Phase Transitions in Al-Cu-Co Quasicrystal

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Introduction

A quasicrystal is an ordered but not periodic structure with lack of translational symmetry [1]. The decagonal quasicrystal Al-Cu-Co (d-Al-Cu-Co) has an axis of 10-fold symmetry. The material is periodic along this axis and non-periodic in the perpendicular plane. Therefore, it is supposed that d-Al-Cu-Co might have anisotropy of electrical conductivity caused by the strong structural anisotropy. During our measurements of d-$Al_{65}Cu_{19}Co_{16}$ magnetoresistance along the periodic axis, we discover two previously non-reported transitions which occurred at about 0.7 K and 3.6 K in zero magnetic field [2]. Here we report results of our study of d-Al-Cu-Co phase diagram.

Experimental Results and Discussion

We measured (i) magnetization of decagonal quasicrystal $Al_{65}Cu_{19}Co_{16}$ in the magnetic field of up to 18 T in the temperature range 0.3 – 10 K and (ii) magnetoresistance in the vicinity of the transitions, i.e. in the temperature range 0.3 – 4 K in very small magnetic fields below 100 mT. All measurements were performed at SCM2 system of the NHMFL DC Field facility equipped by a ^{3}He cryostat. Magnetization measurements were performed by a cantilever magnetometer and did not reveal any significant magnetization in the whole range of fields and temperatures including the domain near the transitions. The magnetoresistance measurements (see Fig.-1) were performed for studying the phase diagram of the transitions in d-$Al_{65}Cu_{19}Co_{16}$. The H-T phase diagram of these transitions is presented in Fig. 2. Suppression of the transitions by the magnetic field is clear seen on Figs. 1 and 2.

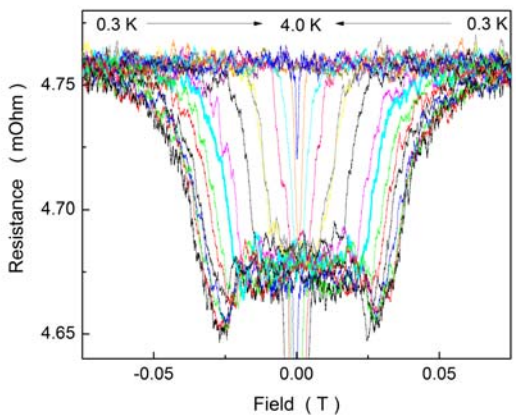

Fig.1 Magnetoresistance of d-$Al_{65}Cu_{19}Co_{16}$ quasicrystal at various temperatures in the vicinity of the phase transition.

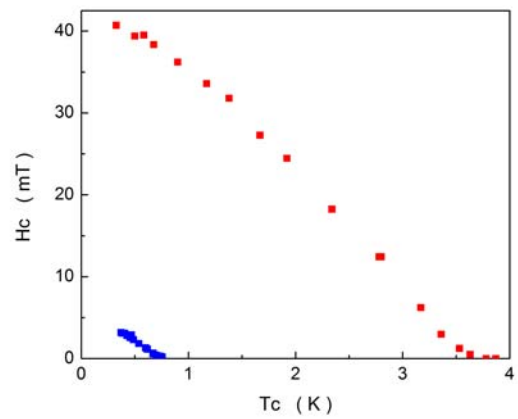

Fig. 2 H-T phase diagram of transitions in d-$Al_{65}Cu_{19}Co_{16}$ quasicrystal.

Conclusions

The nature of the transitions appearing in resistance of d-Al65Cu19Co16 is still puzzling, particularly in view of the fact that the magnetic field suppresses these features, but the material does not reveal any magnetic properties. The latter has been confirmed by measurements in a SQUID magnetometer.

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References

[1] Vekilov, Yu.Kh., *et al*., Phys. Usp., **53,** 537 (2010).
[2] Shulyatev, D., *et al.,* NHMFL Annual report #260 (2013)