Experimental report

16/11/2016

Proposal: 5-31-2439 **Council:** 4/2015

Title: Determination of the magnetic structure of CeRhGe

Research area: Physics

This proposal is a new proposal

Main proposer: Steffen HARTWIG

Experimental team: Steffen HARTWIG

Local contacts: Thomas HANSEN

Samples: CeRhGe

Instrument	Requested days	Allocated days	From	To
D20	3	1	10/09/2015	11/09/2015

Abstract:

We propose to conduct a powder diffraction experiment on CeRhGe at low temperatures both at ambient pressures and at 10 kbar using a clamped-type CuBe pressure cell. The first part of the experiment is aiming to determine this magnetic structure of CeRhGe. Although the crystal structure of this compound is well known, the magnetic structure remains unclear, since this material possesses rather weak magnetic reflections. Therefore we would like to measure at the high flux D20 instrument below the Neel temperature TN = 9.4K with long integration times. The second part shall clarify the influence of pressure to the structure of CeRhGe as the material shows a variety of interesting properties at 10 kbar. We expect, that the experiment will take one day for the ambient pressure and additional two days for 10 kbar measurements. This experiment is part of the PhD thesis of Steffen Hartwig.

Ce-based compounds are known to exhibit a variety of ground states that include valence ordering, superconductivity, various magnetic orders and heavy-fermion behaviour. Recently we have started to investigate the equiatomic germanide CeRhGe that crystallizes in a TiNiSi-related orthorhombic structure (space group Pnma). This material shows a valence-ordering where Ce ions in various valence states order in a specific way. Its structure can be considered as a strongly orthorhombically distorted, ternary ordering variant of the type AlB_2. Chemical bonding in CeRhGe is governed by strong Ce-Rh interactions [3].

Below T_N = 9.4 K CeRhGe orders antiferromagnetically. This magnetic phase transition is visible in many bulk measurements including electrical resistivity, magnetic susceptibility and specific heat measurements [2-4]. Susceptibility measurements from ambient to liquid helium temperature indicated a trivalent cerium state over that temperature range [1]. At high temperatures around 510-520 K, however, the magnetic susceptibility shows a hysteretic transition manifested by large changes in the lattice parameters [3] driven by temperature-dependent chemical bonding (the so-called polyanion switching).

However, no details regarding the low-temperature AF structure are reported yet. It is expected that a spin density wave forms in CeRhGe [5] around the Néel temperature. Previous attempts to find magnetic Bragg reflections using both powder and single crystalline samples had only a limited success. Ueda et al. observed one single peak, indexed as (-0.06, 0.12, 0.91) [4]. In our attempts at PSI we recognized two peaks.

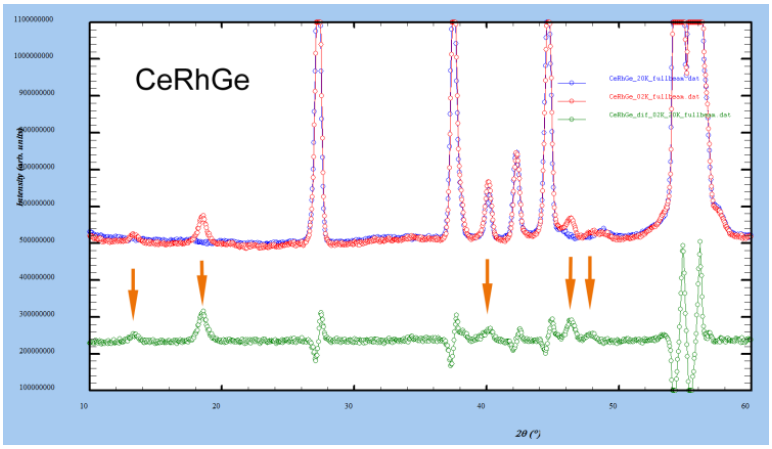

Fig. 1: The diffraction pattern of CeRhGe powder sample recorded at 20 K and at 2 K together with the difference between the. The additional Bragg reflections appearing below the magnetic order temperature are marked by arrows.

In the present experiment we have collected data at 2 and 20 K on D20 in two modes: with a full beam and relaxed resolution to maximize the signal and with 10' Soller collimator. In both configurations we can recognize five magnetic reflections. In Fig. 1 are these additional reflections highlighted by arrows in the differential profile. Two of the reflections agree well with our previous PSI measurement.

The refinement of the crystal structure from data obtained at 20 K leads to crystal structure parameters that are in accord with literature. However, up to date attempts to index the observed magnetic reflections with a unique propagation vector failed. Further attempts to index the pattern are being made. The use of a single crystalline sample would be therefore of a great advantage. We can at the moment only state that the CeRhGe orders indeed antiferromagnetically.

References

[1] P. Rogl, B. Chevalier, M.J. Besnus, J. Etourneau, J. Magn. Magn. Mater. 80 (1990) 305.
[2] W. Bazela, A. Zygmunt, A. Szytu1, E. Ressouche, J. Leciejewicz, W. Sikora, J. Alloys Compd. 243 (1996) 106.
[3] V. Svitlyk, W. Hermes, B. Chevalier, S. F. Matar, E. Gaudin, D. Voßwinkel, D. Chernyshov, R.-D. Hoffmann and R. Pöttgen, Solid State Sciences 21 (2013) 6
[4] T. Ueda, D. Honda, T. Shiromoto, N. Metoki, F. Honda, K. Kaneko, et al., J. Phys. Soc. Jpn. 74 (2005) 2836.
[5] S. Hartwig, et al. unpublished (2015)