HIGH MAGNETIC FIELD INVESTIGATION OF SELECTED FILLED SKUTTERUDITE COMPOUNDS

C.R. Rotundu, B. Andraka (University of Florida, Physics); H. Sugawara, Y. Aoki, H. Sato (Tokyo Metropolitan University, Physics)

Introduction

Recently, there has been great interest in filled skutterudite materials containing rare-earths for their applications and for their unusual electronic and structural properties. Among others, $PrOs_4Sb_{12}$[1] and $PrFe_4P_{12}$[2] are the first clear-cut Pr-based heavy fermions while $SmOs_4Sb_{12}$[3] is the first Sm-based heavy fermion metal. A number of theoretical explanations of their low temperature states have been proposed but there is no consensus about the nature of these states. To gain insight into these states we have performed high field specific heat investigations on $(Pr_{1-x}La_x)Os_4Sb_{12}$, $PrFe_4P_{12}$, and $SmOs_4Sb_{12}$, and The specific goals were to extend the magnetic phase diagram of these systems to higher values of the field and to provide information on possible crystalline electric field (CEF) schemes. The knowledge of the CEF scheme is necessary to form any understanding of the exotic behavior of these systems.

Experimental

High quality single crystalline samples were used in this investigation. Measurements of the specific heat were performed for fields applied along (100) direction.

Results and Discussion

High field measurements on $(Pr_{1-x}La_x)Os_4Sb_{12}$ confirmed the CEF scheme proposed for $PrOs_4Sb_{12}$ [4], but the overall CEF splitting increases by about 20 % for strongly diluted compositions. Measurements of dH_{c2}/dT yield the existence of a crossover concentration ($x_{cr}\approx0.25$) separating the region with a strong variation of m* with x ($x< x_{cr}$) from the region where m* only weakly depends on x ($x> x_{cr}$). These results reinforce our conclusion on a collective nature of the heavy fermion state in $PrOs_4Sb_{12}$, previously suggested based on zero field specific heat and magnetic susceptibility results[5].

Search for clear signatures of CEF in $PrFe_4P_{12}$ and $SmOs_4Sb_{12}$ was unsuccessful, suggesting that the hybridization between f- and conduction-electrons in these compounds is much stronger than in the corresponding $PrOs_4Sb_{12}$. Measurements of $SmOs_4Sb_{12}$ in fields as strong as 32 T yield lack of any field dependence of the specific heat on the magnetic field, within the error bar of the measurement (10 %).

Acknowledgements

Supported by the Department of Energy, grant number DE-FG02-99ER45748.

References

[1] Bauer, E.D., *et al*., Phys. Rev. B, **65**, 100506(R) (2002).
[2] Aoki, Y., *et al*., Phys. Rev. B, **65**, 064446 (2002).
[3] Yuhasz, W.M., *et al*., Phys. Rev. B, **71**, 104402 (2005); Sanada. S., *et al*., J. Phys. Soc. Jpn., **74**, 246 (2005).
[4] Rotundu, C.R., *et al*., Phys. Rev. Lett., **92**, 037203 (2004).
[5] Rotundu, C.R., *et al*., Phys. Rev. B, in press; cond-mat/0402599.