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Coexistence of magnetic order and valence fluctuations in the Kondo lattice system $\text{Ce}_2\text{Rh}_3\text{Sn}_5$.

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I. SUPPLEMENTARY INFORMATION

A. Metallographic study

The microstructures of the $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ sample was inspected optically (Zeiss Axioplan 2) and with a scanning electron microscope (Philips XL 30). For the metallographic examination, a piece of about 3 mm diameter was cut from the annealed sample and embedded in conductive resin. Grinding was performed on abrasive papers (500- and 1000-grid silicon carbide). Polishing was done using slurries of 9, 3 and $1/4 \mu\text{m}$ diamond powder in alcohol-based lubricants.

Images of the sample surface obtained using the optical microscope with polarized light suggest that the sample consists of elongated grains with typical lengths of between $10 \mu\text{m}$ and $100 \mu\text{m}$ oriented randomly in various directions (see panels a and b of Fig. 1). Scanning electron microscopy investigations indicate that basically all the grains belong to the $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ phase. Multiple images recorded from the same sample surface with a secondary electron detector and using a backscattered electron detector with magnifications ranging from $120\times$ to $4000\times$ did not detect impurity phases and shown only a uniform sample density.

The chemical composition was investigated by means of wavelength dispersive X-ray spectroscopy (WDXS) using a CAMECA SX100 electron microprobe equipped with a tungsten cathode. The local composition was determined by intensities of the X-ray lines $\text{Ce}L$, $\text{Sn}L$ and $\text{Rh}L$ which were excited by an electron beam of 20 nA at 15 keV. The X-rays were focused by large monochromator crystals PET (Pentaerythritol, $d = 0.437 \text{ nm}$) on a gas flow proportional counter. The proportions of the three elements were determined with respect to the appropriate reference materials Rh, Sn and CeAl_2 and resulted in analytical totals of 100.1(2) wt.% by using the PAP matrix correction model.¹ Measurements on ten points on the sample surface gave the same results within expected experimental error bars (see Table I). After averaging on the ten points, the following contents were obtained: Ce: 20.06(10) at.%, Rh: 29.95(19) at.%, Sn: 49.99(18) at.%. This composition corresponds to $\text{Ce}_{2.01(1)}\text{Rh}_{3.00(2)}\text{Sn}_{5.00(2)}$ and is in an excellent agreement with stoichiometric $\text{Ce}_2\text{Rh}_3\text{Sn}_5$.

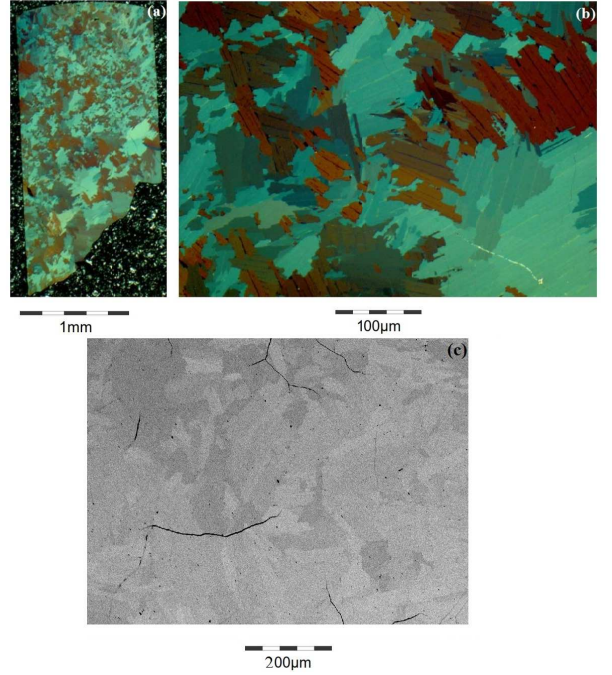


FIG. 1. Metallographic cross-section of an annealed ($800^\circ\text{C}/14$ days) polycrystalline sample of $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ showing orientation dependent reflectivity of the grains in optical (polarized light mode, panels a, b) and scanning electron (back scattered electron mode, panel c) micrographs.

B. X-ray powder diffraction

Phase analysis of the polycrystalline sample was carried out from X-ray powder diffraction patterns collected at room temperature on a HUBER imaging plate Guinier camera G670 using $\text{Cu } K\alpha_1$ radiation in a 2θ range of 3 – 115 degrees with the expose time $6 \times 15 \text{ min}$. For powder XRD study, pieces of the sample were converted to a fine powder by grinding in a mortar with a small amount of acetone. Rietveld-type refinement of the powder pattern performed using Jana2006 program² gave atomic positional and displacement parameters consistent with results of our single crystal X-ray diffraction study. Lattice parameters derived from the refinement are: $a = 4.4992(1) \text{ \AA}$; $b = 26.4839(7) \text{ \AA}$;

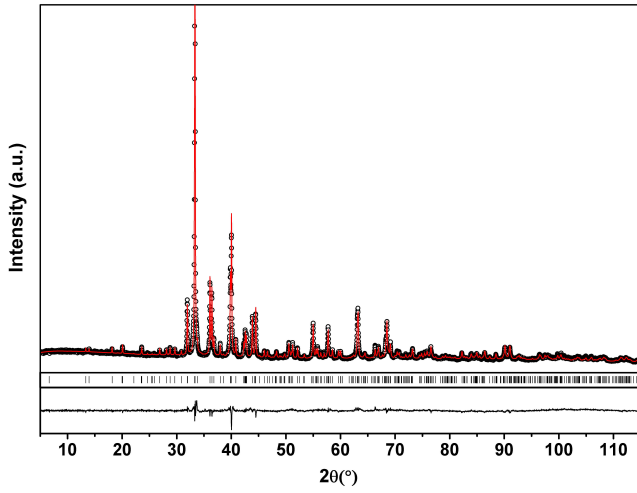


FIG. 2. X-ray powder diffraction pattern for $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ (black circles) and Rietveld refinement (red lines) that resulted in the following statistical factors: $R(\text{all}) = 6.92$; $R_w(\text{all}) = 7.25$; $R_p = 5.17$; $R_{wp} = 6.59$.

TABLE I. Normalized atomic concentrations of Ce, Rh and Sn measured by WDXS method on ten points on the $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ sample surface.

| Nr. | Ce (at.%) | Rh (at.%) | Sn (at.%) |
|-----|-----------|-----------|-----------|
| 1 | 20.03 | 30.26 | 49.71 |
| 2 | 20.06 | 29.79 | 50.14 |
| 3 | 20.10 | 30.00 | 49.90 |
| 4 | 20.01 | 29.81 | 50.18 |
| 5 | 20.12 | 30.03 | 49.86 |
| 6 | 20.08 | 29.76 | 50.16 |
| 7 | 19.99 | 30.15 | 49.86 |
| 8 | 19.94 | 29.81 | 50.25 |
| 9 | 19.95 | 30.16 | 49.89 |
| 10 | 20.28 | 29.77 | 49.95 |

$c = 7.2160(2)$ Å. The sample was found to be nearly single phased. Apart from peaks originating from the $\text{Ce}_2\text{Rh}_3\text{Sn}_5$ phase, there are only few additional very slight features in the diffraction pattern, which we assign to a small amount of an unidentified minority phase (see Fig. 2).

¹ J.L. Pouchou and F. Pichoir, *Rech. Aerosp.* **3**, 13 (1984).

² V. Petricek, M. Dusek and L. Palatinus, *Z. Kristallogr.* **229(5)**, 345 (2014).