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

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Version of record first published: 17 Oct 2011.

To cite this article: BronisŁAw Jachym & Gerard Wiśniewski (1985): A Concept of Electrical Conductivity in Doped Polymers, Molecular Crystals and Liquid Crystals, 118:1, 125-128

To link to this article: http://dx.doi.org/10.1080/00268948508076199

Mol. Cryst. Liq. Cryst. 1985, Vol. 118, pp. 125-128
0026-8941/85/1184-0125/$10.00/0

A CONCEPT OF ELECTRICAL CONDUCTIVITY IN DOPED POLYMERS

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Abstract The coupling of the aliphatic macro-molecules into the conduction mechanism, my be accomplished solely through either a significant, or a total liquidation of the barrier of potential upon the boundary between the macro-molecules - and the admixed conductivity. This achievement may be realized as a consequence from the recombinations between macro-radicals with unpaired spins; upon the surfaces of the admixed conductivity; i.e. - carbon black.

INTRODUCTION

The behaviour of arrangements of polyacetylene type is known[1]. Not only is electrical conductivity of pure acetylene high, but also it may be increased by suitable admixtures e.g. AsF_5 . The material thus obtained is characterized by conductivity of a level equal to that of a metal over a wide temperature range. It is known that polyacetylene molecules are chain structures of conjugated double bonds. Electron delocalization in such an arrangement is high and extends throughout the molecule. The transition mechanism is of considerable importance for pule polyacetylene conductivity. Admixing, suggestively speaking, still lowers the potential barriers at the ends of the macromolecule. In the language of theory, it corresponds to a change of electron hole hamiltonian.

EXPERIMENTAL DATA

When any carbon black of ESR signal higher than 10^{15} spin/gram,as well as radical polymerization initiators and catalysts are added to uncured polyester resin constituting a mixture od styrene,fumaric acid esters and polyglycols,a composite characterizes by electrical conductivity of $10^{-4}\Omega^{-1}cm^{-1}$ level may be obtained after polymerization at carbon black content as small as 0.4% by weight[2]. Dependence of electrical conductivity on carbon black concentration,typical for this kind of composites[3]. The comparison shows that chemical reactions in the course of radical polymerization have decisive influence on electrical properties of the composite obtained in this may. Decisive influence of chemical bonds on physical properties of composites is also shown by the ESR signal observed in samples of various carbon black contents. This is shown in fig.1.

CONCLUSION

The sudden jump observed in electrical conductivity of the described composite arrangement at such a small content of the conductive component is explained by creation of covalent bonds resulting from recombination of radicals on the carbon black globules[3]. In arrangements of polyacetylene type,where the π electron delocalization extends throughout the whole molecule,the last conduction band is unfilled,the potential barriers for the transition of a carrier from one molecule to another one are so low that considerable conductivity is observed. Even weak molecular bonds may still considerably enhance the conductivity,which is achieved by creating suitable

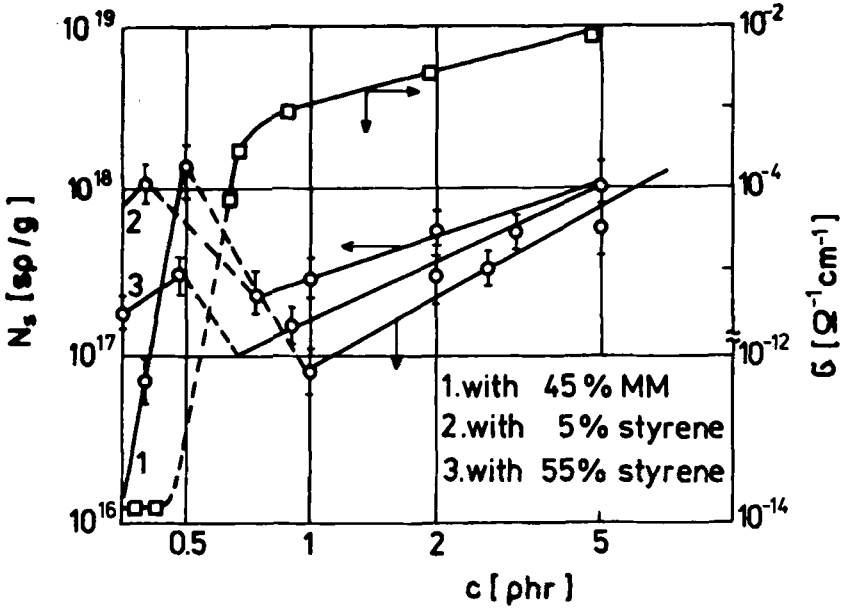

FIGURE 1 Conductivity and ESR signal for compositions with various contents of styrene on concentration of carbon black.

complexes. Materials of this type are called one - dimensional metals. The composition described above may be treated in categories similar to those for polyacetylene arrangement, although it must be noted that "opening" of the structure follows only as a result of covalent bond between carbons, that is as a result of a total elimination of the potential barrier between the molecules.

REFERENCES

1. S.Etemad, A.J.Heeger and A.G.Mac Diarmid, Ann.Rev. Phys.Chem., 33, 443 1982 .

2. B.Jachym,H.Sodolski,T.Słupkowski and R.Zieliński, Phys.Stat.Sol. a 24,K 159 1974 .
3. B.Jachym,Carbon black - polymer composities: The physics of electrically conducting composites, Re E.K.Sichel,Ed. Marcel Dekker Inc.,New York - Basel 1982,pp. 103-34.