Microwave Scanning Tomography Local unit Defects

S.I. Melnyk, M.I. Slipchenko

Abstract - **This article analyzes the possibility of creating a microwave scanning tomography on the basis of existing microwave microscopes. An algorithm for the reconstruction of the size, depth and electrical parameters of the local unit heterogeneity on the basis of scanning at two at two different distances between the sensor and object.**

Keywords - **microwave scanning tomography, resolution, reconstruction, local unit defects.**

I. INTRODUCTION

The resolving power of MSM greatly inferior to microscopy techniques such as atomic force, tunneling, optical. This is due to the fact that by improving the resolution of the method, we automatically reduce the penetration depth of the field. One way to overcome the contradiction is the development of specialized mathematical algorithms for processing the results of the scan.

II. THE POSSIBILITY OF INCREASING THE RESOLVING POWER OF THE MSM METHOD OF RECONSTRUCTION

To assess the resolving power of MSM is most often used raw profile scanning results. This leads to its limit value of the effective width of the scanning field. Previously, we developed an algorithm of reconstruction of small local inhomogeneities in the microwave microscopy, which allows increasing the resolving power of 10-100 times [1]. This is achievable by taking into account the mutual influence of neighboring local inhomogeneities and high values of the amplitude of the signal to noise ratio.

III. MODEL OF INTERACTION OF THE MICROWAVE SENSOR FIELD WITH A LOCAL UNIT INCLUDE

Sensor microwave microscope is a quarter-coaxial resonator with an aperture of small size, and serves the edge of some form at the end of the coaxial insert. We consider the heterogeneity only ε. In the perturbation method shows that the dielectric sphere in a uniform electric field acquires a dipole moment $\vec{p}_e = 4/3\pi r^3 \alpha_e \vec{E}_0$, where $\alpha_e = (\varepsilon_1 - \varepsilon)/(\varepsilon_1 + \varepsilon)$. In the relationships for the frequency shift or Q is the dipole moment of the sphere, in which the variables $r^3\alpha_e$ not separated. In this case, the additional information to determine their parameters can be extracted from the results of the scan. To do so, to abandon the approximation of a homogeneous field in the volume of the defect.

Sergiy Melnyk, Mikola Slipchenko - Kharkov National University of Radioelectronics, av. Lenina, 14, Kharkov, 61166, Ukraine
e-mail: nanolab@kture.kharkov.ua

IV. AN ALGORITHM FOR MICROWAVE TOMOGRAPHY OF INDIVIDUAL LOCAL INHOMOGENEITIES

Assuming the size of the inhomogeneity is small compared with the width of the scanning field; we can take into account their mutual influence and move to an equivalent distribution of non-interacting dipoles [2]. This representation allows us to represent the measured signal as a convolution

$$U(x_0) = k_0 \int E_0^{\;2}(x - x_0, y - y_0, z_0)\beta^*(x,y)dxdy\,, \tag{1}$$

where the distribution of non-interacting dipoles $\beta^*(x)$ associated with real $\beta(x)$ relation:

$$\beta(x,y) = \frac{\beta^*(x,y)}{1 + G(x,y) * \beta^*(x,y)} \tag{2}$$

where $G(x,y)$ - single dipole field in the plane z_0.

As a result, the measured signal profile along the line scan obtained for the inhomogeneity of finite size is broader than the similar profile obtained for a point dipole. On this broadening determine the size of the inhomogeneity. To assess fairly approximated as the unperturbed field sensor, and the effective allocation $\beta^*(x)$ of Gaussian functions different square widths (respectively D_E and $D_{\beta*}$). Then from (1) implies that $D_U = \sqrt{2}D_E + D_{\beta*}$.

Repeated scanning at a different height position sensor provides additional information. From a formal point of view, this method is equivalent to the method is applied to projective tomography, which are integral projection of an unknown distribution in two different directions.

For the reconstruction must be pre-calculated or measured square width of the distribution $D_E(z_0)_{d1}$ and $D_E(z_0)_{d2}$ of the amplitude of the unperturbed field depending on the depth at various altitudes position sensor d1 and d2 of the controlled object. Then, by measuring the linear size of the half-width of the response from the local unit defect, from the equation

$$\sqrt{2}\left(D_E(z_0)_{d1} - D_E(z_0)_{d2}\right) = D_{U1} - D_{U2} \tag{3}$$

determine the depth of the location of the inhomogeneity parameter h, and then from the equation $D_U = \sqrt{2}D_E + D_{\beta*}$ for any of the two dimensions - the width of the inhomogeneity.

REFERENCES

[1] Gordienko JE, Melnyk SI, NI Slipchenko Information towards improving the resolving power of microwave microscopy, Radiotekh., № 147, pp. 157-163, 2006.

[2] S.I. Melnyk, S.S. Melnyk, N.I. Slipchenko, A.L. Ischenko, “Algorithm for reconstruction of the distribution of small inhomogeneities in microwave microscopy” *In Electronic component base. Status and prospects of development.* Kharkiv-Katsiveli 2009. pp.93-96.