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

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Quasicrystals (QCs) and their approximant crystals (ACs) are based on the same local structure, the icosahedral cluster unit. The Tsai type QCs and ACs containing rare earths are known to have localized spins at the vertices of nearly regular icosahedra. Because of their unique structural unit, the magnetic properties of the Tsai type QCs and ACs have become a focus of glowing interest. As a result, the existence of long-range magnetic order was reported in Cd_6Tb and Au-SM-R (SM = Si, Ge, Sn) Tsai-type ACs [1-3] etc. Recently, Ishikawa *et al.* reported that the Au-Al-Gd 1/1 ACs has a broad single phase region and that its magnetism changes from spin-glass to ferromagnetic and antiferromagnetic depending on the change in the valence electron concentration e/a [4-5]. Based on this report, in this work, we have studied the single phase region and the composition dependence of the magnetism of the Au-Al-Tb system by replacing Gd by Tb.

Polycrystalline alloys were prepared by arc-melting high-purity Au, Al, Tb, and then annealed to improve the sample homogeneity under Ar atmosphere. The phase purity of the samples was examined by powder X-ray diffraction (XRD) using CuKα radiation. The lattice constant was determined using RIETAN-FP [6].The temperature and field dependence of the magnetization were measured using a Superconducting quantum interference device (SQUID) or vibrating sample magnetometer (VSM) magnetometer. The specific heat was measured using magnetic property measurement system (MPMS) or physical properties measurement system (PPMS).

Powder X-ray diffraction patterns show that the Au-Al-Tb AC also possesses an extraordinary wide single-phase region at 14 at% Tb, comparable to that of the Au-Al-Gd system. Also, the lattice parameter increases with increasing the Au/Al ratio, which shows that Au and Al are mutually replaceable in a wide region. This system also shows a composition-driven spin-glass to ferromagnetic and antiferromagnetic transition, and the paramagnetic Curie temperature, Θ_p, is clearly dependent on the Au/Al ratio. Therefore, the magnetic properties of this system are considered to depend on the change in the valence electron concentration e/a like the Au-Al-Gd system. Interestingly, the above results are quite similar to that of the Au-Al-Gd system, however, some difference is noticed in the relationship between the composition and the magnetism. Detailed results of the magnetic properties of the Au-Al- Tb AC will be reported in the poster presentation.

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5. A. Ishikawa, T. Hiroto, K. Tokiwa, T. Fujii, T. Takeuchi, R. Tamura in ”13th International Conference on Quasicrystals ”

6. F. Izumi and K. Momma, Solid State Phenom. 130 (2007) 15-20.