Single Component Molecular Conductors  
Based on Metal Dithiolene Complexes

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The multiple-band is one of the concepts that drive recent development of molecular conductors. Single component molecular conductors belong to the multiple-band system where both HOMO and LUMO bands that originate from the same molecule are located near the Fermi level. Metal dithiolene complexes are characterized by a small energy gap between HOMO and LUMO and suitable for the formation of the single component molecular conductors. In order to induce the band overlap, the application of high pressure is very useful because a molecular system has a soft lattice. We developed a diamond anvil cell technique that enables four-probe resistivity measurements under high-quality hydrostatic pressure up to 42 GPa. Under such high pressure, molecular crystals show drastic changes. For example, neutral [Ni(dmit)$_2$], one of the significant and fundamental components for molecular metals and superconductors, turns metallic above 15.9 GPa [1]. We also observed superconductivity of neutral [Ni(hfdt)$_2$] with $T_c = 5.5$ K at 8.1 GPa [2].

In addition, we found the emergence of the Dirac points in neutral [Pd(dddt)$_2$] under high pressure [3]. A unique point of this system is that the Dirac point forms a loop in the three-dimensional $k$-space. A slight variation of the energy on the loop gives an electron pocket and a hole pocket, which implies that the system is a nodal line semi-metal [4].

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