PRESSURE EFFECTS ON THE MAGNETIC INDUCED PHASE-TRANSITIONS OF URu_2Si_2

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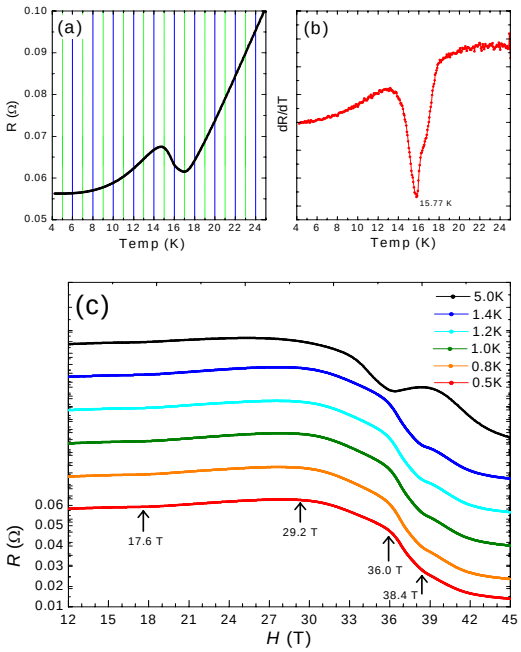
Introduction

Among heavy Fermion systems, the ground states of URu_2Si_2 are particularly complex. This material undergoes a superconducting transition at 1.5 K and a second-order phase transition into an ordered phase at 17.5 K, the so-called "hidden order" state. The existence of many competing interactions leads to a complex phase diagram as a function of the applied magnetic field.[1] The formation of complex phases can be shown to be connected with the existence of a field induced quantum critical point. With the purpose of better understanding of origin of hidden ordered phases, we measured the resistance of URu_2Si_2 as a function of magnetic field under a pressure of 9 kbar.

Experimental

The resistance measurements were performed with the standard four-probe method, which was employed with the current and the magnetic field applied along *c*-axis of a URu_2Si_2 single crystal. Pressure was generated with a BeCu clamped cell and the pressure at low temperatures was measured via the superconducting transition temperature of pure lead. The pressure cell was immersed in liquid ^{3}He. The experiments were performed in the 45 T hybrid magnet.

Results and Discussion



Applying pressure results in a continuous decrease of resistance although the rate of decrease is very small (only 3% for *p* up to 12 kbar). The in-plane sample resistance under 9 kbar and as a function of temperature *T* is shown in Fig. 1 (a) while its first derivative is shown in Fig. 1 (b) indicating that in this crystal the hidden order state takes place at 15.77 K. As an increasing field is applied along the *c*-axis (Fig (c)), field-induced transitions occur, as is evidenced from the change in slope indicated by the four arrows. Compared to the ambient pressure phase diagram, pressure broadens the transitions suppressing their first-order character.

According to heat capacity and susceptibility measurements at ambient pressure, the hidden order state takes place at temperature of 15.8 K which is does not change under pressure. Also, this crystal shows a very small resistivity ratio of ~ 5 indicating the low quality of the sample. To check the real influence of pressure, higher quality single crystals will be necessary.

Figure (a) Temperature dependence of the resistance under a pressure of 9 kbar. (b) First derivative of the resistance as a function of the temperature. (c) Magnetic field dependence of the resistance at various temperatures. Base line at each temperature is vertically shifted for clarity.

Conclusions

Our preliminary results indicate that pressure considerably affects the high-field phase-diagram of URu2Si2, suggesting that magnetoelastic effects play a relevant role in the formation of the phases seen at very high fields.

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References

[1] Kim, K. H., *et al*., Phys. Rev. Lett., **91**, 256401 (2003).