Hybrid Modeling Approaches For Microwave Heating System Design

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Abstract

One of the advantages of microwave heating of a dielectric material is the direct transfer of electromagnetic energy to the core of the dielectric through interactions between electromagnetic waves and the dielectric, without heating the surrounding elements [1]. For an industrial application, the appropriated design of a specific applicator is essential [2]. This usually goes through the following steps:
a) Choice of generator and first of all its working frequency.
b) Identification of the electrical properties of the dielectric to be heated around the working frequency
c) Design of an applicator ensuring a good impedance matching so as to have return losses below a threshold, and those during the heating procedure during which the complex permittivity of heated material will change depending on temperature.
The applicator design work will be taken around a coaxial cell (Fig. 1). This later will be used both as a measurement cell for complex permittivity of a ceramic material having fairly good susceptibility to microwave power, and as part of the microwave applicator, ensuring the supply of electromagnetic energy in the form of a Transverse ElectroMagnetic (TEM) wave and the fixation of the ceramic susceptor.
This article will be divided into 2 parts:
i. The extraction of the complex permittivity by an inverse modeling whose objective function is built using measurements of scattering parameters of measurement cell and a simulation based on the hybridization of a two port model resulting from the experiment and a one port model obtained by using the COMSOL software.
ii. The determination of the geometry of the applicator ensuring a minimum of reflection. For this an optimization will be carried out using LiveLinkTM for MATLAB module to fix the position of the susceptor in the coaxial cell and that of the removable short-circuit at the end of the cell.
The validation of the correct operation by a simulation under COMSOL multiphysics of the heating by microwaves of the applicator will be presented during the conference.
[1] Microwave applications in chemical engineering, Special Issue in Processes, MDPI, 2020 .
[2] Microwave and RF Power Applications, Ed. Cépaduès, Toulouse, 2011

Figures used in the abstract

Figure 1 : Geometry of the coaxial cell for dielectric measurement and microwave heating applicator

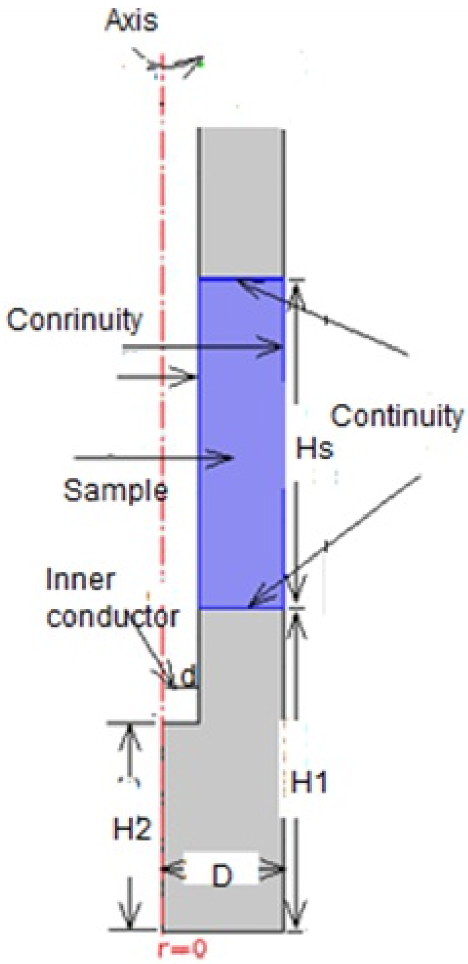

Figure 2 : 2D axisymetric COMSOL modeling of central coaxial structure containing dielectric sample

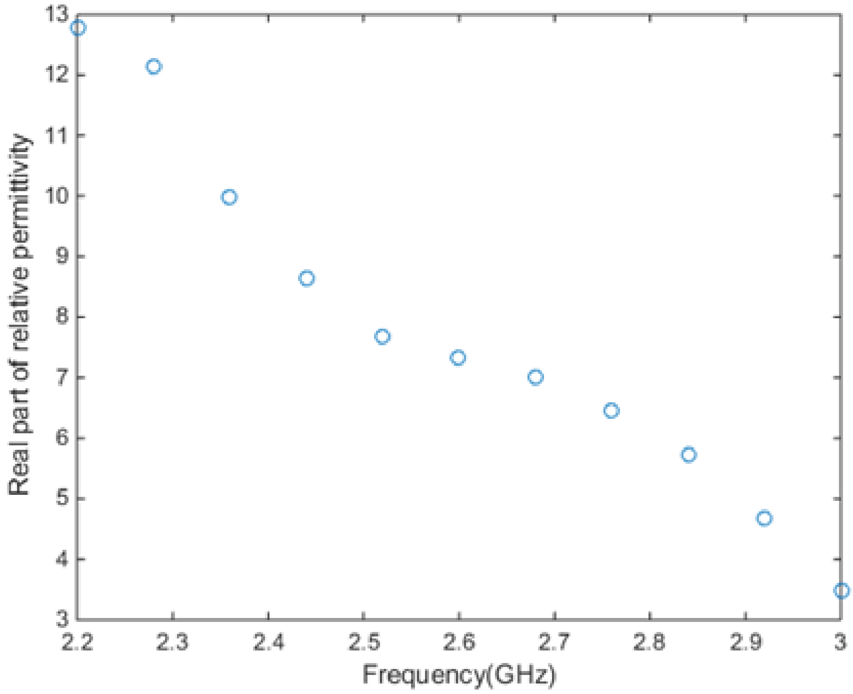

Figure 3 : Extracted relative permittivity

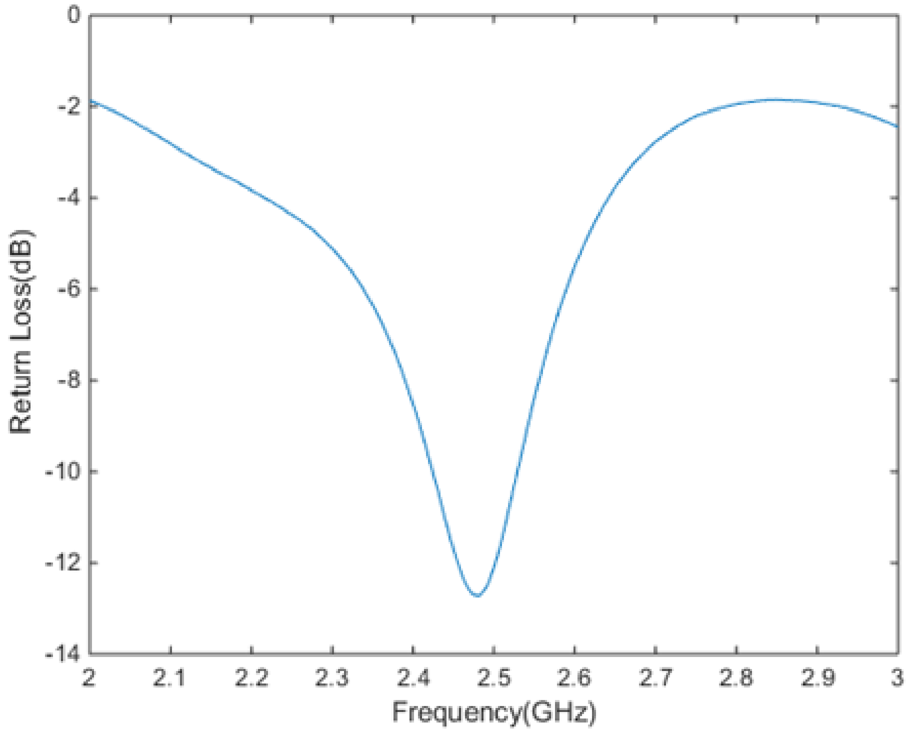

Figure 4 : Measured return loss of designed microwave coaxial applicator