Application of Genetic Algorithms and Electromagnetic Simulation in the Dielectric Characterization of Materials at Microwave Frequencies

Alejandro Díaz-Morcillo[1], Juan Monzó-Cabrera[1] and Maria E. Requena-Pérez[2]

[1] Universidad Politécnica de Cartagena
Plaza del Hospital, 1. 30202 Cartagena, Spain
[2]Consejería de Educación y Cultura de la Región de Murcia
C/Villaleal, 2. Edificio Centro. 30001 Murcia, Spain

An accurate and reliable determination of the electric permittivity of a dielectric material is of key importance in order to know its behavior under the influence of electromagnetic fields. The dielectric characterization of materials at microwave frequencies has undergone an important advance in the last fifty years, with the development of new measurement techniques based, mainly, on transmission lines, as reflection or transmission-reflection methods, and resonators [1]. These direct methods are quick, but they are only valid for macroscopically homogeneous materials which, moreover, can be shaped in canonical geometries, that is, rectangular prisms or circular cylinders.

When the material under study has an irregular geometry and does not admit mechanical treatment (for instance, in a non-destructive quality control system) these conventional methods fail in obtaining its electric permittivity. Besides, if the material is non-homogeneous they only can obtain an effective permittivity as a whole. In these cases it is necessary to develop alternative techniques that can deal with arbitrary shapes or non-homogeneous samples.

In this communication the application of an evolutionary procedure [2] based on genetic algorithms [3] for obtaining the dielectric properties of arbitrary shaped, homogeneous or inhomogeneous materials is presented. The optimization procedure matches the measured and simulated scattering parameters of a waveguide setup that contains the sample under study. Depending on the geometry of the sample, analytic or numerical (2D or 3D) electromagnetic simulations must be carried out in order to obtain the simulated scattering parameters for a set of electric permittivities that are the genes of the individuals at each generation. Results for different polymeric and biological materials show similar uncertainties that the ones obtained by conventional direct methods, with the advantage that this new technique can deal with non-canonical and heterogeneous samples.

Referecnes

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