ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 14, Issue, 08, pp.22102-22104, August, 2022
DOI: https://doi.org/10.24941/ijcr.43904.08.2022

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

MEASUREMENT AND ANALYSIS OF DIELECTRIC PROPERTIES OF 4 – PHENOXY BENZOPHENONE AT MICROWAVE FREQUENCY RANGE

***Dr. Govind Apparao Karhale**

Department of Physics, Madhavrao Patil Arts, Commerce and Science College, Palam Dist. Parbhani 431420 (MS), India

ARTICLE INFO

Article History:
Received 19th May, 2022
Received in revised form
05th June, 2022
Accepted 24th July, 2022
Published online 23rd August, 2022

Key words:
Dielectric constant, Loss factor, Electromagnetic Energy, Relaxation Time, Conductivity, 4-Phenoxy Benzophenone.

**Corresponding Author:*
Dr. Govind ApparaoKarhale

ABSTRACT

The study of organic compounds such as 4 – phenoxy benzophenone has important role as a photosensitizing agent and a plant metabolite related to dielectric behaviour from microwave absorption is of great value. The dielectric parameters are generally dependent on frequency, temperature, packing density and other factors such as material structure and composition. The behaviour of dielectric substance4-Phenoxy benzophenoneis changed by the application of external electric field. The important concept in dielectric theory is that of an electric dipole moment which is measure of electrostatic effect of a pair of opposite charges separated by a finite distance. The present paper examines the effect of packing density and temperature on dielectric parameters of 4-Phenoxybenzophenone. The wave guide cell was designed for holding 4-Phenoxybenzophenone sample in the form of powder. The reflectometric technique was used for the measurement of dielectric constant and loss factor. Measurement of 4-Phenoxybenzophenone powders of different packing fractions at 9.85 GHz microwave frequency are reported. The results indicate that, the values of dielectric constant ($\varepsilon_p^{'}$), dielectric loss ($\varepsilon_p^{''}$), relaxation time (τ_p) and conductivity (σ_p), increases with the increase of relative packing fraction (δr) 0.9501, 0.9685, 1.000, and decreases with the increase in temperature 15^0c, 25^0c to 60^0c. The experimental values have been used to obtain transformation to 100% solid bulk, using co-relation formulae of Landu-Lifshitz, Looyanga and Bottcher. The results show that there is a fair agreement between the experimental and theoretical values of dielectric constant and dielectric loss.

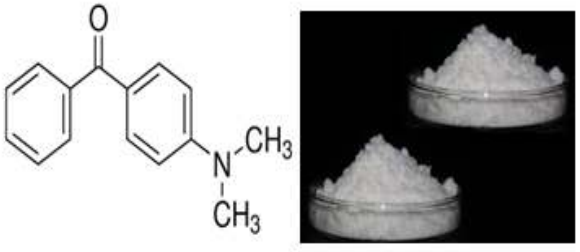
Citation: ***Dr. Govind Apparao Karhale.*** **2022.** "Measurement and Analysis of Dielectric properties of 4 – Phenoxy Benzophenone at Microwave Frequency Range.". *International Journal of Current Research*, 14, (08), 22102-22104.

INTRODUCTION

Dielectrics and dielectric properties of materials are defined, and the fundamental relationships of dielectric properties with electromagnetic energy are discussed in this paper. The dielectric constant and the dielectric loss factor are components of the complex relative permittivity, which is also explained. The dielectric constant is associated with the ability of a material to store energy in the electric field in the material, and the loss factor is associated with the ability of the material to absorb or dissipate energy, that is, to convert electric energy into heat energy. The variation in the dielectric properties of materials—with respect to the frequency of the fields to which they are subjected, the temperature of the materials, and the density of the 4-Phenoxybenzophenone material which have molecular formula $C_{19}H_{14}O_2$. General principles for measuring dielectric properties are discussed, and techniques and instruments used for measurements on organic chemical compounds presented. The measurement techniques appropriate for any particular application depend on the frequency of interest; the nature of the dielectric material to be measured, both physical and electrical; and the degree of accuracy required.

Many different kinds of instruments can be used for measurement, but we used reflectometric technique for the measurement any instrument that provides reliable determinations of the required electrical parameters involving the unknown material in the frequency range of interest can be considered. Equipment and techniques are described for measurements ranging from 9.85 GHz frequencies upthrough the radio frequencies and into the microwave region.

Chemical Structure of 4- Phenoxy benzophenone:



MATERIALS AND METHODS

Dielectric constant (ε') and dielectric loss (ε") were measured by using reflectometric technique [1,2,] Measuring the reflection co-efficient from air dielectric boundary of sample in the microwave X – band at 9.85 GHz frequency at 20º, 35º and 50ºC temperature. The following equations were used to determine the dielectric parameters.

$$\epsilon' = \left(\frac{\lambda_0}{\lambda_c}\right)^2 + \left(\frac{\lambda_0}{\lambda_d}\right)^2 \quad (1)$$

$$\epsilon'' = \frac{1}{\pi}\left(\frac{\lambda_0}{\lambda_d}\right)^2 \alpha_d \beta_d \quad (2)$$

Where,

λ_0 = the wavelength in free space.
λ_c =2a is cut-off wavelength of the wave guide.
a – is broader dimension of the rectangular wave guide.
αd = is the attenuation introduced by the unit length of the dielectric materials.
βd = $2\pi\lambda_d$ is phase shift introduced by the unit length of the dielectric materials.
λ_d = wavelength in the dielectric powder.

Figure X. Band Experimental set up to measure the Dielectric parameters

Detail regarding the procedure is given in[3] the present investigation, small quantity of powder was introduced in the cell and the plunger was brought over the powder column. A pressure was allowed to exert by plunger on powder in the dielectric cell. The height of the powder column and the corresponding reflection co-efficient was measured by means of a crystal pick-up in the directional coupler. This process was repeated at every addition of powder in the cell. The relationship between reflected power and height of the powder column was approximately given by a damped sinusoidal wave. The distance between two adjacent minima's of the curve gave half the dielectric wavelength (λ_d=2L). For the determination of dielectric parameters of 4- phenoxy benzophenone samples of various particle sizes were prepared by using sieves of different size. For the comparison of correlation formulae between powder and bulk, the packing fraction (δ_r) were taken as the ratio of density of powder and the density of the finest crushed closely packed particle assembly of the sample[5]. The conductivity (σ_p) and relaxation time (τ_p) were obtained by using following relations.

$$\sigma_p = \omega \epsilon_0 \epsilon'' \quad (3)$$

$$\tau_p = \frac{\epsilon''}{\omega \epsilon'} \quad (4)$$

Where,
ω - is angular frequency of measurement (9.85 GHz).
ε_o - is permittivity of free space.

For low loss materials, dielectric constant (ε') and loss factor (ε") for bulk materials can be correlated with their powder form by the relations[6,7] derived independently by Landau-Lifshitz and Looyenga,[8].

$$\epsilon'_S = \frac{\left[\left(3\delta + 2\,\epsilon'_p - 2\right)\epsilon'_p\right]}{\left(3\delta - 1\right)\epsilon'_p + 1} \quad (5)$$

$$\epsilon''_S = \left(\frac{\epsilon''_P}{\delta_r}\right)\left(\frac{\epsilon'_S}{\epsilon'_P}\right)^{2/3} for \frac{\epsilon''}{\epsilon'} << 1 \quad (6)$$

Where,

ε'_s – is the dielectric constant for the material in bulk,
ε'_p – is the dielectric constant of powder sample at relative packing fraction (δr).
ε''_s and ε''_p – are the dielectric losses for solid and powder respectively.
The results obtained have been verified with values obtained from Bottcher's equation [3].

$$\epsilon'_S = \frac{\left(2\,\epsilon'_P + 3\delta - 2\right)\left\{\left(3\delta - 1\right)\left(\epsilon'^2_P + \epsilon''^2_P\right) + \epsilon'_P - 2\,\epsilon''^2_P\right\}}{\left(3\delta - 1\right)^2\left(\epsilon'^2_P + \epsilon''^2_P\right) + 2\,\epsilon'_P\left(3\delta - 1\right) + 1} \quad (7)$$

$$\epsilon''_S = \frac{2\left(3\delta - 1\right)\left(\epsilon''^3_P + \epsilon'^2_P\,\epsilon''_P\right) + \epsilon''_P\left(3\delta - 2\right) + 4\,\epsilon'_P\,\epsilon''_P}{\left(3\delta - 1\right)^2\left(\epsilon'^2_P + \epsilon''^2_P\right) + 2\,\epsilon'_P\left(3\delta - 1\right) + 1} \quad (8)$$

RESULTS AND DISCUSSION

Dielectric constant (ε') and dielectric loss (ε") along with the values of relative packing fraction (δr) of 4 – phenoxy benzophenone sample given in table -1. The values of (ε'_p) and (ε''_p) obtained experimentally for different grain sizes and temperature showed that, there is simultaneous increase in dielectric constant (ε') and loss factor (ε") with increasing temperature. This was expected, because with higher values of relative packing fraction (δr) the inter particle hindrance offered to the dipolar motion for a compact medium will be much higher than for less bounded particles. Such observations have been already made by other workers [8,9] for higher values of packing fraction. Values of relaxation time (τ_p) loss tangent (tanδ) conductivity (σ_p) and values of moisture content with relative packing fraction and different temperature revealed that there was increase in (σ_p), (τ_p) and (tanδ) with the increasing values of packing fraction (δr). There was systematic decrease in (σ_p), (τ_p) and (tanδ), moisture percentage with increasing values of temperature. Such behaviour is expected because when polar molecules are very large, the rotator motion of the molecules is not sufficiently rapid for the attainment of equilibrium with the field. The increase in conductivity therefore suggests that at higher compactions, no micro cracks are developed in the sample due to high mechanical pressure. The decrease in relaxation time (τ_p) with increasing temperature may be due to increase in the effective length of dipole. In addition, due to increasing temperature, number of collisions increase causes increase in energy loss and thereby decreasing relaxation time. Table -2 shows measured and computed values of dielectric parameters for bulk from powder measurements. The results reported at δr = 1 are those measured on the finest crushed powder sample packed very closely in a wave-guide cell pressing it under a fixed pressure, so as to obtain minimum voids between the particles.

Table 1. Values of dielectric constant ($Є'_p$), dielectric loss ($Є''_p$), loss tangent (tanδ), relaxation time (τ_p), conductivity (σ_p) of 4-Phenoxy Benzophenone at different temperatures

Temp °C	Dielectric constant (ε')	Dielectric loss (ε")	Tanδ	Relaxation Time τ_p (10^{-12})	Conductivity σ_p (10^{-2})
15	2.354	0.035	0.016	0.255	1.92
25	2.291	0.009	0.004	0.065	0.49
35	2.287	0.008	0.004	0.065	0.44
45	2.233	0.048	0.021	0.348	2.63
50	2.632	0.043	0.016	0.265	2.35
60	2.975	0080	0.027	0.435	4.38

Table 2. Measured and calculated values of dielectric constant ($Є'_s$), and dielectric loss ($Є''_p$) for bulk from 4 – Phenoxy Benzophenone at different temperature

Temp °C	Є's for solid bulk			Є"s for solid bulk		
	Measured	Calculated From Bottcher's formula	Calculated From Landu, et al formula	Measured	Calculated From Bottcher's formula	Calculated From Landu, et al formula
45	2.233	2.233	2.232	0.048	0.048	0.048
50	2.632	2.632	2.631	0.043	0.043	0.043
60	2.975	2.975	2.952	0.080	0.080	0.080

Out of the three powder samples of different packing fractions, the samples having minimum particle size is defined as finest which is about 0.70μm. In this case, we assumed it as solid bulk for getting correlation between powder and solid bulk. The correlation formulae were used to find other value for (δr>1). The bulk values obtained for (ε') and (ε") are same to the measured values and those calculated from [8], are closer to the values calculated fromformulae[3]. The values of packing density increase linearly with the values of dielectric constant, dielectric loss and conductivity increases. There was a simultaneous decrease of dielectric constant, dielectric loss and conductivity with increase in the temperature.

CONCLUSION

Thus, it was found that experimentally measured values of (ε') and (ε") at (δr = 1) are similar to those calculated from Landau-Lifshitz-Looyenga formulae. There was agreement between the values obtained experimentally and calculated theoretically by using Bottcher's formulae. The correlation formulae of Landau-Lifshitz-Looyenga and Bottcher can be used to provide accurate estimate of (ε') and (ε") of powder materials at known bulk densities. It may be thus, predicted that 4 – phenoxy benzophenone sample is having cohesion in its particles and serve as a continuous medium.

REFERENCES

Sisodia M L. and Raghuvanshi G S. 1990. Basic Microwave techniques and Laboratory Manual, (Willey Eastern ltd).

Yadav J S and Gandhi J M. 1992. Simple Microwave technique for measuring the dielectric parameters of solids and their powders. *Indian Journal of pure and Applied Physics*, 30, 427.

Kalamse G M and Kalamse V G. 2007. Microwave dielectric cell for measurement of dielectric parameters of pulverized materials, Lab Experiments, 7, 30-38.

Bansal A K, Singh P J and Sharma K S. 2001. Microwave dielectric measurements in different varieties of a pressed-mustard seeds in powder*, Indian Journal of pure and Applied Physics*, 39, 799-803.

Bhatnagar D, Gandhi J M and Yadav J S. 1996. Estimation of Dielectric behavior of bulk material using its powder, Indian Journal of Physics, 70 A(4), 539-542

Landu L D and Lifshitz, Electromagnetic of continuous media, (Pergamon Press, London) 1965.

Loovenya H, Physica, 1965. 31, 401. Bottcher C J F, Theory of electric polarization, (Elsevier, Amsterdam), 1952.

Karhale G A, Kawale R S, Tumberphale U B, Pawar N P and Kalamse G M. 2011. Dielectric Study of Amla at Microwave Frequency. Bionano Frontier, 4 (1),173-177.

Gawali P G, Pande Rekha, Narwade B S and Kalamse G M 2005. Dielectric Behaviour of pulverized Mungbean at Microwave Frequencies, *Indian J pulses Res.*

****