] N. Mōri and H. Takahashi, *Pressure Eng. (J. High Pressure Inst. Jpn.)* 28 (1990) 124 (in Japanese).
- [5] Y. Uwatoko, G. Oomi, T. Graf, J.D. Thompson, P.C. Canfield, H.A. Borges, C. Godart and L.C. Gupta, *Phys. B* 206&207 (1995) 234.