INVESTIGATIONS ON THE STRUCTURE OF POLYMERS AND FIBRES THROUGH DIELECTRIC RELAXATIONS

BY

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CERTIFICATE

i) I am satisfied that the thesis presented by Mr. Navin Chand is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by him under my guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

ii) I certify:

a) that he has pursued the prescribed course of research

b) that he is of good moral character.

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Dedicated

TO MY FATHER

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ABSTRACT

Dielectric investigations on polymers and fibres in relation to their structure have been presented in this thesis. Basic principles of the dielectric technique in relation to their use in investigating the structure of polymers are described and an extension of the usefulness of this technique in the following two directions is described:

(i) for studying the structure of polyacrylonitrile (PAN) and its glass transition behaviour and also in determining the glass transition temperature, from the dielectric relaxation data.

(ii) for studying the dielectric properties of fibres, which involves also the problem of interpretation of the dielectric data on mixtures.

As regards the structure of PAN, two distinct views exist about it. The one-phase paracrystalline structure suggested by some authors, does not favour the occurrence of glass transition. The glass transition and the two-phase structure of this polymer is suggested by various other authors. This study has suggested that both these types of structures are possible in PAN under different conditioning treatments.

The presence of amorphous phase in PAN has been confirmed by X-ray diffraction and the changes produced on it due to gradual copolymerization of PAN with relatively bulky group containing comonomers, hydroxyethyle methacrylate (HEMA).

Changes in dielectric relaxation produced by the copolymerization investigated in this work supported the origin of the observed relaxation in the amorphous phase of PAN.

This work also describes the more definite methods for ascertaining the glass transition behaviour of the dielectric relaxations and also for determining the glass transition temperature from these data.

For the investigation of dielectric properties of fibres, this work describes some new methods for reducing the initial difficulties in the dielectric measurements on fibres. Polyethylene terephthalate (PET) fibres were used for this study.

Initial difficulties of holding fibres between test condenser plates have been solved through the method of holding fibres in discs. This has a further advantage that fibres can be held both parallel and perpendicular to the disc surface, thus making possible an investigation of the anisotropic effects in the dielectric properties of fibres.

Dielectric constant of PET fibres with applied electric field perpendicular to the fibre axis has been determined through the data on wide range of mixture composition.

An empirical method for determining dielectric constant of one component of the mixture has been described. Also an equation for the dielectric loss parameter of the mixtures has been derived for the interpretation of the dielectric data on mixtures.

Anisotropy of dielectric β- relaxation in PET fibres has been investigated and its quantitative correlation with the oriented structure of the fibres is discussed. This has also provided a means of ascertaining the origin of β-relaxation of PET.

Effect of draw ratio on the dielectric anisotropy of these fibres is also studied.

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