Composition dependence of the magnetism and transport properties of the Tsai-type Au-Ga-Ce 1/1 approximant

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Since the observation of quantum criticality in the Au-Al-Yb Tsai-type quasicrystal [1], Tsai-type quasicrystals and their approximants containing rare-earth elements, which exhibits duality of itinerant and localized characters of electrons (e.g. Ce, Yb), have attracted particular attention. One of the interesting topics from this point of view is realization of heavy fermion state and establishment of its phase diagram for both quasicrystals and approximants. In this respect, recent work has shown that the Ag-In-Ce 1/1 approximant exhibits extraordinarily large *C/T* (specific heat per temperature) which exceeds 6 J/K^2 per mole of Ce ions [2], forming spin glass state below ~ 0.4 K. In our work, the Au-Ga-Ce system was extensively investigated and we found that the 1/1 approximant is formed in large single-phase region. We have also closely studied chemical doping effect on the magnetic property for the Au-Ga-Ce system, as in ref. [3].

Polycrystalline samples were prepared by arc-melting method. The synthesized Au-Ga-Ce compounds were confirmed to have same crystal structure as other Tsai-type 1/1 approximants from powder X-ray diffraction patterns. To evaluate the physical properties, the temperature dependence of electric resistivity was measured using four-probe method. Also, the temperature dependence of magnetization and specific heat were measured with commercial magnetic property measurement system (Quantum Design, MPMS) and physical property measurement system (Quantum Design, PPMS), respectively.

The temperature dependences of the resistivity commonly show a coherence peak at 30-100 K depending on the chemical ratio of Au/Ga. In addition, the inverse magnetic susceptibilities exhibit a kink at the same temperature region, which implies that the observed coherence peak comes from Au/Ga or (Au,Ga)/Ce ratio dependence of the crystal electric field. On the other hand, the heat capacity shows essentially the same temperature dependence, irrespective of the Au/Ga or (Au,Ga)/Ce ratio. The *C/T* of all samples exceeds 5 J/K^2 per mole of Ce ions at 0.5 K. Details will be reported in the presentation.

[1] K. Deguchi et al., Nat. Mat., 11, 1013–1016 (2012)
[2] K. Imura et al., J. Phys. Soc. Jpn., 86 093702 (2017).
[3] A. Ishikawa et al., Phys. Rev. B, 98 220403 (2018).