CHEMISTRY LETTERS, pp. 931-932, 1987.

New Organic Superconductor, $(DMET)_2Au(CN)_2$

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We discovered a new organic superconductor, $(DMET)_2Au(CN)_2$, which is a radical salt of an asymmetrical donor. The room-temperature conductivity of this salt was very high (2500 $S\cdot cm^{-1}$) at ambient pressure. This salt showed a metal-insulator transition at about 25 K at ambient pressure, but it exhibited superconductivity below 0.80 K at 5 kbar.

Since the discovery of superconductivity in TMTSF salts,[1] some organic superconductors have been discovered, but all these superconductors contain symmetrical donors.[2] Namely, TMTSF or BEDT-TTF salts that exhibit superconductivity are composed of a symmetrical donor molecule and a radical anion. TTF-$Ni(dmit)_2$ is also composed of symmetrical donor and acceptor. Are symmetrical donors necessary for organic superconductors ? In order to answer this question, we have investigated asymmetrical donors.[3] In this letter, we briefly report the synthesis and the electrical property of the first organic superconductor based on an asymmetrical donor. This organic superconductor is $(DMET)_2Au(CN)_2$ (DMET= dimethyl(ethylenedithio)diselenadithiafulvalene as shown in Fig.1).

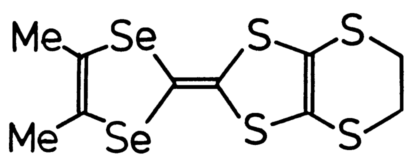

Fig. 1. DMET.

The synthesis of DMET was carried out as already described.[4] $Au(CN)_2$ salt was crystallized by electrochemical oxidation of DMET in chlorobenzene with $(n\text{-}Bu)_4NAu(CN)_2$ as the supporting electrolyte. Plate-like crystals were obtained after one week. The stoichiometry of this salt was determined to be 2:1 by XPS. The electrical conductivity was measured by the four-probe method along the long crystal axis.

The room-temperature conductivity was 2500 $S\cdot cm^{-1}$, which is much larger than TMTSF salts (700 $S\cdot cm^{-1}$ for $(TMTSF)_2ClO_4$[5]). At ambient pressure a resistivity of $(DMET)_2Au(CN)_2$ showed an upturn at about 25 K, which disappeared under 5 kbar. Figure 2 shows the temperature dependence of the electrical resistivity of

$(DMET)_2Au(CN)_2$ under 5 kbar. As temperature decreases, the resistivity decreases as $T^{0.65}$ down to 15 K, and a large drop of resistivity was observed below 1.0 K. When magnetic field was applied to the crystal, this drop was suppressed completely (Fig. 2). This result confirmed that this drop is due to a superconducting transition. The transition temperature T_c is 0.80 K and ΔT_c is 0.15 K.

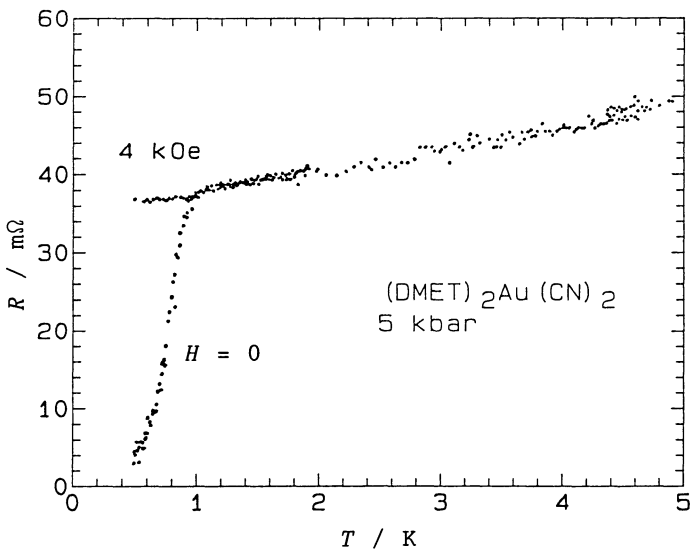

Fig. 2. Resistivity of $(DMET)_2Au(CN)_2$ under pressure.

In summary, $(DMET)_2Au(CN)_2$ is found to be the first organic superconductor based on an asymmetrical donor. Details of the superconducting properties and crystal structure will be published in the forthcoming papers.

This study was supported by the Grant-in-Aid for Special Project Research No. 61105003 from the Ministry of Education, Science, and Culture.

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(Received February 27, 1987)