

Synthesis and magnetic properties of Au-Ga-Tb 1/1 approximant

K.Inagaki¹, A.Isikawa¹, T.Hiroto², K. Tokiwa³, T.Fujii⁴, R.Tamura¹

¹*Department of Faculty of Industrial Science and Technology Tokyo University of Science (Japan)*

²*Graduate School of Frontier Sciences, The University of Tokyo, Chiba (Japan)*

³*Department of Applied Electronics, Tokyo University of Science, Tokyo (Japan)*

⁴*Cryogenic Research Center, The University of Tokyo, Tokyo (Japan)*

The behavior of spins in quasiperiodic structure is one of the fundamental issues in the physics of quasicrystals. Rare-earth containing Tsai-type approximant crystals have been investigated in order to clarify the behavior of the localized spins on the vertices of the icosahedron^[1-2]. Recently, Ishikawa *et al.* reported that the Au-Al-Gd 1/1 approximant possesses an extraordinary wide single-phase region at 14 at% Gd^[3] and a FM-AF transition occurs with change in the valence electron concentration^[4]. Following this work, we have studied the phase constitution and magnetic properties of the Au-Ga-Tb system, and the aim of the present study is to search for a new magnetic transition phenomenon in Tsai-type approximants.

Polycrystalline alloys were prepared by arc-melting and annealed under Ar atmosphere. The phase purity of the samples was examined by powder X-ray diffraction (XRD) using CuK α radiation. The temperature and field dependence of the magnetization were measured using a superconducting quantum interference device (SQUID) or a vibrating-sample magnetometer (VSM). The specific heat was measured using physical property measurement system (PPMS).

Powder X-ray diffraction patterns show that the Au-Ga-Tb 1/1 approximant possesses an extraordinary wide single-phase region at 14 at% Tb. Also, the lattice parameter is found to increase with the Au/Ga ratio. The value of the effective magnetic moment, μ_{eff} , shows that the Au-Ga-Tb 1/1 approximant have well-localized spins on the above mentioned icosahedron shell. Furthermore, it was found that the paramagnetic Curie temperature, θ_p , oscillates from a positive value to a negative value depending on the valence electron concentration, and both a ferromagnetic and an antiferromagnetic phase exist in the high Au concentration region. Besides, occurrences of magnetic transitions in the region between the ferromagnetic and antiferromagnetic phase are observed by anomalies in the specific heat: Two anomalies are noticed in the $C_p/T-T$ curve at 11 and 7.9 K, at the near temperatures of the anomalies observed in the $\chi-T$ curve. All these new results will be presented.

1. R. Tamura, *et al.*, *Phys. Rev B* 82.22 (2010)
2. T. Hiroto, *et al.*, *J.Phys. Condens. Matt.* 25.42 (2013)
3. A. Ishikawa, *et al.*, *Phys. Rev B* 93.024416 (2016)
4. A. Ishikawa, T. Hiroto, K. Tokiwa, T. Fujii, T. Takeuchi, R. Tamura, submitted