Quantum Oscillations Variation due to Different Particle Alloying (κ-$(BETS)_2GaBr_4$, $FeCl_2Br_2$)

Eden Steven (FSU, Physics), Heng-Bo Cui (NHMFL), with J.S. Brooks (FSU, Physics)

Introduction

κ-$(BETS)_2Ga_xFe_{1-x}Cl_{4-y}Br_y$ is a quasi 2 dimensional charge-transfer conductor. In this work, the variation of the Shubnikov-de Haas (SDH) oscillations, specifically, the α and β oscillation (Figure 1.c) as the acceptor is varied, is studied. Variation of acceptor is done by alloying the system with magnetic and/or larger size anion (Figure 1.a). The samples measured in this experiment are κ-$(BETS)_2GaBr_4$ and κ-$(BETS)_2FeCl_2Br_2$.

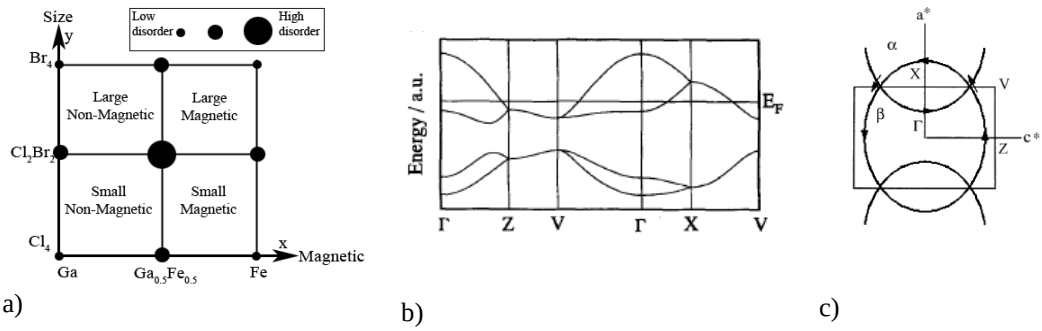

Figure 1. (a) Alloying diagram and disorder level. (b) Energy band diagram and (c) Fermi surface of κ-$(BETS)_2FeCl_4$ and $GaCl_4$ [1], [2]. The smaller lens orbit corresponds to α oscillation, and the larger ellipse orbit corresponds to β oscillation.

Experimental

The 4-point contact resistance measurement vs magnetic field are done in the magnet cell utilizing the 33 T resistive magnet. These measurements are done at different set of temperatures down to Liquid ^{3}He temperature.

Results and Discussion

Table 1. The extracted parameters from our measurements, which indicate that for the alloy $FeCl_2Br_2$, which corresponds to higher disordered system, the mean free path is much lower, and no α or β orbit observed, only a much smaller orbit. The m_{eff} is reduced for magnetic anions.

	Disorder	Magnetic?	Size	Area ($10^{18}/m^2$)	k_F (10^9/m)	v_F (10^4m/s)	T_D (K)	τ (10^{-12} s)	l (nm)	m_{eff}
$GaBr_4$ (α orbit)	Low	No	3.94	9.060	1.698	4.357	0.554	2.194	96	4.51
$GaBr_4$ (β orbit)	Low	No	3.94	44.08	3.746	4.805	1.298	0.937	45	9.02
$FeCl_2Br_2$ (other orbit)	Medium	Yes	3.45 – 3.97	2.482	0.888	4.280	3.49	0.348	15	2.4

Conclusions

The higher disorder system has lower mean-free-path. The α and β orbits were not observed for $FeCl_2Br_2$ system, although a very small orbit of unknown origin was observed for this case. Alloying the system with magnetic particle (Fe) suggests a reduction in the cyclotron effective mass.

Acknowledgements

This work is supported by NSF-DMR 06-02859.

References

[1] H. Kobayashi, H.T., et al, J. Am. Chem. Soc., **118**, 368-377 (1996).
[2] H. Tajima, A.K., T. Naito, H. Kobayashi, Solid State Communications, **98**, 755-759 (1996).