A New Single-component Magnetic Molecular Conductor [Cu(tmdt)$_2$] (tmdt = trimethylenetetrathiafulvalenedithiolate)

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Since the discovery of the first metallic crystal composed of a single kind of molecule, [Ni(tmdt)$_2$] in 2001, where tmdt (trimethylenetetrathiafulvalenedithiolate) is an extended-TTF type ligand, many single-component molecular metals [M(L)$_2$] (M = Ni, Pd, Pt, Cu, Au, Co) with analogous extended-TTF type ligands L (= tmdt, dmdt, dt, etdt, ptdt, etc.) have been prepared [1]. However, due to the difficulties in the preparation of sufficiently large single crystals, their characterization is usually fairly difficult. Among these, [M(tmdt)$_2$] (M = Ni, Au, Pd, Pt and Cu) were found to give a series of isostructural systems. The structure of [M(tmdt)$_2$] is very simple. The unit cell contains only one M(tmdt)$_2$ molecule and the difference between the crystal structures of the systems belonging to the [M(tmdt)$_2$] family is only in the difference in central metal atom located on the lattice point. We have found that [M(tmdt)$_2$] exhibit a variety of electromagnetic properties, which is of course originated from the difference in the role of *d*-orbitals of M atom in the electronic band structure formations. [Au(tmdt)$_2$] crystal undergoes an antiferromagnetic transition at 110 K, while maintaining a metallic state at lower temperatures. [Pt(tmdt)$_2$] is metallic from 300 K to 4 K (σ(RT)~350Scm^{-1} (compacted pellet)). To demonstrate the high metallicity and small anisotropy of the resistivity of [Pt(tmdt)$_2$], we have tried to prepare the conducting paint by using crystalline powder of [Pt(tmdt)$_2$] [2]. Recently, microcrystals of [Cu(tmdt)$_2$] were prepared. In contrast to Cu(dmdt)$_2$ molecule with tetrahedral coordination, Cu(tmdt)$_2$ takes a planar structure. Interestingly, unlike other [M(tmdt)$_2$] with metallic behavior, [Cu(tmdt)$_2$] shows semiconducting behavior (σ(RT)~1.8 Scm^{-1} (compacted pellet)) and the susceptibility indicates 1D Heissenberg behavior with J=-105 cm^{-1}.

[1] A. Kobayashi; E. Fujiwara; H. Kobayashi, *Chem. Rev.* **2004**, *104*, 5243
[2] B. Zhou et al. *Adv. Mater*. **2009**, *21*, 1.