



ON COLE – COLE PLOTS OF ANIMA CARTILAGE

R. GANGADHAR, KALEEM AHMED JALEELI, ADEEL AHMAD

Biophysics Research Laboratory, Department of Physics, Nizam College (Autonomous), Osmania University, Hyderabad –India
e. mail: dr_adeelahmad@yahoo.com

ABSTRACT

The paper presents Cole – Cole plots drawn for ovine Cartilage. Dielectric constant and Dielectric loss of scapular cartilage are measured in the frequency range of 20 Hz to 2MHz at room temperature. For this purpose, multi frequency auto scanning LCR meter is used. Cole - Cole plots are drawn between Dielectric loss on Y-axis and Dielectric constant on X- axis and dielectric relaxation time is calculated.

Key words - Dielectric constant, Dielectric loss, Relaxation time

1. INTRODUCTION

The living system contains a wide variety of tissues in which different types of physico chemical processes proceed to keep an organism in living condition. Tissues are matrix of the body, which will together make up the machinery of the complete living system. Moreover, tissues play an important role in conducting and transmitting electrical impulses from neuron in order to carryout living process.

The study of dielectric properties of macro molecules, cells and tissue of biological interest become part of inter disciplinary research in the biological sciences. Advances in such studies certainly are of benefit to some branches of medicine.

The dielectric properties of animal cartilage could result in the development of tools for diagnostic and therapeutic application [1]. The physiological effects of electric current had drawn the attention of research in 19th century. The early theories of Cole [2]and Danzer [3] for the dielectric properties of cell suspensions were further simplified and extended by Schwan and co -workers [4]. Animal bone is known to be denser and less porous than the human bone [5] The micro damage does not affect other parameters to such an extent that conductivity is not as sensitive for interface processes as compared to dielectric constant [6].

Adeel Ahmad and his co - workers did extensive work on animal integuments [7], animal bone [8], animal soft tissues [9], Human blood [10] and molluscan shells [11] and discuss the results with respect to molecular composition, cellular arrangement, physiology and environmental influences.

A perusal of literature reveals that extensive work has been done on physical properties of biological tissues, in general, and mineralized tissues in particular. But systematic studies have not been done on solid state properties of cartilage. Therefore, an attempt has been made to study dielectric properties of scapular cartilage.

2. Materials and Methods

Cartilage samples, 14 in number, of the animal –ox was collected from local slaughter house and were cut into discs of uniform thickness. Maximum care was taken to get uniform cross section. The thickness of the sample was measured by screw gauge. Weight of the samples was taken using electronic weighing machine of L. C. 0.001gm. Multi frequency (20 Hz – 2 MHz) Auto scanning LCR meter was used to collect the data on dielectric parameters as a function of frequency. Cole – Cole plots were drawn between dielectric constant (ϵ') on x- axis and dielectric loss (ϵ'') on y-axis. Dielectric relaxation time (τ) was calculated measuring Cole – Cole

parameters such as θ , u and v at a frequency ω . The formulae used for the calculation of dielectric relaxation time (τ) are: $\theta = \pi h/2$ and $\omega \tau = (v/u)^{1-h}$

Table 1(a) Cole – Cole Parameters of Ovine cartilage

Sample Code	ϑ (deg)	h	u (cm)	v (cm)	ν (Hz)
C01	24	0.27	1.2	2	400
C02	22	0.24	2.0	2.5	350
C04	25	0.27	1.9	2.5	300
C05	40	0.44	1.5	3.7	422
C06	17	0.18	1.6	4.0	250
C07	35	0.38	0.9	2.4	751
C08	17	0.18	1.0	3.7	474
C09	27	0.30	1.5	3.3	178
C10	19	0.21	1.0	2.5	632
C11	27	0.30	1.9	2.0	422
C12	27	0.30	2.2	3.2	178
C13	30	0.33	1.4	2.3	300
C14	27	0.30	1.2	2.0	400

Table 1(b) Cole – Cole Parameters of Ovine cartilage

Sample Code	ϑ (deg)	h	u (cm)	v (cm)	ν (Hz)
C1	24	0.27	5.9	20.9	30
C2	22	0.24	7.9	17.7	34
C4	25	0.28	9.8	18.5	23
C5	40	0.44	9.2	17.0	23
C6	17	0.19	8.4	19.0	21
C7	35	0.39	6.9	19.0	31
C8	17	0.19	6.5	20.0	23
C9	27	0.3	7.8	18.5	25
C10	19	0.21	7.9	21.1	25
C11	27	0.3	7.8	18.8	30
C12	27	0.3	8.7	18.0	21
C13	30	0.33	7.8	17.5	22
C14	27	0.3	8.5	18.0	25

Table 3 - Dielectric Relaxation Time of Ovine Cartilage

Sample Code	T ₁ (μ sec)	T ₂ (μ sec)
C01	9.70	92.59
C02	8.02	81.69
C04	9.68	120.77
C05	13.34	120.77
C06	25.78	132.27
C07	8.46	89.60
C08	20.62	120.77
C09	29.65	111.11
C10	10.06	111.11
C11	4.95	92.59
C12	18.01	132.27
C13	12.15	126.26
C14	9.49	111.11

3. RESULTS AND DISCUSSION

As is known Biological tissues are complex in nature. They contain both inorganic and organic materials along with water. Cartilage is a connective tissue. Cartilage of the present investigation contains the protein called collagen along with considerable quantity of water. This tissues reveals two dielectric relaxations in the frequency range of 20 Hz to 2 MHz and relaxation time is (4 – 30 μ sec) and (82 – 132 μ sec). The wide range of relaxation time exhibiting in both the relaxations of cartilage may perhaps be due to in homogeneity in molecular composition. In this case water content may not be the same in different samples of the cartilage.

The paper suggests that there may be two polarisation mechanisms namely, space charge polarisation and interfacial Maxwell – Wagner polarisation between adsorbed water and protein, operating in fresh (wet) scapular cartilage.

Acknowledgement

One of the authors (R. G.) is thankful to Osmania University and UGC for providing UGC Non-Net fellowship to carry out research work.

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