Antiferromagnetic ordering of $Eu_3Rh_4Sn_{13}$

K. Iwasa[A], T. Kumada[B], Y. Suzuki[B], Y. Nambu[C, D, E]

[A]Research and Education Center for Atomic Sciences, Ibaraki Univ., [B]Graduate School of Science and Engineering, Ibaraki Univ., [C]IMR, Tohoku Univ., [D]Fusion Oriented Research for Disruptive Science and Technology, JST, [E]Organization for Advanced Studies, Tohoku Univ.

The Remeika phase compound $Ln_3Tr_4Sn_{13}$ (Ln = rare earth elements and Tr = transition metal elements) have been studied for characteristic structural transformation to noncentrosymmetric structures and magnetic orders [1]. In particular, the Ln = Ce compound was recently established to be a Weyl–Kondo semimetal characterized by a linear dispersion relationship of Kondo hybridized electronic band [2]. The Ln = La compounds are superconductors below approximately 2.5 K in the chiral structure phase [3]. Additionally, the antiferromagnetic (AFM) state in the chiral structure phase of $Nd_3Rh_4Sn_{13}$ was recently established using X-ray and neutron diffraction techniques [4]. In present study, we investigated the 4f-electron state in $Eu_3Rh_4Sn_{13}$, which was reported to undergo AFM ordering below 10 K [5]. Since no detailed magnetic structure was identified in previous study, we studied in present study AFM structure using a neutron diffraction (ND) technique.

The ND experiments for the powder sample of $Eu_3Rh_4Sn_{13}$ synthesized using the molten Sn-flux method was performed at the powder diffractometer HERMES (T1-3). Because of high absorption effect of the Eu nuclei, the powdered sample solved in CYTOP (an amorphous fluoropolymer from AGC Chemicals) and spread on surface of a cylindrical vanadium foil. Measurement was conducted with neutron wavelength 2.2 Å and a He-gas closed cycle cryostat.

Figure 1 shows ND patterns measured at selected temperatures. The 2-K data shows strong peaks, indexed by (h, k, l) with h and k = half integers and l = odd, as shown by black letters. These peak intensities decrease with increase of temperature to 9 K, and these vanish above 20 K. These reflections are not identical to those of nuclear reflections observed also above 20 K, indexed by the red letters. Therefore, the AFM structure is characterized by a superlattice represented by a propagation vector **q** = (1/2, 1/2, 0).

We also performed a synchrotron X-ray diffraction study on crystal structure of $Eu_3Rh_4Sn_{13}$. This compound undergoes a structural phase transition at 27 K, characterized by the same wave vector **q** = (1/2, 1/2, 0). Therefore, the AFM structure takes the same unit cell as that in the low-temperature crystal structure. We have already initiated structural refinement analysis for the crystal symmetry, which will be followed by an analysis of the magnetic structure.

The present study was performed under the approved proposal No. 23619.

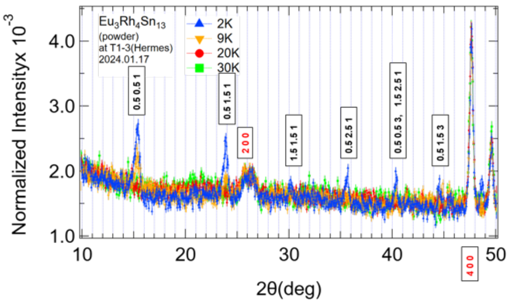

Fig. 1. ND patterns of $Eu_3Rh_4Sn_{13}$ at 2, 9, 20 and 30 K measured at HERMES.

[1] R. Gumeniuk, "Structural and Physical Properties of Remeika Phases" in Handbook on the Physics and Chemistry of Rare Earths, edited by J.-C. G. Bünzli and V. K. Pecharsky (Elsevier Science B.V., North-Holland, 2018) Vol. 54, p. 43–143. [2] K. Iwasa et al., Phys. Rev. Mater. **7**, 014201 (2023). [3] K. Suyama et al., Phys. Rev. B **97**, 235138 (2018). [4] A. Shimoda et al., Phys. Rev. B **109**, 134425 (2024). [5] A. Maurya et al., JPS Conf. Proc. **3**, 017022 (2014).