Pressure-induced heavy-fermion superconductivity in non-centrosymmetric compound $CeNiC_2$

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The intermetallic compound RNiC₂ (R: rare-earth elements) crystallize in the orthorhombic $CeNiC_2$-type structures(space group: *Amm*2). One of the remarkable features are the lattice lacks inversion symmetry along the c-axis. The existence of inverstion symmetry is believed to be a favorable factor for forming Cooper pairs, especially for the spin-triplet configuration. The relationship between superconductivity and the lack of inversiton symmetry is an important issue to be clarifried in the f-electron systems.

$CeNiC_2$ shows the multiple magnetic transitions at 20 K, 10 K, and 2 K[1]. In earlier investigation, neutron powder diffraction of $CeNiC_2$ was carried out[2]. In result, it transforms from a paramagnetic to an incommensurate antiferromagnetic (AFIC) phase below 20 K. At 10 K, the transition from an incommensurate to commensurate antiferromagnetic (AFC) structure takes place. Finally, a weak ferromagnetic (F) component appears at 2 K.

In this study, we have investigated the electrical resistivity measurement up to 15 GPa. Here, pressure-induce superconductivity has been discovered at $T_c \sim 3.5$ K around 11 GPa[3], which is the highest superconducting transition temperature in Ce-based compounds.

A polycrystalline sample was prepared by arc-melting in a tetra-arc furnace The details were written by previous report[4]. The electrical resistivty was measured by a conventinal DC four-probe method. High pressure experiments were performed by using a cubic anvil cell, which is known to generate hydrostatic pressure owing to the multi-anvil geometry. Glycerol were used as a pressure medium.

Figure 1 shows pressure phase diagram of $CeNiC_2$. At ambient pressure, resistivity was fallen due to AFIC transition below 20 K. With increasing pressure, AFIC transition temperature substancely increases and reaches a maximum at about 35 K around 7 GPa. AFC and F transition temperatures were determined by previous specific heat measurements[4] because their anomalies are not obvious in resistivity results. The pressure dependences of AFC and F transition temperatures do not change largely.

Above 8 GPa, AFIC transition temperature falls. The superconducting transition was observed at $T_c \sim 3.5$ K around 11 GPa. In result of the magnetic field effects, upper critical field is roughly estimated to be 20 T. This is higher than the Pauli paramagnetic limiting field of 6.5 T evaluated from $\Delta/\sqrt{2}\mu_B \sim 1.86T_c$. It indicates that the superconducting system is unconventional state as well as other non-centrosymmetric Ce-based superconductivity.

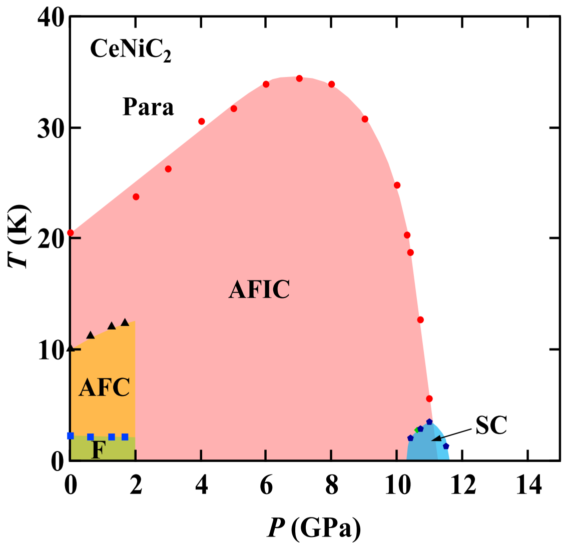

Figure 1. Pressure phase diagram of $CeNiC_2$[3]

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