DIELECTRIC PROPERTIES OF A TIMBER SAMPLE UNDER PRESSURE OF SEVERAL BARS

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ABSTRACT

There is a considerable interest in the dielectric properties of a material under a pressure other than the atmospheric pressure. Most interest seems to stem from chemical reactions or material property modification.

We have studied the variation of the dielectric properties of gas under pressure with frequency. A gas, such as LPG, shows an increase in the dielectric constant from 1.002 to 1.05 and in the loss factor from 0.007 to 0.01 when the pressure is increased from one bar to seven bars. However with a liquid such as water or ethanol, there is little change in dielectric properties under pressure. For instance the dielectric properties of water and ethanol remain 72 –j10.08 and 10-j9 respectively under 7 bars.

The dielectric properties are measured with a specially designed open ended coaxial probe, a specially developed software package and a network analyser [1]. The probe is made of a semi-rigid coaxial cable without a flange. An appropriate correction is made for the fringing capacitance at the end of the probe to obtain accurate measurements. The correction is based on a static field approximation, which tends to limit the upper frequency. This is not serious however for frequency up to 20 GHz [1]. Simulation software can also be used to perform the inverse transformation to obtain the dielectric properties at almost any frequency because this approach does not rely on the static field approximation.

In order to measure the dielectric properties of a sample of timber under any absolute pressure, we use a network analyser and a specially designed sample holder or alternatively a stable high power microwave generator with a double circulator, a six port impedance analyser and a specially designed sample holder. There is no restriction in sample cross section with the approach we use. This is an advantage because to produce a circular cross section usually requires turning the sample with a lathe. This operation tends to cause more invasive interference with the sample and more loss of moisture.

We record the S_{11} parameter variation with pressure and sometimes with temperature using a fiber optic temperature sensor. We then carry out an inverse transformation to deduce the dielectric properties.

The experimental results show that there is little change in the dielectric properties of the wood sample. We have carried out this measurement for several timber including Blue Gum, Mountain Ash, Shining Gum, radiata pine and hoop pine. However in the microwave heating measuring technique, we do observe a step change in dielectric properties under pressure. For instance, the dielectric properties of Mountain Ash are 18.8 –j2.73 under one bar become 6.45-j.37 under 4.5 bars. This change may be due to a phase transformation occurring in the sample when it is heated.

The paper discusses in detail our experimental procedure, our inverse transformation approach and the results obtained.

REFERENCES

[1] Tran, V.N. “Successful Microwave Processing Applications in Industry”, in Microwave and Radio Frequency Applications, proceeding of the Third World Congress, September 2002, Sydney Australia, pp359-366.