INVESTIGATION OF TEMPERATURE-PRESSURE PHASE DIAGRAM AND MAGNETORESISTANCE OF β-(BDA-TTP)$_2$MBr$_4$ (M=Fe, Ga)

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The existence of local magnetic moments as magnetic anions in charge transfer salts induces dramatic changes in the ground state of some organic conductors. In other cases, the magnetotransport properties show distinct behaviors between magnetic and non-magnetic compounds even when they show similar ground states. The π-d interaction was attributed to account for those behaviors, and the magnitude of the interaction (expressed as *J*) can be varied depending upon the distance between conducting planes and neighboring magnetic anions. As a continuous effort to understand the π-d interaction in charge transfer salts, we have investigated a temperature-pressure (*TP*) phase diagram and magnetoresistance of β-(BDA-TTP)$_2$MBr$_4$ (M=Fe, Ga). The clamped pressure cells made of either BeCu or MP35N alloy developed in NHMFL were used in this study. SCM II and Cell 12 magnet were used to measure high field magnetoresistance.

The *TP*-phase diagram of β-(BDA-TTP)$_2$MBr$_4$ is insensitive to the existence of magnetic anions and more or less similar to that of β-(BDA-TTP)$_2$MCl$_4$ (M=Fe, Ga)[1] as shown in Fig. 1 (a). As the temperature is decreased, β-(BDA-TTP)$_2$MBr$_4$ undergoes metal to insulator transition at T_{MI}. The insulating phase is suppressed with pressure and the superconductivity eventually appears at 12.8 kbar with $T_c^{onset} \sim 0.5$ K for both M=Fe and Ga samples. Compared to β-(BDA-TTP)$_2$MCl$_4$, the pressure for T_{MI} and T_c shifts to higher values for β-(BDA-TTP)$_2$MBr$_4$, which may be due to the higher negative chemical pressure effect for the larger MBr$_4$ anion.

It is of note that both M=Fe and Ga samples show positive magnetoresistance (MR) with small differences between them as shown in Fig. 1 (b). This behavior is rather unusual compared to other organic conductors with local magnetic moments which show negative MR. It is speculated that the π-d interaction in this compound can be much smaller than others. In a simple picture that the interaction is proportional to the extent of overlap between the energy levels of donors and anions, one may need higher pressure to observe the effect of the π-d interaction in this compound.

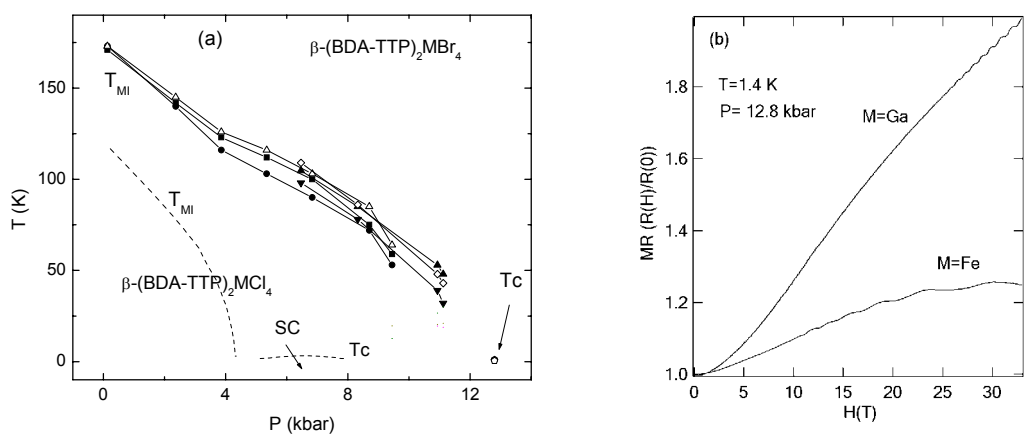

Fig. 1 (a) The *TP*-phase diagram of β-(BDA-TTP)$_2$MBr$_4$ (M=Fe, Ga). Each symbol represents different samples with filled symbols for M=Fe and unfilled symbols for M=Ga. The dashed lines are phase boundaries for β-(BDA-TTP)$_2$MCl$_4$ compounds. (b) MR (R(H)/R(0)) of β-(BDA-TTP)$_2$MBr$_4$ at 1.4 K at 12.8 kbar. The SdH oscillation is also observed from for both samples with similar FFT frequency of 900 T. A slow oscillation with frequency of 100 T is observed only for M=Fe sample.

Acknowledgements

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References

[1] Choi, E. S. et al., Phys. Rev B, **70** 024517 (2004).