CHAPTER 2

MATERIALS AND THEIR CHARACTERISTICS
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2.1. Introduction.

The knowledge of the electrical properties as well as the charge storage phenomena of biological materials are of great interest because such knowledge may lead to greater understanding of structure-function relationships as a fundamental component of all living systems. This area of study requires the combination of skills of Biologists, Chemists and Physicists. It is for the last few years that the cooperation among the various disciplines has begun to emerge. The research in this field is continuing and publications appear in a wide spectrum of journals and books (1-13). In fact, the field is in its beginning and much valuable work has to be done. It is in this context that a variety of biological materials are subjected to the detailed study of their charge storage and transport phenomena.

Though the different techniques that are used to analyze the biomaterials are same as those for other materials, yet specific changes and modifications in these techniques are necessary to be incorporated. The details are explicitly discussed below.
Materials of biological origin can not be easily put in a single crystal form and mostly the polymer fibers or powder samples are used. But in some cases such as cellulose and D.N.A a film may be obtained. In such cases the orientation of the macro molecule in relation to the film may be investigated by X-rays or by optical techniques and may be important for the interpretation of the results observed. A typical case is that of the natural electret effect in keratin found in highly oriented samples of biological origin.

The purity and the originality of the biological samples are very important factors for the electret investigation. Therefore, great attention is required in the preparation and handling of the samples, preferably with the assistance of biochemists or biologists.

Many biological molecules change their properties by denaturation, hydration, dehydration, oxidation or even by the exposure to light, therefore careful attention to all these factors is inevitable during the electret investigation of biological materials.
Most of the biological materials are studied intensively in solution, but in the majority of cases a little is known about the true "solid state" of the materials and the investigator should be careful not to assume that the properties investigated in solution apply to solid samples. For instance the collagen molecule, a triple helix, may denature thermally partially into random coils or completely into isolated helixes (gelatin). In solution the denaturation temperature is around 65 °C. However in the solid state collagen can be heated up to 150 °C with no appreciable denaturation.

The water molecules attached to the macro molecule, which are free to rotate and hydration water or free water may also play important role in electrets. Therefore the percentage of water in the sample should be identified before the electret investigation.

In working with biological materials, in most cases a polycrystalline pressed sample will probably be the only form available for experiments. In this situation, Maxwell-Wagner losses may be present. This is certainly one of
the main criticisms of the use of polycrystalline samples. Whether peaks are due to Maxwell-Wagner losses rather than to intrinsic dipolar effects can be seen by changing the physical conditions of the sample, such as crystalline size or forming pressure. Maxwell-Wagner peaks will shift and charge profile or area under these changes. In any case, it is not always simple to separate Maxwell-Wagner losses from intrinsic bulk properties of the material under investigation, and this is a point always to be kept in mind with biological samples(14).

2.2 The Materials

Though a large number of biomaterials are subjected to experimental study by various workers, vitamins which are very important in various life processes remain untouched till now. Polysaccharides are other group of biomaterials where the investigations are very limited. In the present investigation a polysaccharide, Dextrin and a vitamin Folic acid are chosen because of their biological and physical importance. Their importance and the properties of the materials are briefly discussed below.
2.2.1 Dextrin

Dextrin \( (C_6H_{10}O_5)^n \) is an important polysaccharide in which the monomer unit is d-glucose. Studies have already been reported on glucose and, therefore the present study may help to compare the electret effects in the macromolecule and their monomer units. Dextrin, widely used as sweetening material, is produced by the degradation of starch. It is used as an excipient dry extract and pills, for preparing emulsion and bandages. The monomer unit of Dextrin is as shown in fig (2.1).

2.2.2 Folic acid

Folic acid was first isolated from spinach leaves but has a very broad biological distribution. It has three major components glutamic acid, p-aminobenzoic acid and a derivative of the heterocyclic fused ring compound, pteridine as shown in fig (2.2).
On a world wide basis the deficiency of folic acid in human body is believed to be the most common form of vitamin under nutrition. Deficiency of folic acid also known as Pteroyl-glutamic acid causes anemia in which blood red vessels do not mature properly. Its active form is called Terahydro folate. Folic acid acts as a co-enzyme in enzymatic reaction involving 1-carbon- group transfer.

To check the purity of the samples the IR spectrum of the samples are taken and are shown in fig (2.3) and (2.4). Fig (2.3) shows the IR spectrum of Dextrin and fig (2.4) that of Folic acid. In both the cases the different peaks have been compared to the functional groups of the samples and are found to be exactly matching, barring those corresponding to structural water and free water.

To observe the effect of water absorption in the crystallinity of the samples X-ray diffraction spectrogram is taken and are presented here. The spectrograms at different hydrations of the samples, Dextrin and Folic acid are found to be exactly the same. Figure (2.5) shows the XRD spectrum of Dextrin and Fig (2.6) shows that of Folic acid. This behaviour is a clear indication that the crystallinity of these materials are not affected with respect to water absorption.
FIG. 2.3
IR SPECTRA OF DEXTROIN
FIG. 2.4
IR SPECTRA OF FOLIC ACID
FIG. 2.5

XRD PATTERN OF DEXTRIN
2.3 Conclusion

From the comparisons and analysis of various spectrums reported, the purity and originality is checked. The materials are also subjected to change in various parameters which are proposed in various studies to identify whether the samples have any structural change. From the different spectra, it has been ascertained that the samples do not change their inherent properties during which they are subjected to study the charge storage and transport phenomena.
2.4. References

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[5]. Harvey, S.C., and Hoekstra, P., J. Phys. Chem 76, 21 2987 (1972)


