

MOISTURE MEASUREMENT FOR GREEN CIVIL ENGINEERING MATERIALS USING DIELECTRIC SPECTROSCOPY

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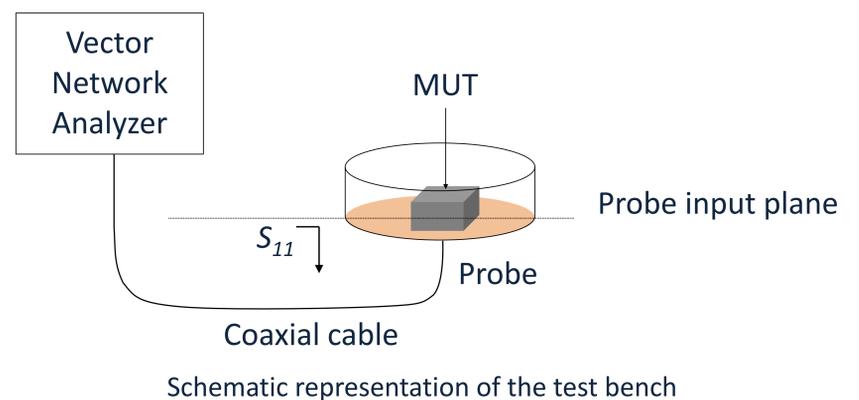
ABSTRACT

A dielectric spectroscopy approach is proposed to characterize the moisture in new materials used for green civil engineering. The method relies on reflectometry measurements using an open ended coaxial probe. We report preliminary dielectric spectroscopy characterization of Hempcrete, a material used as an insulator and a moisture regulator in green buildings, carried out over the 30 MHz – 3GHz frequency range for samples featuring different moisture contents.

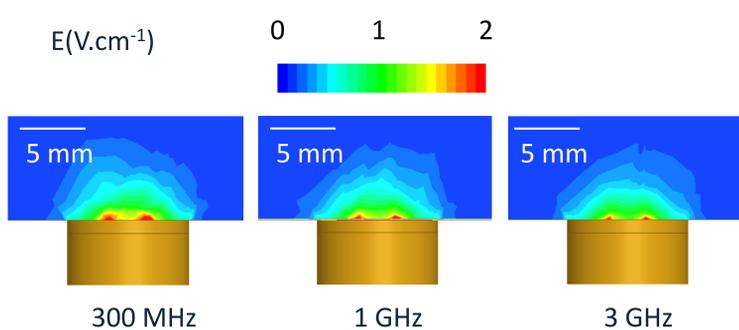
INTRODUCTION

Non destructive evaluation (NDE) of moisture in civil engineering materials such as concrete is useful either at early stage of construction or for ageing works, since moisture is a key element involved cracks generation. NDE of moisture may also be useful regarding new materials like Hempcrete which is used as an insulator and a moisture regulator in green buildings. Electromagnetic methods are good candidates for moisture characterization since the dielectric permittivity of porous materials is greatly influenced by moisture. In this paper we propose a dielectric spectroscopy approach relying on reflectometry measurements [1], which may represent a suitable alternative to time domain reflectometry (TDR) [2], as far as NDE is concerned. Indeed, thanks to the use of an open ended coaxial probe to be simply put in contact with the material to characterize, the method is non invasive, conversely to measurements implementing TDR probes. We report preliminary broadband reflectometry measurements carried out over the 30 MHz – 3GHz frequency range for Hempcretes featuring different moistures.

EXPERIMENTAL SET UP

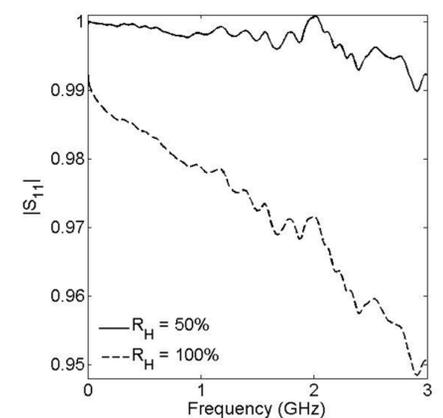
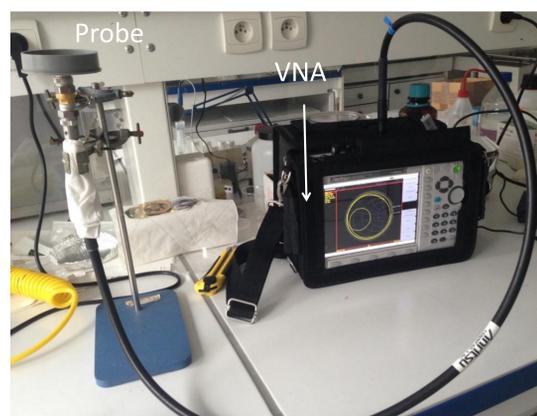


ELECTROMAGNETIC SIMULATION

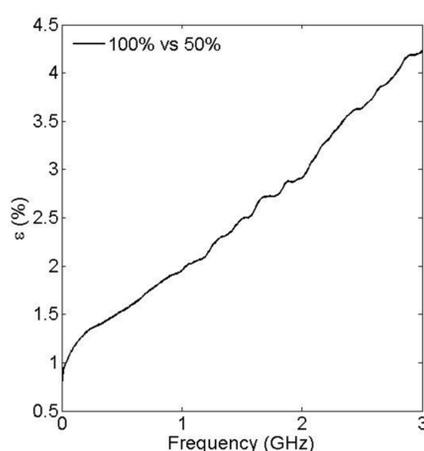


Magnitude of the electrical field distributions at the test frequencies 0.3, 1 and 3 GHz in cross-section (on air).

RF MEASUREMENTS



MOISTURE DETECTION



CONCLUSION

The obtained preliminary experimental results show that the moisture influences the probe input signal which lets the proposed experimental approach to be envisaged with NDE of new green civil engineering materials in view. To confirm this point, the next step of the study will consist in dielectric spectroscopy experiments involving Hempcrete samples featuring a variety of water contents at different temperatures, thanks to appropriate conditioning.

[1] Kremer, F., "Broadband dielectric spectroscopy", Berlin: Springer, 2003.

[2] Königer, F., Emmerich, K., Kemper, G., Gruner, M., Gaßner, W., Nüesch, R., & Schuhmann, R., "Moisture spreading in a multi-layer hydraulic sealing system (HTV-1)". Engineering Geology, 98(1), 41-49, 2008.

ACKNOWLEDGEMENTS



$$\text{Relative absolute error } \varepsilon = \left| \frac{|S_{11}^{RH100\%}| - |S_{11}^{RH50\%}|}{|S_{11}^{RH50\%}|} \right|$$