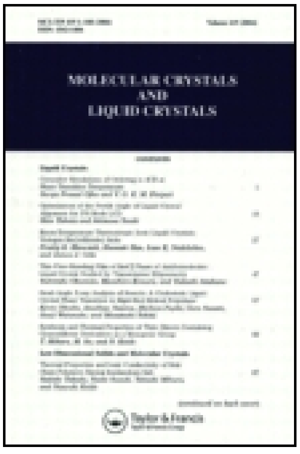

Molecular Crystals and Liquid Crystals
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl16

AC Conduction of Polycrystalline p-Terpkenyl Layers

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Version of record first published: 20 Apr 2011.

To cite this article: G. Bak & A. Lipinski (1980): AC Conduction of Polycrystalline p-Terpkenyl Layers, Molecular Crystals and Liquid Crystals, 56:5, 139-143

To link to this article: http://dx.doi.org/10.1080/01406568008070901

Mol. Cryst. Liq. Cryst. Vol. 56 (Letters), pp. 139-143
0140-6566/80/5605-0139$04.50/0

AC CONDUCTION OF POLYCRYSTALLINE p-TERPHENYL LAYERS

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(Submitted for Publication October 25, 1979)

Abstract The ac conduction measurements in polycrystalline p-terphenyl layers at different temperatures and different values of an external steady field are reported. In our opinion, the conductivity of examined layers at low frequencies is controlled by intergrain barriers. The intergrain barrier heights are 0.07-0.08 eV. The predominant conduction mechanism inside the grains appears to be a hopping process between localized states in a "impurity" band near the Fermi level.

EXPERIMENTAL

Polycrystalline p-terphenyl layers was obtained by vacuum evaporation on mica and glass substrates in the way described elsewhere[1,2]. AC conduction of these layers was measured using MCG 76 ac bridge at different temperatures /190-360K/ and at frequencies between 100Hz-100kHz. The measurements were carried out in a vacuum of about 10^{-3}torr in order to eliminate the influence of humidity on the electrical properties of the p-terphenyl layers. The temperature of the samples was controlled with a copper-constantan thermocouple.

RESULTS AND DISCUSSION

The typical dependence of the ac conductivity on frequency at a number of external voltages are shown in Fig.1. Fig.2 shows the temperature dependence of the conductivity at different frequencies.

It may be shown[2] that: 1° ac conduction at low frequencies is controlled by intergrain barriers and 2° ac conduction at high frequencies refers to the inside of the grains.

In accordance with Fig.2 the activation energy of the conductivity of the grain material is about 0.01 eV. This experimental result of ac conductivity measurements can be explained in terms of hopping of carriers between pairs of localized states at the fermi level.

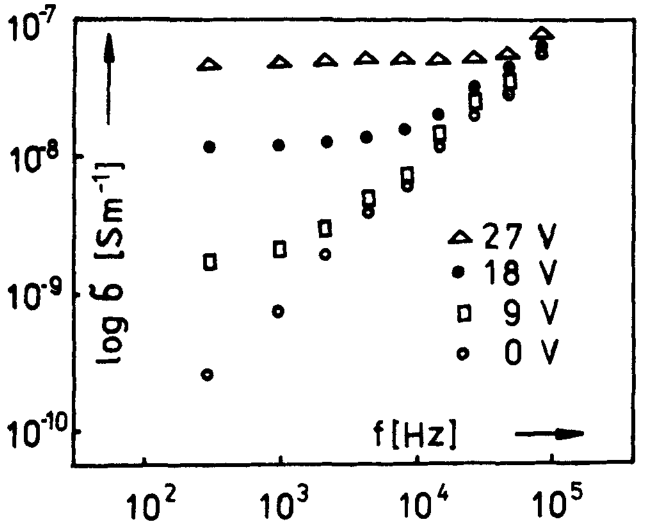

Fig.1 The typical dependence of the ac conductivity on frequency at a number of external voltages.

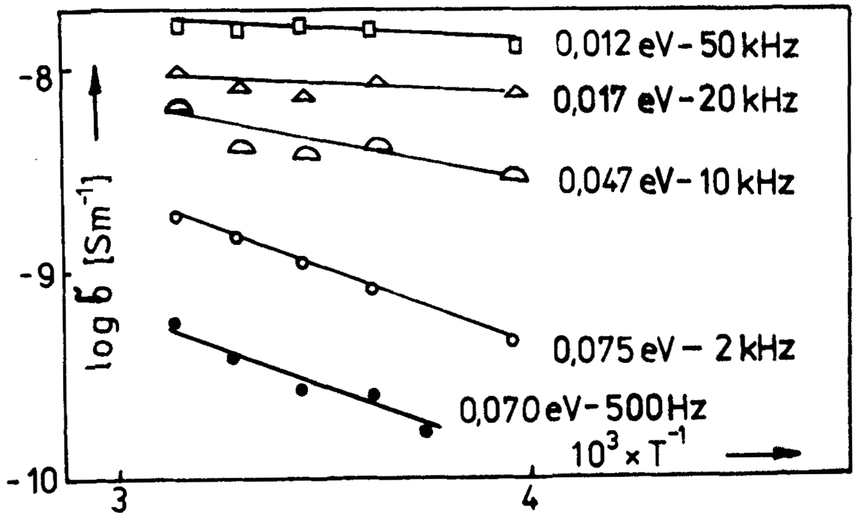

Fig.2 Temperature dependence of the ac conductivity at different values of frequency. $V_{ext} = 0$ V.

According to the Austin-Mott formula[3], the ac conductivity is related to the density of states at the Fermi level $N/E_F/$ by:

$$\sigma(\omega) = \frac{1}{3}\pi e^2 kT \left[N/E_F/\right]^2 \alpha^{-5}\omega \left[\ln \frac{\nu_{ph}}{\omega}\right]^4$$

where α is the exponential decay parameter of localized states wave-function, ν_{ph} is the phonon frequency, k is the Boltzmann constant, t is the temperature of the sample and e is the elementary charge. We can make an estimate of $N/E_F/$ using the Austin-Mott's formula and taking $\alpha^{-1} = 9$Å /the mean value of a distance between molecules in p-terphenyl crystals/ and ν_{ph} to be $10^{12}s^{-1}$ /the typical frequency for molecular crystals without hydrogen

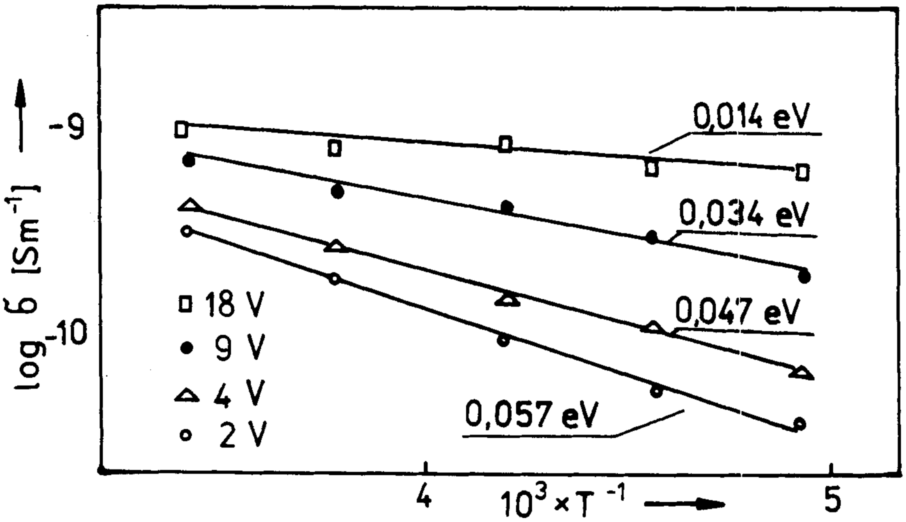

Fig.3 Temperature dependence of the ac conductivity at different values of V_e. f = 500 Hz.

bonds[4]/. As a result of these calculations we obtained $N/E_F/ = 5\cdot10^{18} cm^{-3}eV^{-1}$.

In order to confirm that the intergrain barriers influenced the ac conduction at low frequencies, and in order to define the nature of these barriers, we obtained the activation energies of the conductivity at different values of an external field, as it is shown in Fig.3. The activation energies decrease in voltage according to Poole-Frenkel formula, as it is shown in Table 1. /The values, which were used in Table 1: $\varepsilon = 3.4$[5], thicness of the sample L = 10 µm, ϕ_o = 0.07 eV[2]./

TABLE 1 Comparison of activation energies and Poole-Frenkel law.

External voltage [V]	$\phi_o - \beta_{PF}E^{1/2}$ [eV]	E_a [eV]
2	0.052	0.057
4	0.044	0.047
9	0.031	0.034
18	0.015	0.014

Acknowledgments

The autors are grateful to dr W. Mycielski for helpful discussions.

This work was supported by Polish Academy of Sciences, contract MR I 5-9.05.

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