Growth of High Quality Single Crystals of Cerium-Based Heavy Fermions and Their Lanthanum Analogs

Abstract: During the course of this work at ICC-IMR, using self-flux method, high-quality single crystal samples of Cerium-based heavy fermions were grown along with their non-4*f* reference analogs based on Lanthanum. Characterization measurements like EDX to establish the elemental composition and XRD to determine crystallographic orientations were are performed.

Cerium-based heavy fermions (HF) offer an amazing platform to study emergent physical phenomena like unconventional superconductivity, non-Fermi liquid behavior, quantum criticality and so on. Therefore, high quality samples of HFs are an utmost necessity to explore such interesting physics.

During my stay at ICC-IMR Japan, I tried to grow several samples of the popular Ce-based HF family, Ce_mMIn_{3m+2} (M = Rh, Co, Ir, Pt, Pd etc). In particular, the samples grown are the antiferromagnetic Ce_2RhIn_8 [1], superconducting (SC) Ce_2CoIn_8[2], Ce_2IrIn_8 that shows field-induced non-Fermi liquid behavior [3] as well as corresponding Lanthanum analogs, as shown in Fig 1.

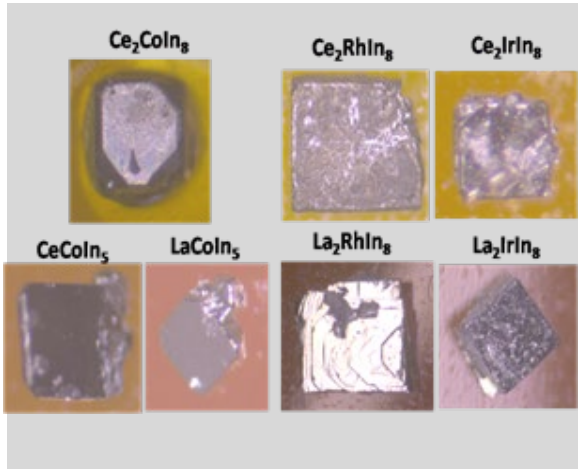

Fig. 1 Single crystals of Ce-based heavy fermions and La analogs grown at ICC-IMR.

Ce_2CoIn_8 grew in mixed phase along with $CeCoIn_5$ while Ce_2CoIn_8 grew along with $CeIn_3$. Ce_2RhIn_8 grew in single phase. EDX and XRD methods were employed for elemental characterization of these samples. Transport and thermodynamic properties of Ce_2CoIn_8 were determined as shown in figure 2.

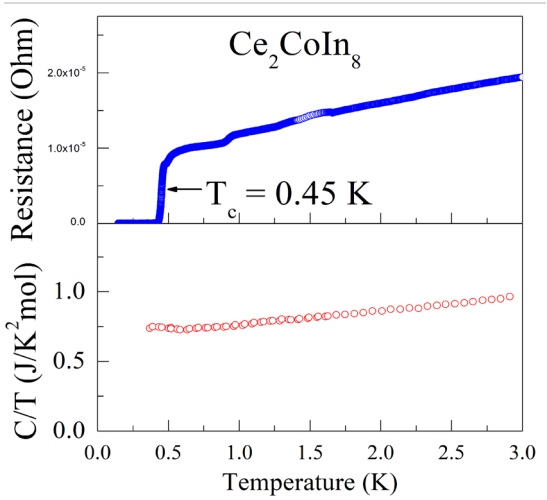

Fig. 2 (a) Transport and (b) specific heat capacity measurements in Ce_2CoIn_8

Ce_2CoIn_8 becomes SC at a critical temperature (T_c) ~ 0.45 K. Also, an enhanced Sommerfield coefficient ~ 0.75 J/K²mol was observed indicating heavy-fermion behavior as expected. Furthermore, observation of quantum-oscillations confirms high-quality of Ce_2CoIn_8 crystals. To thoroughly determine the Fermi-surface of Ce_2CoIn_8, a dHvA study in high fields is planned in future.
However, Ce_2IrIn_8 and Ce_2RhIn_8 do not show any quantum oscillations in the dHvA effect up to 18 T. These systems also needs to be tested in high fields for quantum oscillations.

In summary, during the course of this stay, high-quality single crystals of heavy fermion systems were successfully grown which are vital to understand emergent physical phenomena.

References

[1] A. L. Cornelius et al, Phys. Rev. B, **64**,144411 (2001).
[2] G. Chen et.al., J. Phys. Soc. Jpn. 71, 2836 (2002).
[3] J. S. Kim et al, Phys. Rev. B, **69**, 024402 (2004).

Keywords: Heavy Fermions, single crystals, superconductivity
Sanu Mishra (LNCMI-CNRS, UGA, Grenoble France)
E-mail: sanu.mishra@lncmi.cnrs.fr
http://lncmi.cnrs.fr