Investigation of Low-Frequency Charge and Spin Dynamics in Correlated π-Electron Systems with Multi-Degrees of Freedom

Recently, in the family of molecular conductors it has been shown that electronic states can be reversible set by utilizing the inherent glassy character of the materials. In θ-(BEDT-TTF)$_2$RbZn(SCN)$_4$ crystallization can be kinetically avoided when quenching the system after applying a heat pulse, thus a charge glass can be realized. The origin of the charge glass-crystal transition still demands a detailed transport investigation.

We have demonstrated that the partially deuterated molecular conductor κ-(d$_{0.8}$/h$_{0.2}$-BEDT-TTF)$_2$Cu[N(CN)$_2$]Br (κ-Br) can be tuned across a Mott transition by utilizing its inherent glass-like properties [1]. While coupled to a low temperature heat bath a heat pulse is applied and after switching it off the local temperature rapidly relaxes and introduces a Mott insulating state [2]. By partially relaxing the material at the glass-like temperature T_g=75 K it is possible to realize any state between the Mott insulator and the complete relaxed metallic/superconducting state [1].
Applying a heat pulse quench to a similar material θ-(BEDT-TTF)$_2$RbZn(SCN)$_4$ (θ-RbZn) it enters a charge glass state, which can analogues to κ-Br reversibly relaxed into a charge crystal. The charge glass state has been investigated by optical conductivity measurements on a compound in the same family θ-(BEDT-TTF)$_2$CsZn(SCN)$_4$ [4].
In order to study the charge glass state and its transition to the charge crystal state by optical conductivity, there are certain experimental requirements to fulfill. The cryogen free optical cryostat in use for the optical conductivity measurement is not capable of realizing rapid cooling rates. Therefor the heat pulse method has been considered to realize the desired ground states in θ-RbZn. This demands some modifications compared to usual measurements: the sample holder has to be insulating to avoid shortcutting the conductivity measurements, but still has to thermally couple the sample to the cryostat. Therefore a sapphire plate has been chosen, which has further been equipped with a small resistor. It can be used to locally implant a heat pulse alternatively to the sample itself, which is more difficult to control, because of its large dR/dT. The proof of principle has been demonstrated and is shown in figure 1. After a heat pulse the red curve (charge glass state) has been measured. Waiting certain times in the temperature range 150-220 K relaxes θ-RbZn away from the charge glass towards the charge crystal state (green and yellow curve).
In addition the first order character of the transition to the charge crystal state is visible by

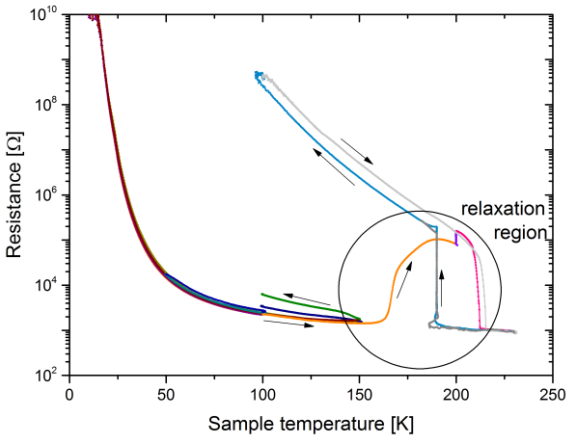

Fig. 1 Resistance of θ-RbZn for a temperature protocol.

the large and abrupt resistance jump and a wide hysteresis. The charge crystal (or charge ordered) state is difficult to avoid for the first cooldown of the system because no pulse method is applicable. Therefore usually the sample undergoes the first order transition. This often leads to sample breaking or at least misalignment due to tension coming from electrical wires. Nevertheless first reflectivity data has been collected and a guideline for an optimized procedure has been established.

References

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