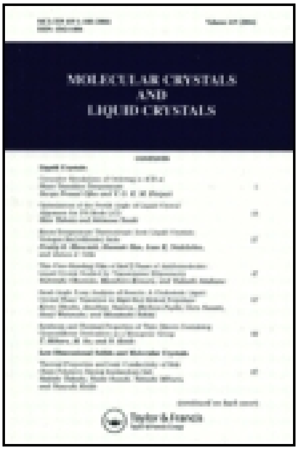

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Oriented Polyacetylene Epitaxially Formed on Crystalline Benzene

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ORIENTED POLYACETYLENE EPITAXIALLY FORMED ON CRYSTALLINE BENZENE

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Abstract Highly oriented polyacetylene film formed epitaxially on the surface of crystalline benzene in the presence of a Ziegler catalyst, shows unexpextedly small electrical anisotropy on doping I_2 and AsF_5.

INTRODUCTION

The polymerization procedure of polyacetylene [$(CH)_x$] reported by Shirakawa *et al.*[1] typically yielded randomly oriented fibrils which form $(CH)_x$ films. They also obtained partly oriented $(CH)_x$ by stretching films. Such orientation leads to electrical anisotropy.[2]

MacDiarmid[3] recently reported interesting method of preparing highly oriented $(CH)_x$ film. We also reported a method of preparing highly oriented $(CH)_x$ films epitaxially on crystalline benzene.[4]

ELECTRICAL ANISOTROPY OF HIGHLY ORIENTED $(CH)_x$

Electrical conductivity measurements of doped, highly oriented cis-$(CH)_x$ were carried out.[4] Results are shown in Figure 1 (I_2 doped and AsF_5 doped), which are plotted with $\log\sigma\,(\Omega^{-1}cm^{-1})$ on the y axis and doping time(hours) at a dopant gas pressure(torr) on the x axis;

$\sigma_{\parallel}$ is the electrical conductivity parallel to the orientation direction and $\sigma_{\perp}$ is that perpendicular to the orientation direction.

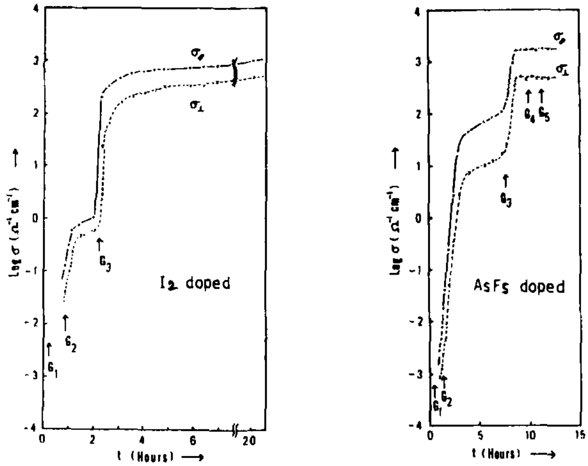

FIGURE 1 Electrical conductivity of highly oriented (CH)x. $\sigma_{\parallel}$ and $\sigma_{\perp}$ refer to the electrical conductivity parallel and perpendicular to the orientation

$\sigma_{\parallel}$ of I_2 and AsF_5 doped $(CH)_x$ are quite large, however, the electrical anisotropy ($\sigma_{\parallel}/\sigma_{\perp}$) is unexpectedly small. These values are summarized in Table I, comparing with those of stretched-$(CH)_x$ reported by Park[2].

TABLE I Electrical anisotropy of (CH)x film.

	highly oriented (CH)x	stretched (CH)x l/l_0 = 3
$(CHI_{0.15})x$	3.1	13
$(CH(AsF_5)_{0.10})x$	3.2	16

ELECTRICAL CONDUCTION MECHANISM

The anisotropy of the stretched-$(CH)_x$ is thought to be due to the deformation of randomly entangled network of fibrils, so this bigger anisotropy is rather apparent, while the anisotropy of highly oriented $(CH)_x$ is thought to be intrinsic because this anisotropy corresponds to the ratio of $\sigma_{\parallel}$ and $\sigma_{\perp}$ within single fibril. When the electrical field is applied an electrical carrier is thought to transport by hopping from one conjugation chain to the adjacent conjugation chain via dopant which exists between the chains. This is shown in a model for carrier transport in Figure 2.

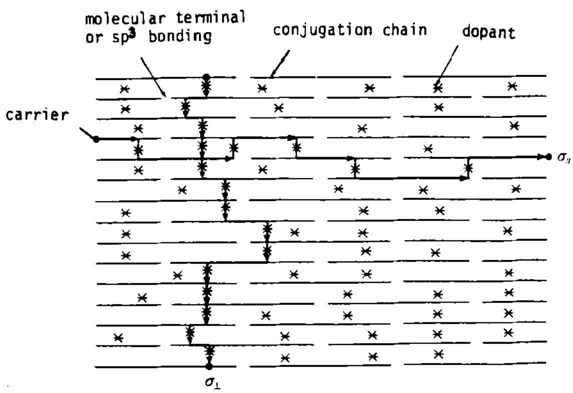

FIGURE 2 Model for carrier transport.

The anisotropy comes from the difference of hopping distance in directions, and $\sigma_{\parallel}/\sigma_{\perp}$ is given by the ratio of hopping lengths in two direction.

From the anisotropy value we can evaluate the length of conjugation chain. Using the values of 8 Å of chain separation distance as reported by Baughman[5], conjugation length is calculated to be about 50 Å.

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