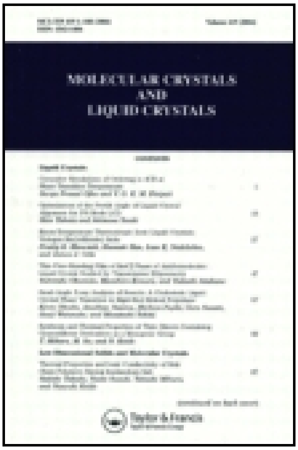

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Complex Conductivity of Lightly Doped Polyparaphenylene (P.P.P.)

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COMPLEX CONDUCTIVITY OF LIGHTLY DOPED POLYPARAPHENYLENE (P.P.P.)

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Abstract The evolution of the frequency and temperature dependence of the complex conductivity $\sigma^*(f,T)$ of lightly doped polyparaphenylene is reported.
The main features of the experimental devices are the followings : a) an automatic determination of σ^* within a large frequency range from 1Hz up to the microwave region; b) a cell structure allowing the measurement of films or pellets (thickness <1mm;c) a large temperature range (70K-400K).
The d.c.conductivity (σ'_{dc}) is found to be strongly temperature dependent (our data are consistent with the Kivelson's model: $\sigma'_{dc} \propto T^n$ with $n \sim 11$). The a.c.conductivity (σ'_{ac}) is proportional to f^s where $s \sim 0.9$. The T-dependence of σ'_{ac} slightly decreases as the frequency increases.

EXPERIMENTAL TECHNIQUES

P.P.P. was synthesized by using the Kovacic method.The powder was doped with AsF5 or Iodine and then pressed into pellets of various thickness [1] .

Conductivity measurements were made in a pellet-cell (figure 1). The sample was located at the end of a coaxial line (APC 7 standard) and it was maintained in a nitrogen atmosphere during the experiments.

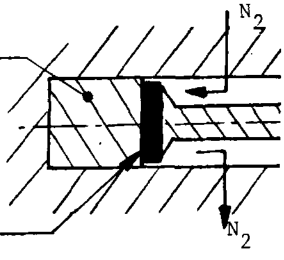

Figure 1 The experimental cell.

The $\sigma(f)$ was obtained at fixed temperature using Hewlett-Packard Impedance Analyzers driven by a H.P. table computer (Figure 2).

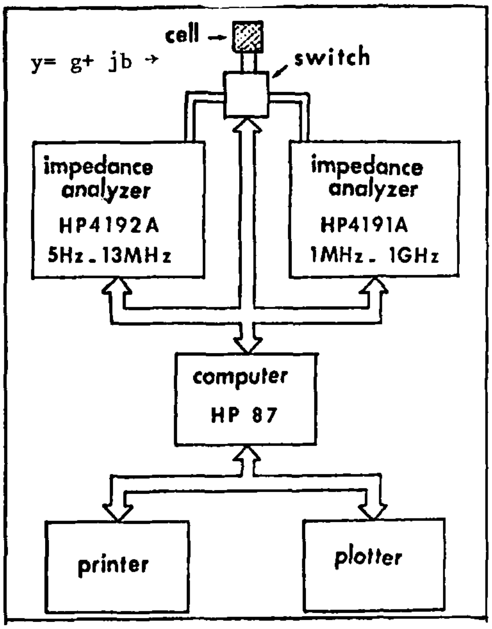

FIGURE 2 The $\sigma(f)$ experimental set-up.

For a given frequency automatically fixed by the calculator via an IEEE bus, the input admittance y was obtained and then the complex conductivity σ^* deduced :

$$y = g + jb = \sigma^* C_a = (\sigma' + j\sigma'') C_a \qquad (1)$$

where C_a is the active capacitance.

The real part (σ') of the complex conductivity (σ^*) is usually divided in a f-independent contribution σ'_{dc} and a f-dependent contribution σ'_{ac} according to Eq.2 :

$$Re(\sigma^*) = \sigma' = \sigma'_{dc}(T) + \sigma'_{ac}(f,T) \qquad (2)$$

From the imaginary part (σ'') of σ^* one uses to deduce, the dielectric constant of the material ε' using equation(3):

$$\sigma'' = \omega\varepsilon' \quad \text{where} \quad \omega = 2\Pi f. \qquad (3)$$

Our data are given using the following three forms: $\sigma'_{dc}(T)$, $\sigma'_{ac}(f,T)$, $\varepsilon'(f,T)$

EXPERIMENTAL RESULTS

Figure 3 shows the variation of dc-conductivity σ'_{dc} with temperature. In the range of temperature investigated, the data are seen to fit the form : $\sigma'_{dc} \propto T^n$. For all doping levels and dopants, $n \sim 11$ which is consistent with the Kivelson's model [2] and other data previously published [3].

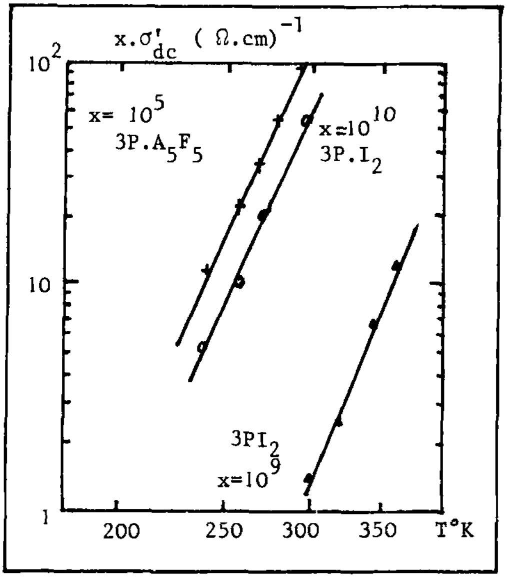

FIGURE 3 σ_{dc} vs temperature for different doping levels and dopants

In figure 4, is given the dependence of ac-conductivity σ'_{ac} vs frequency and temperature. It shows that σ_{ac} increases as f^s with $s \sim 0.9$. Moreover, σ'_{ac} is much less dependent on T than σ'_{dc}. This dependence decreases as f increases.

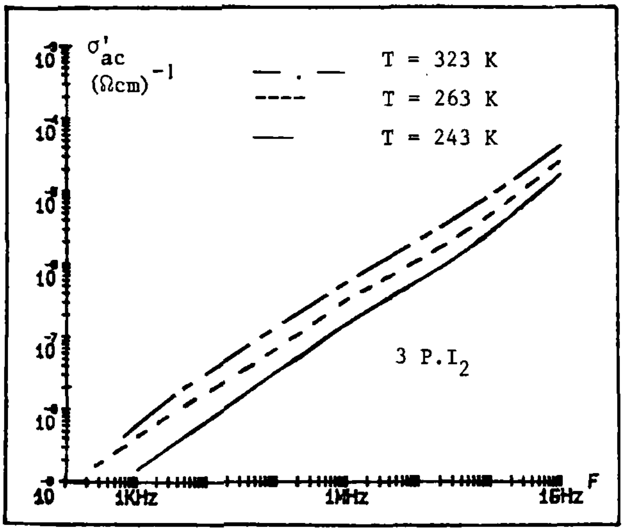

FIGURE 4 σ'_{ac} vs frequency at different temperatures

Finally, in Figure 5 is shown the variation of ε' with f and T. In the high frequency range ε' is only slightly temperature dependent and is independent on f. The value obtained with iodine (∿4.5) is only slightly higher than the undoped P.P.P.pellet (∿3.5). The variation of ε' with f and T in the low frequency range is connected with an electrode polarization effect due to the conductivity. It does not affect significantly the σ' results.

REFERENCES

1. G.Froyer,J.Y.Goblot,J.L.Guilbert,F.Maurice,Y.Pelous, J.de Physique, C3,44,745 (1983)
2. S.Kivelson, Phys.Rev.B,25,6,3798 (1982)
3. see A.J.Epstein, H.Rommelmann, H.W.Gibson, Synth.Met.,9, 103 (1984)

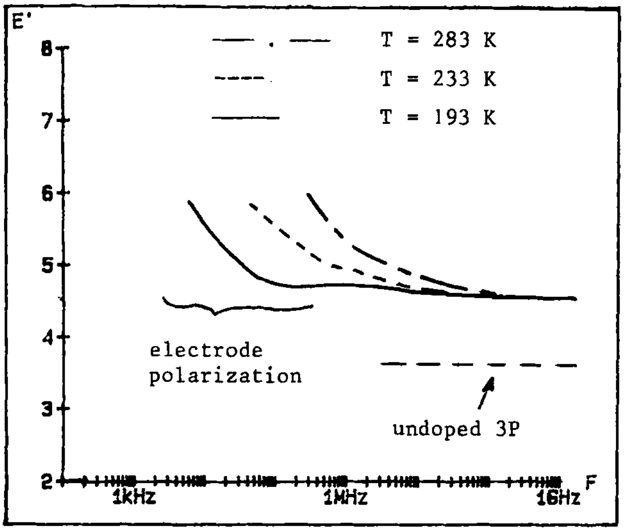

FIGURE 5 Frequency dependence of ε' for different temperatures