

Organic superconductors with an incommensurate anion structure

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Abstract. Superconducting incommensurate organic composite crystals based on the methylenedithio-tetraselenafulvalene (MDT-TSF) series donors, where the energy band filling deviates from the usual 3/4-filled, are reviewed. The incommensurate anion potential reconstructs the Fermi surface for both (MDT-TSF)(AuI₂)_{0.436} and (MDT-ST)(I₃)_{0.417} neither by the fundamental anion periodicity q nor by $2q$, but by $3q$, where MDT-ST is 5*H*-2-(1,3-dithiol-2-ylidene)-1,3-diselena-4,6-dithiapentalene, and q is the reciprocal lattice vector of the anion lattice. The *selection rule* of the reconstructing vectors is associated with the magnitude of the incommensurate potential. The considerably large interlayer transfer integral and three-dimensional superconducting properties are due to the direct donor–donor interactions coming from the characteristic corrugated conducting sheet structure. The materials with high superconducting transition temperature, T_c , have large ratios of the observed cyclotron masses to the bare ones, which indicates that the strength of the many-body effect is the major determinant of T_c . (MDT-TS)(AuI₂)_{0.441} shows a metal–insulator transition at $T_{MI}=50$ K, where MDT-TS is 5*H*-2-(1,3-diselenol-2-ylidene)-1,3,4,6-tetrathiapentalene, and the insulating phase is an antiferromagnet with a high Néel temperature ($T_N=50$ K) and a high spin–flop field ($B_{sf}=6.9$ T). There is a possibility that this material is an *incommensurate Mott insulator*.

Hydrostatic pressure suppresses the insulating state and induces superconductivity at $T_c=3.2$ K above 1.05 GPa, where T_c rises to the maximum, $T_c^{\max}=4.9$ K at 1.27 GPa. This compound shows a usual temperature–pressure phase diagram, in which the superconducting phase borders on the antiferromagnetic insulating phase, despite the unusual band filling.

Keywords: organic superconductor, incommensurate composite crystal, Fermi surface, metal–insulator transition

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