μSR study of the density wave state in α-$(BEDT\text{-}TTF)_2MHg(SCN)_4$ (M=K, Rb)

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Charge density wave (CDW) and spin density wave (SDW) are well-known ground states in low-dimensional conductors and are based on different interactions. The former is due to electron-phonon interaction and the latter is due to on-site Coulomb interaction. Although manifests of CDW and SDW have been discussed separately, the coexistence of CDW and SDW is still an open problem.

In terms of the mixture of CDW and SDW, we focus on the low-dimensional organic conductor α-$(BEDT\text{-}TTF)_2MHg(SCN)_4$ (M=K, Rb). The compounds undergo the density wave state at T_{DW}= 8 and 12 K for K and Rb-salt, respectively, as a consequence of the nesting of Fermi surfaces. Commonly, organic conductors have too little carrier density to screen the Coulomb interaction. SDW was suggested by anisotropy of the magnetic susceptibility[1)]. On the other hand, CDW was suggested by NMR[2)], in which no magnetic order was observed. Accordingly, no clear evidence for the ground state of α-$(BEDT\text{-}TTF)_2MHg(SCN)_4$ has been obtained as yet. We believe that this lack of evidence comes from the coexistence of CDW and SDW. Such a mixture of CDW and SDW forms a new ground state in low-dimensional conductors, and is interesting in terms of g-ology[3)], which is a theoretical approach to ground states in one-dimensional system. The present system is expected to be located at the boundary between CDW and SDW. To the best of our knowledge, no study thus far has been able to determine whether CDW and SDW coexist or compete with each other.

For K-salt, Pratt *et al.*[4)] performed a zero-field μSR measurement at a temperature range from 5 to 16 K. They reported SDW ordering with an amplitude of 3×10^{-3} μ_B. However, this suggested value of the magnetic moment is extremely smaller than that of conventional SDW, for which the amplitude is in the order of 0.1 μ_B. In order to re-examine the density wave state in α-$(BEDT\text{-}TTF)_2MHg(SCN)_4$, we performed a μSR experiment at a lower temperature with higher statistics.

Small flakes of single crystals of α-$(BEDT\text{-}TTF)_2MHg(SCN)_4$ (M=K, Rb) were grown by a standard electrochemical method with deuterated BEDT-TTF molecules to eliminate the nuclear spin of protons. In this experiment, we concentrated on Rb-salt, which has a higher T_{DW} than K-salt. The transition temperature was determined as T_{DW}= 12 K based on the temperature dependence of the static magnetic susceptibility. The powdered sample was mounted as a fly-past setup for a ^3He refrigerator. The μSR measurement was performed down to 0.3 K.

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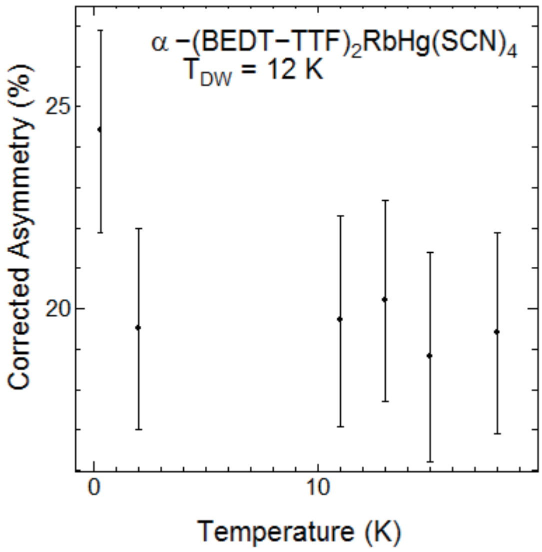

Fig. 1. Temperature dependence of asymmetry for deuterated α-$(BEDT\text{-}TTF)_2RbHg(SCN)_4$.

Figure 1 shows the temperature dependence of the muon-spin precession component along the longitudinal-field (LF) of 20 G applied along the initial spin-polarization of the injected muon. This component reflects the existence of a static component obtained from internal fields at the muon site in deuterated α-$(BEDT\text{-}TTF)_2RbHg(SCN)_4$. No drastic change was observed in the local field at T_{DW}= 12 K. This tendency is qualitatively consistent with that obtained by Pratt *et al.*[4)]. At present, data accuracy is not considerably higher than that of Pratt *et al.* with large error bars. We will try to improve the accuracy by collecting more muon events in the next trial. This is expected to reduce the upper limit of the expected magnetic moment which has been suggested by Pratt *et al.* to be 3×10^{-3} μ_B following the same logic[4)]. On the other hand, we found an unusual increase in the asymmetry below 2 K. This might be an indication of some degree of freedom or subphases[5)] in the density wave phase.

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