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DIELECTRIC AND MAGNETIC PROPERTIES OF MICROWAVE MATERIALS

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ABSTRACT

Microwave technology owes its beginning to the structure and improvement of radar and increased a colossal advancement during the World War II. In the previous phases of improvement, the development of microwave generators like klystron, magnetron and so forth opened the gigahertz frequency district of electro-attractive spectrum to communication engineers. Thus the significant advancement particularly comes in the field of satellite communication. It tends to be seen that microwaves comprise just a little part of electromagnetic spectrum, however their utilizations have gotten progressively significant in the material characterization for modern, logical and clinical applications.

The dielectric data have likewise been utilized to assess the measure of moisture in wood, sand and rural products. The dielectric properties are required for the computation of inward electric fields coming about because of the introduction to non-ionizing electromagnetic (EM) fields and are

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consequently significant in the advancement of diagnostic and therapeutic clinical utilizations of this vitality and investigations of potential dangers of EM fields. Electromagnetic waves in the radio and microwave frequencies are successfully utilized in the treatment of hyperthermia of tumors and different issue. The current paper highlights the dielectric and magnetic properties of microwave materials.

KEYWORDS:

Microwave, Magnetic, Dielectric

INTRODUCTION

Material characterization is basic for the best possible choice and usage of a substance when utilized in mechanical, logical and clinical applications. The dielectric parameters over a wide scope of temperature on low misfortune dielectrics are expected to evaluate their appropriateness for use in telecommunications, dielectric waveguides, focal points, radomes, dielectric resonators and microwave integrated circuit (MIC) substrates; and on lossy materials for assessing their warming reaction in microwave warming applications.

The dielectric data would likewise be required on lossy pottery for their utilization as microwave safeguards, lossy glues for the plan of new food bundles, for warming in microwave stoves and on organic materials for

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diathermy. The measurement of the dielectric parameters will fill in as a device for examining the intermolecular and intramolecular components of compounds.

It is discovered that any single method of complex permittivity measurement isn't appropriate over such a wide scope of frequency and complex permittivity. Additionally, various materials might be accessible in various physical states, for example, gas, Fluid, powder, glue, strong and so on. Indeed, even on account of solids, they are accessible in various shapes, for example, level sheet, grains and difficult to-crush self-assertive geometrical shapes, for example, rocks.

The methods for estimating the unpredictable permittivities of materials can be extensively arranged into two classes:

I. Frequency domain methods

2. Time domain methods

The frequency domain methods are entrenched and have been being used for in the course of recent years. Be that as it may, the time domain methods are as of late created. Be that as it may, time domain methods are developing in acknowledgment as these give brisk measurement to gauge the dielectric reaction of a material over a wide frequency run. These days, this range covers past 10 GHz with the by and by accessible gear.

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FREQUENCY DOMAIN METHODS

As a matter of first importance, different classes of frequency domain procedures are thought of.

Free Space Methods

By and large, these methods were viewed as appropriate for frequencies in the millimeter wave district. Both reflection and transmission methods have been utilized. A significant disadvantage of these methods was the necessity of a huge example to maintain a strategic distance from diffraction impact around test edges for performing measurements in the centimeter wave district. Anyway it has been indicated that with exactness horn focal point antennas which have better far-field centering capacity, it is conceivable to make precise free space measurements in the low frequency groups.

Contrasted with different methods, free space methods have the accompanying favorable circumstances.

(a) These give contactless methods to the unpredictable permittivity measurement. Henceforth they are progressively reasonable for high temperature measurements.

(b) In the shorted waveguide method and cavity method, it is important to machine the example to fit precisely in the waveguide or cavity. During the example arrangement, it is hard to machine the example precisely to

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the necessary measurements. This prerequisite restricts the precision of measurement of hard and weak materials. Free space methods don't experience the ill effects of the above confinements, on the grounds that no example readiness might be required, if the material is accessible as a sheet.

Transmission Line Methods

In transmission line methods, an example of the dielectric material is put either between the external and inner conductors of a coaxial line or inside a waveguide. The example when put toward the finish of the waveguide might be ended with either a short or some other known impedance. The intricate permittivity of the material is then controlled by the measurements of the line without the example and with the example.

In this method, a waveguide is ended by the example in physical contact with a short out. This method has been broadly utilized previously and is suggested as a standard method by the American Culture for Testing and Materials (ASTM).

This program is pertinent to measurements made in rectangular and round waveguides just as to coaxial lines. Certain amendments are additionally remembered for the program for the impact of the space in the opened waveguide area, and the distinction in speed of proliferation in air and vacuum.

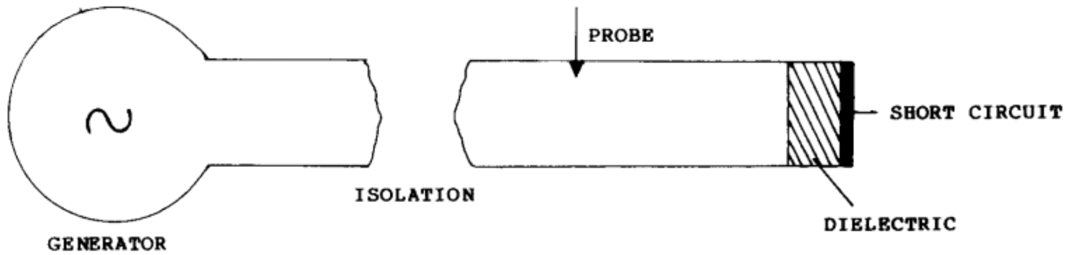

Figure 1: Transmission Line Method

Different transmission line methods with various structures for holding the example have been talked about in the writing and the adjustment is as yet going on. For instance, a two port round cell which requires an example of tube shaped shape machined with a gap in the center to fit between the inner and external conductors of the cell has been utilized.

Automatic Network Analyzer Methods

In specific angles, automatic network analyzer (ANA) methods can likewise be considered as transmission line methods on the grounds that the example is held in a transmission line and dielectric constant is controlled by estimating the reflection or potentially transmission coefficient. The scattering parameters are estimated with a vector network analyzer (HP 8510 sort) comprising of an orchestrated sweeper and parameter test set. A PC (90001300 arrangement instrumentation

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PC) can be utilized for robotization, data securing, printing of S-parameters and so on.

Despite the fact that these methods have likeness with transmission line methods, they can be considered as isolated class since ANA methods have risen as ground-breaking modem methods with which dielectric measurements can he completed over a wide scope of frequencies in single measurement.

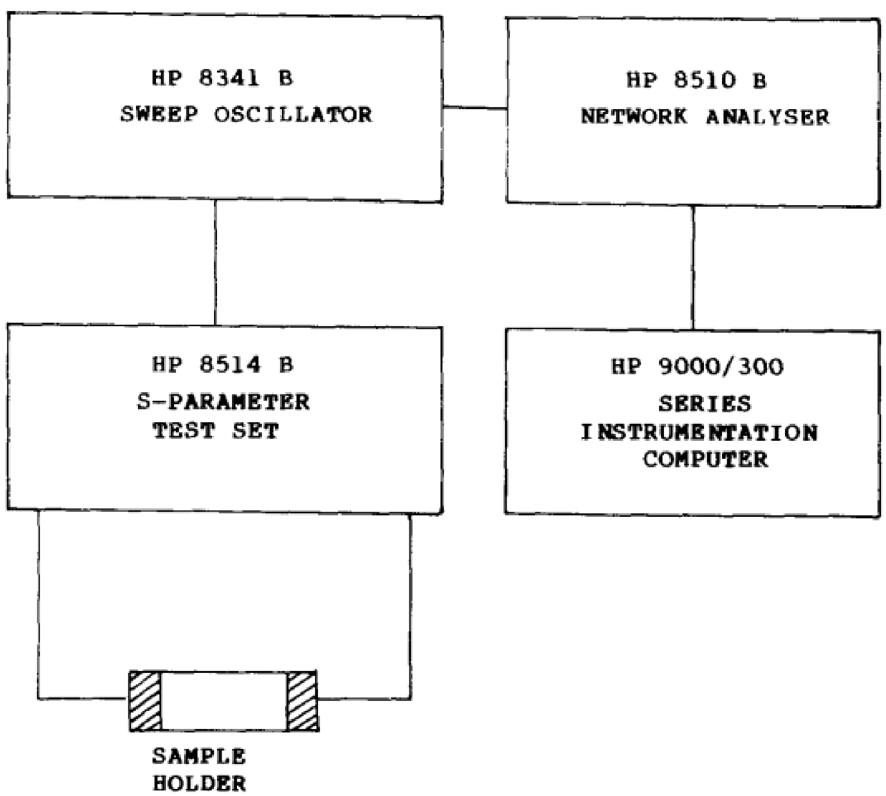

Figure 2: Automatic network analyzer method

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In ANA methods, different measurement blunders are altogether diminished by an alignment strategy. The most broad technique utilizes a through way association, coordinated end, a short and an open (TMSO). With wide-band clear oscillators, and heavily influenced by a PC, dielectric measurements have been done precisely by ANA's over a wide scope of frequencies and materials.

On account of expansive band measurements, the TMSO alignment method endures in exactness. In this manner various scientists have recommended the utilization of different methods of alignment. In one such method an open finished coaxial test (sensor) is submerged in a material of known permittivity.

A significant advancement here is the utilization of open finished waveguide or coaxial line. This is a non-dangerous method of dielectric measurement in which the issue of test readiness is extraordinarily decreased.

DISCUSSION

The created procedures are applied to examine the dielectric properties and conductivity of contaminated water, leading polymers, elastic latex, ferrites and certain natural fluids. Attractive properties of ferrite materials are additionally researched. Microwave method for water

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contamination study talked about in the postulation is a pioneer procedure to distinguish different toxins in water.

Studies on directing polymers might be helpful in choosing appropriate leading polymer coatings for radomes, reflector antennas and frequency specific surfaces. The dielectric properties of elastic latex with fillers should be read for microwave vulcanization. The dielectric parameters of fumes of water and natural fluids are utilized as a source of perspective data for the investigation of lessening of microwave proliferation in environment. It can he created as a non dangerous method for recognizing the constituents of oil based goods in industry.

Additionally, the rectangular waveguide cavity perturbation strategies used to decide the dielectric properties of human blood and pee has sweeping impacts in the clinical field. Therefore the created methods have logical, clinical and modern applications.

The strategies can be stretched out to active cavity perturbation. This utilizes a swaying circle containing the test cavity to such an extent that the frequency of wavering is near that of full cavity with it5 test. Fitting calculations alter the parts in the resounding circle with the end goal that the swaying frequency is made precisely equivalent to the thunderous frequency of the test cavity.

A bit of leeway of the active cavity perturbation method is that all the measurements are identified with the phase reaction of the cavity instead

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of its adequacy reaction to such an extent that pinnacle of the cavity reaction is precisely decided. Phase controlled measurements are more exact than direct plentifulness reaction measurements where the signals are effortlessly mutilated by the non linearity's in locators and different gadgets.

In addition, active measurements can be utilized to warm the example during the measurements. This gives an exact assurance of material conduct under warmth stresses created by microwave power. It permits the synchronous measurements of various parameters like moisture content, power assimilation, dielectric constant and so forth.

CONCLUSION

Among the different methods talked about in the past segments, the cavity perturbation strategies are more exact and exact than different methods. For I to 10 GHz go, rectangular or roundabout waveguide holes are commonly utilized.

Prior, the measurements were completed at single frequency due to non-accessibility of microwave sources covering wide frequency groups. With the progression of microwave technology, the orchestrated scope generators and vector network analyzers are accessible. Likewise these instruments can be interfaced with arrangement instrumentation PCs.

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REFERENCES

- Musil and F. Zacek, Microwave measurements of complex permittivity by free space methods and their applications, Elsevier Science Publishing Company, Inc., New York, 2016.
- D. K. Ghodgaonkar, V. V. Varadan and V. K. Varadan, Free space measurement of complex permittivity and complex permeability of magnetic materials at microwave frequencies, IEEE Trans. IM, Vol. 39, pp. 387-394, 2010.
- R. Von Hippel (Ed.), Dielectric materials and applications, John Wiley and Sons, New York, 2014.
- S. 0. Nelson, L. E. Stetson and C. W. Schlaphoff, A general computer programme for precise calculation of dielectric properties from short circuit4 waveguide measurements, IEEE Tms. IM, Vol. 23, pp. 455-460, 2015.
- R. Van Loon and R. Finsey, Measurement of complex dielectric constants of liquids at frequencies from 60 to 150 GHz, The Review of Scientific Instruments, Vol. 45, pp. 523-525, 2014.
- M. Nicolson and G. F. Ross, Measurement of the intrinsic properties of materials by time-domain techniques, IEEE Trans. IM, Vol. 19, pp. 377-382, 2010.

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ISSN NO:0377-9254

- W. B. Weir, Automatic measurement of complex dielectric constant and permeability at Microwave frequencies, Proc. IEEE, Vol. 62, pp. 33-36, 2014.
- M. F. Iskander and S. S. Stuchl , A time-domain technique for measurement of the dielectric properties o biological substances, IEEE Trans. lM, Vol. 21, pp. 33-36, 2015.
- M. R. Taherian, D. I. Yuen, T. M. Habashy and J. A. Kong, A coaxial circular waveguide for dielectric measurement, IEEE Trans. Geoscience and Remote Sensing, Vol. 29, pp. 321-329, 2011.
- W. R. Scott, A new technique for measuring the constitutive parameters of planar materials, IEEE Trans. IM, Vol. 41, pp. 639-645, 2012.

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