Disorder Effects on Unconventional Superconductivity in $(TMTSF)_2ClO_4$

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Since the first organic superconductor $(TMTSF)_2X$ with the superconducting critical temperature of around 1.2 K was discovered, various studies have been performed to understand its unconventional superconducting properties and its relation to the neighboring spin-density wave magnetic-ordered state.

Among members of this $(TMTSF)_2X$ family, $(TMTSF)_2ClO_4$ is particularly interesting, This is the only member that exhibits ambient-pressure superconductivity, making many experimental probes easily accessible. Moreover, $(TMTSF)_2ClO_4$ has a unique feature that the degree of disorder can be simply tuned by changing the cooling rate across the anion-ordering temperature ($T_{AO} \sim 24$ K). With very fast cooling, the ClO_4 anions remain disordered and this disorder suppresses superconductivity. This effect, which has been known for many years, provides a unique opportunity to study disorder effects on unconventional superconductivity using one identical sample and with reversible control of the amount of disorder.

We are investigating the evolution of superconductivity as a function of the anion randomness in detail. Simultaneous measurements of electrical resistivity and magnetic susceptibility of single crystal samples revealed interesting crossover from disorder-controlled *d*-wave-like superconductivity for small disorder to granular superconductivity for higher disorder [1]. Specific-heat measurements under various disorder allows us to investigate the residual density of states as a function of disorder. We found that the residual term evolves as predicted by theories for *d*-wave superconductivity [2]. In addition, the evolution of the normal-state resistivity has been studied and we found that the non-Fermi-liquid-like *T*-linear resistivity coefficient is gradually suppressed, in agreement with a theory taking into account the finite-lifetime effect and phase coexistence [3].

In this talk, we explain disorder effects on superconducting and normal-state properties $(TMTSF)_2ClO_4$ and discuss the origin of these observations.

References

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