Materials Science

1B, 4C/2004G226

Incommensurate Structural Modulation of the Incommensurate Organic Superconductor (MDT-TS)$(AuI_2)_{0.441}$

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Introduction

In organic superconductors, the ratios of the donor molecules to anions are represented by an integer (typically 2:1) [1]. By contrast, the MDT-TSF (methylenedithio-tetraselenafulvalene) series salts are incommensurate ambient pressure organic superconductors and the charge transfer degrees deviate from 0.5 [2]. Moreover, (MDT-TSF)$(AuI_2)_{0.436}$ has shown the characteristic Fermi surface reconstruction by an incommensurate anion potential [3]. (MDT-TS)$(AuI_2)_{0.441}$, where MDT-TS is 5*H*-2-(1,3-diselenol-2-ylidene)-1,3,4,6-tetrathiapentalene, shows a metal-insulator transition at T_{MI} = 50 K in spite of the basically same crystal structure as those of the MDT-TSF superconductors [4]. The ground state of this salt changes from an "incommensurate antiferromagnetic insulating state" with T_N = 50 K to a superconducting phase at 3.2 K under 10.5 kbar [4]. The present paper reports discovery of structural modulation of (MDT-TS)$(AuI_2)_{0.441}$.

Results and Discussion

Figure 1 shows the synchrotron radiation x-ray oscillation photograph at 290 K. This photograph clearly displays incommensurate layer lines. We distinguish the donor lattice and the anion lattice by indices h and h', respectively. There are clear satellite spots at $h \pm \xi$.

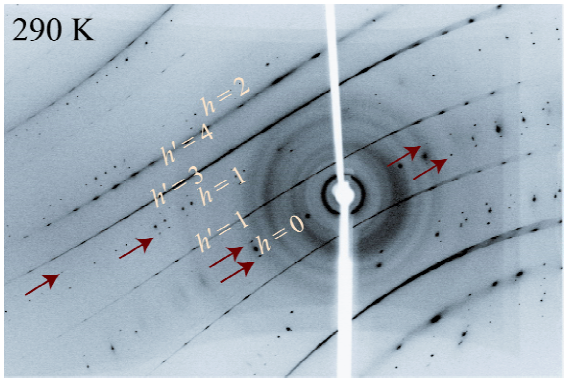

FIG. 1. X-ray oscillation photograph at 290 K.

The exact wave number of the satellite spot (ξ 4 2) is determined by a four-circle diffractometer and is found to be ξ = 0.114(3). Although the obtained wave number is close to 1/9, we find that the satellite spot (1-ξ 2 2) overlaps with the h' = 2 line of the anion lattice; this indicates that the modulation periodicity is incommensurate with the donor stacking periodicity.

The energy spectra of the satellite reflections do not include the scattering factor of Au atoms, E_{abs} = 11.9212 keV [5], but include that of Se atoms, E_{abs} = 12.6545 keV [5], as shown in Fig. 2. This demonstrates that the structural modulation occurs in the donor lattice.

In summary, we have found the incommensurate structural modulation in the donor lattice of (MDT-TS)$(AuI_2)_{0.441}$ with $\boldsymbol{q}$ = 0.114(3)$\boldsymbol{a}$*.

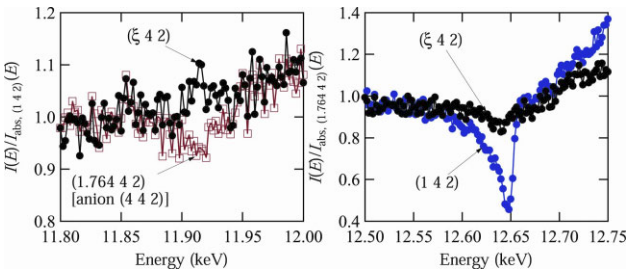

FIG. 2. Energy dependence of the intensity of (ξ 4 2).

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