

Synthesis and magnetic properties of the Au-Ga-Eu 1/1 and 2/1 approximants

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Tsai-type quasicrystals (QCs) and their approximant crystals (ACs) are composed of the same cluster unit. The Tsai-type ACs are found in various alloy systems starting from the binary Cd-based systems [1-3]. Since the Tsai-type cluster contains an rare earth icosahedron shell, they have caught particular interest with respect to the magnetism of QCs and ACs. Recently, the existence of various long-range magnetic orders was reported in Tsai-type 1/1ACs [1-3]. However, a long-range magnetic order has been rarely reported in Tsai-type 2/1ACs. In this work, we searched for new Tsai-type 2/1 ACs and investigated their magnetic properties.

Polycrystalline alloys were prepared by arc-melting high-purity Au, Ga, Eu, and then annealed at 873 K for 50h under Ar atmosphere to improve the sample homogeneity. 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). The specific heat was measured using physical properties measurement system (PPMS).

Both 1/1 and 2/1 ACs were found in the Au-Ga-Eu system at nearby compositions. Magnetic susceptibility and specific heat measurements show that both Au-Ga-Eu 1/1 and 2/1 approximants exhibit an AFM transition at $T_N = 7.0$ and 8.5 K, respectively (Fig.1 and Fig.2). This is the first observation of long-range magnetic order for ACs having different degrees in a single alloy system. Single crystal structural analyses are currently in progress and details will be reported in the poster presentation.

[1] R. Tamura, et al., : Phys. Rev. B 82, 220201(R) (2010).

[2] A. Ishikawa, et al., : Phys. Rev. B 93, 024416 (2016).

[3] A. Ishikawa, et al., : Phys. Rev. B 98, 220403(R) (2018)

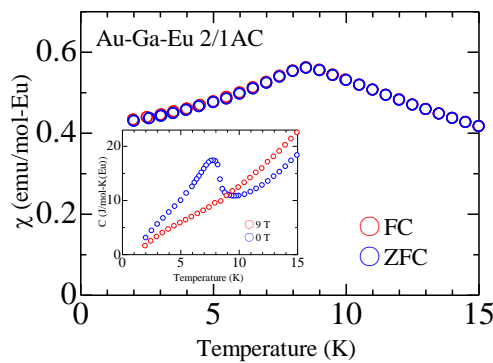


Fig.1: Temperature dependence of ZFC and FC magnetic susceptibilities for Au-Ga-Eu 2/1AC. The inset shows temperature dependences of the specific heat.

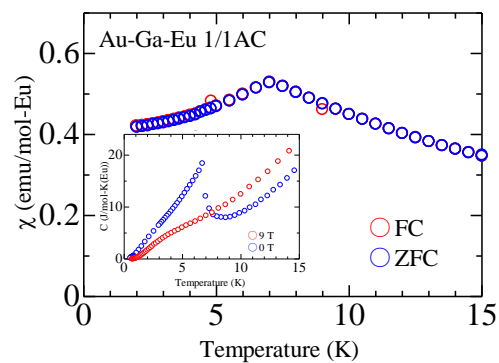


Fig.2: Temperature dependence of ZFC and FC magnetic susceptibilities for Au-Ga-Eu 1/1AC. The inset shows temperature dependences of the specific heat.