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Studies on dielectric behaviour of *Myrtaceace and Mimosoideae* family Indian wood species

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Abstract: The measurement of dielectric properties of materials is critical to understanding the electromagnetic field distribution in the materials. Apart from those, wood is a complex biomaterial has basic properties and significantly different even in the same tree. Therefore it would be affected the function in its use. The present investigation explores dielectric properties such that dielectric constant , dielectric loss and ac electric conductivity were measured at low frequency range (100Hz-1MHz) for eight *Myrtaceace and Mimosoideae family* tree wood species at room temperature 308K.The variations in their dielectric properties observed from one species to other. The relaxation time behaviour is also analyzed for each species and analyzed their structures critically.
Key wards: Dielectric constant, dielectric loss, electrical conductivity, relaxation time, *Myrtaceace and Mimosoideae family wood species.*

Introduction:

Wood is considered as a complex biomaterial that it had provided multi-purpose functions. It can be seen clearly in its structure and composition. Those components, therefore gives great contribution to the particular functions and services [1].Wood has great variation in their structure and cells for each species of wood or even in the same species has conspicuously. Therefore it gives well establish its function as well as appropriation in further used. Wood utilization closely intertwined by its properties as well as has to be cautiously considered due to it's possess hygroscopic characteristic which of relate closely to the surrounding environmental [2].

Dielectric properties of wood have both theoretical and industrial applications. They also provide a better understanding of the molecular structure of wood and wood-water interactions [3]. The behaviour of water with the constituents of wood such as cellulose and lignin can be understood more clearly by studying dielectric properties. Dielectric properties of material are influence frequency, temperature, water content, density, composition and material structure. Wood has dielectric properties and non ideal polarization conduct dissipation phenomena, energy adsorption, and damages that influence dielectric constant [4-7].

This paper deals with relaxation time, dielectric constant, dielectric loss factor and electrical conductivity at room temperature of *Myrtaceace and* Mimosoideae *family wood species* in the frequency range 100Hz to 1MHz.

Experimental Procedure:

For the study of dielectric properties, eight different wood logs (Table.1) are collected belonging to *Myrtaceace* and *Mimosoideae* botanical families from different places at normal dried condition for present investigation. The test samples were obtained from the sapwood region in the form of pellets; Dielectric constant and dielectric loss factor and electrical conductivity were measured at low frequencies from 100Hz to 1MHz by the computer using the low frequency impedance analyzer Hioki 3532-50 LCR-Hi tester Koizum, Japan.

Table.1. Data of wood species for the present investigation

Name of wood species	Type	Botanical Family
Psidium Guajava (PG)	Hard wood	Myrtaceace
Eucalyptus Melliodora(EM)	Hard wood	Myrtaceace
Syzium Cumini (SC)	Hard wood	Myrtaceace
Prosopis Juliflora(PJ)	Hard wood	Mimosoideae
Acacia Nilotica (AN)	Hard wood	Mimosoideae
Leucaena Leucocephala (LL)	Soft wood	Mimosoideae
Pithecellobium Dulce(PD)	Hard wood	Mimosoideae
Albizia Saman (AS)	Soft wood	Mimosoideae

Results and Discussion:

Dielectric Properties

Dielectric data for frequencies from 100Hz to 10M Hz at room temperature 308K are presented in Fig.1-3 by taking 5 samples each. The variations in dielectric properties are observed from one wood species to other and they depend on type of wood species (Hard and soft wood) .The dielectric constant decreases for all the eight wood species nearly up to 200 KHz at room temperature 308K, also it was observed that by varying the frequencies in hard wood species dielectric constant decreases to 1MHz, indicating that the contribution of interfacial polarization becomes insignificant, and the predominant polarization is molecular; that is, energy is absorbed in the form of induced dipole moment of the molecule, and in the form of alignment of molecules having fixed dipole moment. In soft wood species such as in Leucaena Leucocephala (LL) and Albizia Saman (AS) after 200 KHz, the dielectric constant increases abruptly with frequency. The increase in dielectric constant at low frequency can be explained by the fact that the dipolar groups are bound in the solid structures so that the dipole is a structural element of the solid lattice and rigidity of the lattice hinders the orientation of the dipoles .It is assumed that the fixed dipole moment of the cellulose molecules and the interfacial polarization at lower frequencies are both activated by thermal energy. This concludes that dielectric constant affect the amount of power that is dissipated in soft wood in the form of heat [8]. Fig.2 shows that a decrease and increase in the dielectric loss at low frequency range from 100Hz to 1MHz. An elevated dielectric loss in hard and soft wood results in higher power absorption by wood in the form of heat. Conversely a lower dielectric constant favors higher heat absorption in wood. Inhomogenity likes defects, space charge formation and lattice distortions etc. in the interfacial layers together produce an absorption current resulting in dielectric loss.

Fig.3 represents variation electrical conductivity of different for different woods species, when measured 100Hz to 1MHz frequency range , reveals that the significant variations which may be attributed to the extent of hydration, molecular architecture, nature and composition of woods. In spite of the fact that each constuient of the wood has its own physiological individuality, definite relations between wood parameters

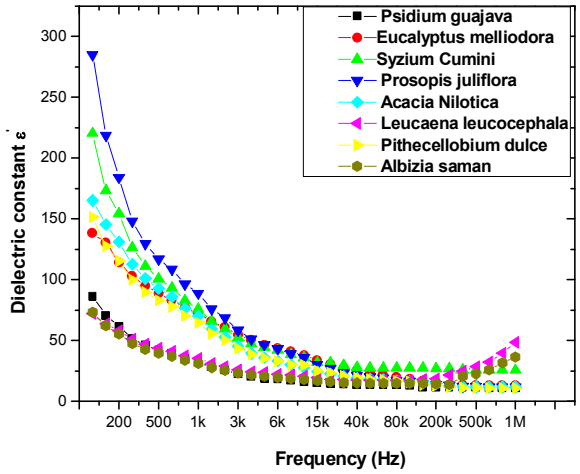

Fig.1 Diectric constant of *Myrtaceace* and *Mimosoideae* family wood species as a function of frequency from 100Hz to 1MHz.

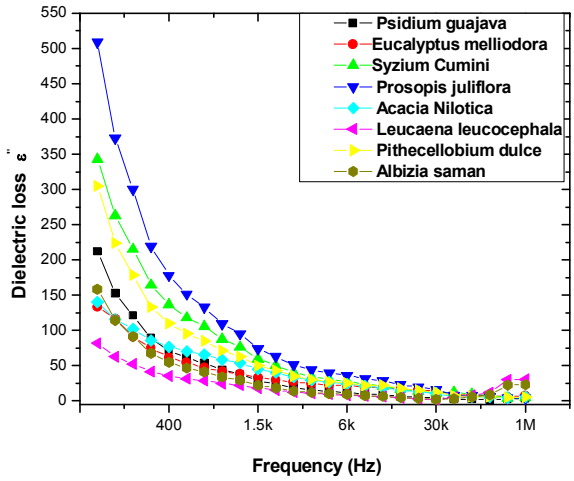

Fig.2. Diectric loss of *Myrtaceace* and *Mimosoideae* family wood species as a function of frequency from 100Hz to 1MHz.

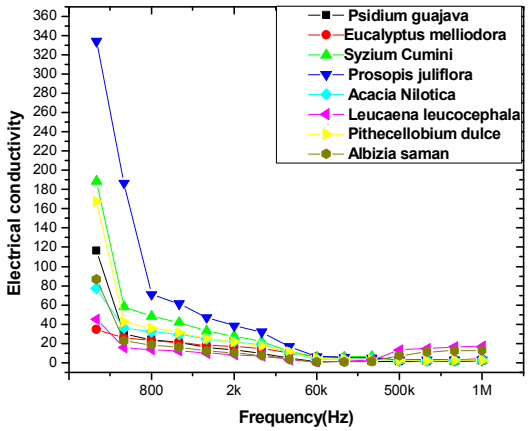

Fig.2. Electrical conductivity of *Myrtaceace* and *Mimosoideae* family wood species as a function of frequency from 100Hz to 1MHz.

Relaxation Time:

Dielectric parameters of materials are function of many exponential controlled parameters, the main issue is the temperature dependency of characteristics of relaxation times, it represents rate of chemical reaction rates. The Cole – Cole plot is a simple, elegant and highly useful tool to determine dielectric relaxation of a material in a particular range of frequency. Dielectric relaxation exhibits in wood due to the frequency and temperature dependence of dielectric parameters, different dielectric relaxations observed in different woods with different characteristic frequencies (Table 2).The number of relaxations from Cole-Cole plots, which show proportionality to the concentration of dipoles contributing to the orientation polarization, increasing with increase accessibility of dipoles in wood samples. In the present investigation, the results of dielectric parameters of different type of woods, reveals that hard woods shows three dielectric relaxations where as soft woods shows two dielectric relaxations. This concludes that in soft wood the power that dissipated in the form of heat with frequency variation which diminishes the relaxation of water content present in wood ie, the orientation polarization of hydroxyl group

Table.2. Data on Cole-Cole parameters

Name of wood species	Type	Characteristic frequency(Hz)	U	V	θ	Relaxation time(sec)
Psidium Guajava (PG)	Hard wood	1.5K 5K 15K	11.4 5.4 2.5	40.2 11.5 7.9	27 11 13	0.65 μ 0.75 μ 0.4 μ
Eucalyptus Melliodora(EM)	Hard wood	4K 15K 200K	19.3 12 4.7	29.6 13.8 7.8	25 9 12	0.72 μ 0.12 μ 8.13 μ
Syzium Cumini (SC)	Hard wood	1.5k 4K 15K	15.9 8.8 4.1	37.9 12.8 9.5	20 9 16	0.084 μ 0.604 μ 0.3 μ
Prosopis Juliflora(PJ)	Hard wood	2k 5K 150K	18.6 12.2 1.8	32 19.3 3.2	24 21 28	0.02 μ 0.58 μ 2.46 μ
Acacia Nilotica (AN)	Hard wood	2K 10k 30K	16.3 5.9 3.3.	24.3 12.3 7.9	18 9 11	0.013 μ 0.36 μ 0.74 μ
Leucaena Leucocephala (LL)	Soft wood	1.5K 8K	10.9 4.4	22.3 11.7	10 17	0.03 μ 0.66 μ
Pithecellobium Dulce(PD)	Hard wood	4K 20K 200K	12.8 5.8 2.5	28.7 9.8 3.8	35 32 35	0.15 μ 0.18 μ 1.56 μ
Albizia Saman (AS)	Soft wood	2K 8K	8.1 4.4	37.4 12.1	22 12	0.06 μ 0.64 μ

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