Electrical Conduction in Thioxanthene

S. Pietra and A. Tenaglia
Istituto Chimico, Facoltà di Ingegneria, Università di Bologna, Italy

(Z. Naturforsch. **31 b**, 1301–1302 [1976]; received June 16, 1976)

Electrical Conductivity, Organic Compounds

Electrical conductivity of thioxanthene single crystals has been observed. The electrons, injected from the electrodes or freed by sulphur atoms, are responsible for the electrical properties. The activation energy for the conduction is higher than in thianthrene, it depends maybe on the number of S atoms in the molecule.

The similarities between thianthrene and thioxanthene molecules are well known. In a preceding communication[1] we have studied the current-voltage characteristics of thianthrene, now we report on the electrical properties of thioxanthene single crystals.

Experiments

Thioxanthene was purified by liquid chromatography using petroleum ether as eluent and alumina as adsorber. The product thus obtained was further purified by crystallization. Needlelike crystals elongated in the *b*-direction, were grown by vacuum sublimation.

All the electrical measurements at fields up to 6000 V/cm were carried out in N_2-atmosphere, allowing the current to reach steady state value. Silver paste has been painted on both sides of the crystal, perpendicular to the *b*-axis. The temperature ranges between 6 and 46 °C.

The crystallographic unit cell is orthorhombic and contains 4 molecules[2].

Results and Discussion

The I–V relationship is superlinear at low fields, at fields higher than 2500 V/cm the current becomes more or less proportional to the voltage and at still higher voltages it tends to saturate (Fig. 1). We have the same situation postulated by Pope and Kalmann[3].

The saturation current is independent of the field and depends only on the charges which are injected from the electrodes or freed from sulphur atoms in the crystal. If we have only the injection from electrodes, the current would be proportional to T^2. But the saturation current at 319 K is higher than $\left(\frac{319}{291}\right)^2$ times the saturation current at 291 K, thus we think that a part of the current is freed by S atoms.

From the temperature dependence of σ (Fig. 2) follows:

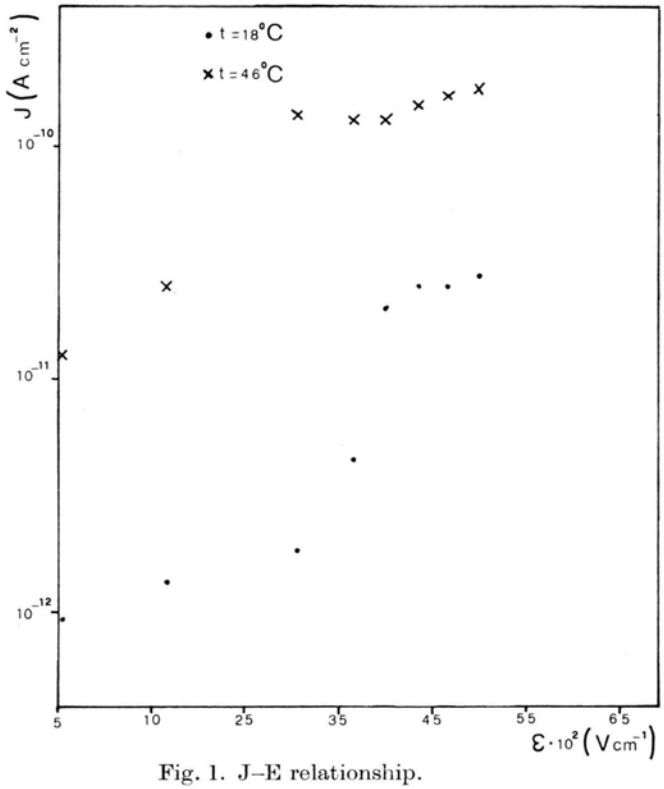

Fig. 1. J–E relationship.

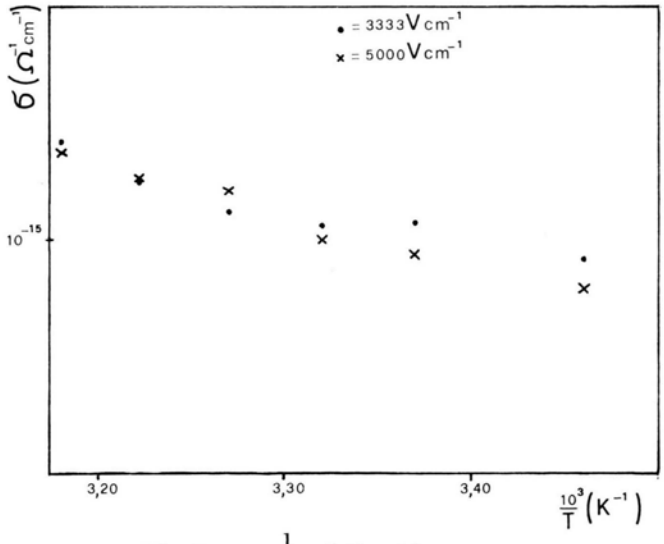

Fig. 2. $\sigma - \frac{1}{T}$ relationship.

Requests for reprints should be sent to Dr. S. Pietra, Istituto Chimico, Facoltà Ingegneria, Università, Viale Risorgimento 2, *I-40136 Bologna*, Italy.

$$\sigma = \sigma_0 \exp(-\Delta E/hT)$$

where $\Delta E = 0.39$ eV.

In thioxanthene we have no π-interaction with the phenylene groups[2] and the conduction band for the electrons is originated by S orbitals.

It is understandable that the activation energy of thioxanthene with one S atom per molecule is higher that the activation energy of thiantrene with two sulphur atoms per molecule.

The authors wish to thank Dr. C. Berti for preparing the sample.

[1] S. Pietra and M. Finetti, Z. Naturforsch. **31 b**, 285 [1976].

[2] J. A. Gillean, D. W. Phelps, and A. W. Cordes, Acta Crystallogr. **B 29**, 2296 [1973].

[3] M. Pope and H. Kallmann, J. Chem. Phys. **36**, 2482 [1962].