MAGNETIC AND TRANSPORT PROPERTIES OF $EuPt_2Si_2$ UNDER HIGH PRESSURE*

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We present the temperature (T) dependence of magnetic susceptibility (χ) and electrical resistivity (ρ) of $EuPt_2Si_2$ under high pressure. The Néel temperature (T_N) is lowered with applying pressure. Above 2.5 GPa, the T_N is collapsed and the residual resistivity drops dramatically with pressure. However, there exists no evidence of the valence transition, which is observed as a clear peak in the ρ–T curve in $EuNi_2Ge_2$ under high pressure.

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$EuPt_2Si_2$, which crystallizes in the $CaBe_2Ge_2$ type structure, has been reported to show a stable localized moment corresponding to Eu^{2+} ($4f^7$, $J = 7/2$) and an antiferromagnetic ordering at $T_N \sim 15$ K [1]. We take notice of an isomer shift (IS) of this compound measured by ^{151}Eu Mössbauer effect at 300 K. The IS value of -8.1 mm/s [1, 2] is shifted a little toward a Eu^{3+} state ($IS(Eu^{3+}) \sim 0$ mm/s), compared with the other divalent Eu compounds (*e.g.* $IS(EuAg_2Si_2) = -10.4$ mm/s [2, 3], $IS(EuNi_2Ge_2) = -9.1$ mm/s [4]). Recently, a pressure-induced valence transition from Eu^{2+}

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to Eu^{3+} accompanied by collapse of an antiferromagnetic ordering has been found in $EuNi_2Ge_2$ [5, 6]. Since the Eu valence of $EuPt_2Si_2$ is closer to a trivalent state than that of $EuNi_2Ge_2$, we expected that similar behavior would be observed also in $EuPt_2Si_2$ under high pressure. In order to elucidate that point, we measured magnetic susceptibility (χ) and electrical resistivity (ρ) as a function of temperature under high pressure.

A polycrystalline sample of $EuPt_2Si_2$ was prepared by argon-arc-melting stoichiometric amounts of constituent elements with a purity of more than 99.9% and subsequently annealing in an evacuated quartz tube at 800°C for one week. The sample was confirmed by powder X-ray diffraction to be a single phase with the $CaBe_2Ge_2$ type structure. Magnetization measurements under high pressure up to 1.2 GPa was performed from 4.2 K to 200 K by an extraction technique using a Ti-Cu clamp cell. Electrical resistivity under high pressure up to 9.0 GPa was measured from 3 K to 300 K by a standard dc four-probe method using a cubic-anvil-type pressure cell.

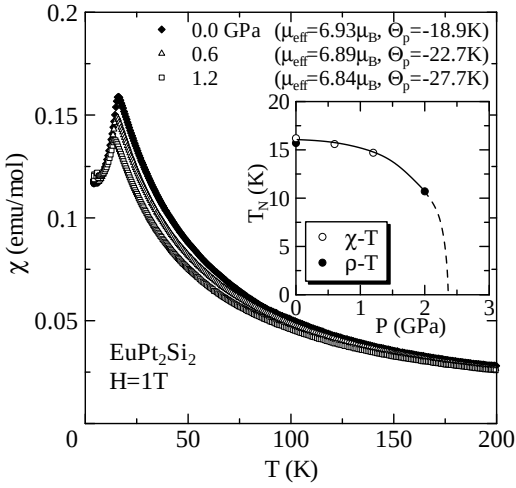

Fig. 1. Temperature dependence of magnetic susceptibility of $EuPt_2Si_2$ under various pressures. The inset shows pressure dependence of the Néel temperature. The open and solid circles are determined from a peak position in the χ–T curve (Fig. 1) and from an inflection point in the ρ–T curve (see Fig. 2), respectively. The solid and dashed lines are guides to the eye.

The magnetic susceptibility χ is plotted in Fig. 1 as a function of temperature and pressure. For all pressures, a definite peak is observed at around 15 K, corresponding to the antiferromagnetic ordering. With applying pressure, the Néel temperature T_N, determined from the peak position, is lowered as shown in the inset of Fig. 1 and the peak is gradually suppressed, which

suggests the Eu valence is shifted little by little toward a nonmagnetic trivalent state. Above T_N, the χ follows the Curie-Weiss law with the effective moment of $\mu_{eff} \sim 7\mu_B$ and the Weiss temperature of $\Theta_p = -27\,K \sim -18$ K. The value of μ_{eff} (even for ambient pressure) is rather smaller than a theoretical value of Eu^{2+} ($7.94\mu_B$) and an experimental value of other divalent Eu compounds. This result also suggests the Eu valence of $EuPt_2Si_2$ is in the vicinity of the valence fluctuating state.

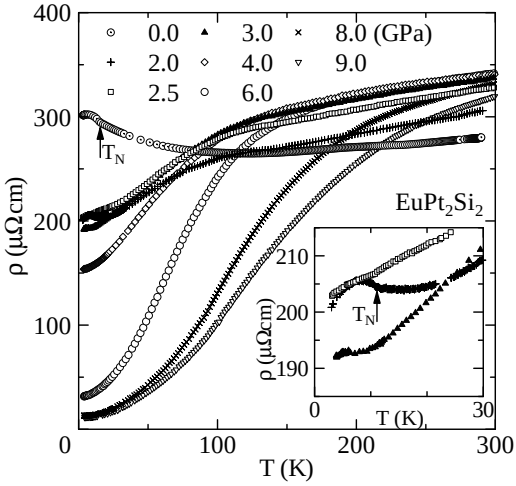

Fig. 2. Temperature dependence of electrical resistivity of $EuPt_2Si_2$ under various pressures. The inset shows data for 2.0, 2.5, 3.0 GPa in the temperature range from 3 K to 30 K. The arrows show an inflection point corresponding to the T_N.

In order to investigate higher-pressure behavior, we measured the temperature dependence of electrical resistivity ρ for pressures ranging from ambient pressure to 9.0 GPa, as shown in Fig. 2. At ambient pressure, with decreasing temperature, the ρ increases below 120 K and shows tendency to saturate to a large residual resistivity of $\rho_0 \sim 300\,\mu\Omega$cm at lowest temperature. The ρ–T curve has an inflection point at $T_N = 16$ K. These features of the ρ is quite different from those of other divalent Eu compounds showing an antiferromagnetic ordering such as $EuNi_2Ge_2$ [6–8]. Applying pressure depresses the inflection point to 11 K at 2.0 GPa and to $T < 3$ K above 2.5 GPa, as displayed in the inset of Fig. 2. The T_N estimated from the inflection point is also plotted as a function of pressure in the inset of Fig. 1. The antiferromagnetic ordering seems to disappear at around 2.5 GPa. However, there exists no evidence of the valence transition, which is observed as a clear peak in the ρ–T curve in $EuNi_2Ge_2$ under high pressure [6]. Instead, at 2.0 $\sim$ 3.0 GPa, a broad and small hump is seen in the temperature range

of 60 K $\sim$ 140 K, of which origin is unknown. On the other hand, with applying pressure, the ρ_0 drops dramatically to $\sim 10\,\mu\Omega$cm at 9.0 GPa. Accordingly, at $P \geq 2.0$ GPa, the temperature dependence of ρ transfers into metallic behavior. In normal metallic materials, a residual resistivity is generally interpreted as due to scattering of conduction electrons by impurities or lattice defects which are independent of pressure and temperature. Therefore, we must take into account another scattering mechanism in order to explain the pressure-sensitive behavior of the ρ_0. At $P \geq 4.0$ GPa, the ρ exhibits T^2 dependence at lowest temperatures, which suggests Fermi-liquid behavior. The T^2 coefficient A is derived to be $\sim 0.035\,\mu\Omega\mathrm{cm/K}^2$ for 4.0 and 6.0 GPa and $7 \sim 8 \times 10^{-3}\,\mu\Omega\mathrm{cm/K}^2$ for 8.0 and 9.0 GPa.

In conclusion, in $EuPt_2Si_2$, the application of pressure induces collapse of the antiferromagnetic ordering, drastic reduction in the residual resistivity and the occurrence of the Fermi-liquid-like behavior. However, a clear evidence of the valence transition is not observed. Further investigations are now in progress.

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