COMPLEX PERMITTIVITY RECONSTRUCTION OF MULTI-SECTIONAL DIAPHRAGM IN A RECTANGULAR WAVEGUIDE FROM THE REFLECTION COEFFICIENT

Derevyanchuk E. D.

Penza State University,Russia, Penza, Krasnaya st.40, 8(8412)368096, catherinderevyanchuk@rambler.ru

Determination of electromagnetic parameters of dielectric composites is an urgent problem. As a rule, these parameters cannot be directly measured; it is because of composite character of the material and small sizes of the samples. For this reason mathematical modeling is one of the most suitable methods to determine these parameters [1].

In this paper we consider an inverse problem of the complex permittivity determination of a multi-sectional diaphragm using measured reflection coefficient. It is supposed that the diaphragm consists of n sections; each section of the diaphragm is filled with a medium having frequency-dependent permittivity $\varepsilon_j(\omega) = \varepsilon_j^1 + i\sigma_j/\omega$, where ε_j^1 is the real part of complex permittivity and σ_j is conductivity ($j = 1, 2, n$). This inverse problem for Maxwells equations is reduced to a system of nonlinear transcendental equations. Solving the system we obtain a recurrent formula, which links n unknown permittivities with measured reflection coefficient (which we denote as B/A). Using this recurrent formula at different frequencies we obtain a system of n equations with n unknown permittivities:

$$\frac{B(\omega_k)}{A(\omega_k)} = \frac{\gamma_n(\omega_k)p_{n+1}^-(\omega_k) + \gamma_0(\omega_k)q_{n+1}^-(\omega_k)}{\gamma_n(\omega_k)p_{n+1}^+(\omega_k) + \gamma_0(\omega_k)q_{n+1}^+(\omega_k)}, \quad j = 1, \dots, n, k = 1, \dots, n, \tag{1}$$

where

$$\gamma_{n+1} = \gamma_{n+1}, \alpha_j = \gamma_j(l_j - l_{j-1}), \gamma_j = \gamma_j(\omega) = \sqrt{\omega^2\mu_0\varepsilon_j^1 + \omega\mu_0\sigma_j - \pi^2/a^2} \tag{2}$$

$$p_1^\pm = 1, p_2^\pm = \gamma_0 p_1^\pm cos(\alpha_1) \pm \gamma_1 q_1^\pm isin(\alpha_1), p_{j+1}^\pm = \gamma_{j-1}p_j^\pm cos(\alpha_j) \pm \gamma_j q_j^\pm isin(\alpha_j)$$

$$q_1^\pm = 1, q_2^\pm = \gamma_0 p_1^\pm isin(\alpha_1) \pm \gamma_1 q_1^\pm cos(\alpha_1), q_{j+1}^\pm = \gamma_{j-1}p_j^\pm isin(\alpha_j) \pm \gamma_j q_j^\pm cos(\alpha_j)$$

Solving system (1) numerically by using Levenberg-Marquardt algorithm we find all unknown permittivities. This developed numerical-analytical method can be applied for determination of electro physical parameters of composite materials.

References.

1. Smirnov, Yu.G, Shestopalov, Yu.V., and Derevyanchuk, E.D. Permittivity reconstruction of layered dielectrics in a rectangular waveguide from the transmission coefficients at different frequencies. — Inverse Problems and Large-Scale Computations, Series: Springer Proceedings in Mathematics Statistics 52, 2013. Pp. 169-182.