Research on Scanning Characteristics of Periodically-Nonuniform Dielectric Plate

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Abstract - **In this paper scanning capabilities of periodically-nonuniform dielectric plate are tested in order to create scanning antennas and radiative devices for the millimetric and optical ranges waves.**

Keywords – **modulated dielectric plate, scanning antennas, optical devices.**

I. INTRODUCTION

An increased complexity of the assignments for authentication of movable objects in the wide sector of the space, development of communication, telemetry and telecontrol, scanning microscopy enhances actuality of the creation of scanning antennas and high-resolution, high speed and power gain optical devices. Therefore, this paper aims to research the issue of scanning capabilities of periodically-nonuniform dielectric plate (PNDP), as well as the methods for its control by an electromagnetic beam.

II. OBJECT AND SUBJECT OF RESEARCH

PNDP stimulated by a the threadlike source of magnetic current is chosen as an object of the present research (fig. 1).

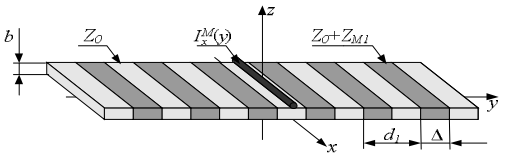

Fig.1. Flat nonuniform dielectric plate.

The subject matter of the present research covers spatial distribution of the field, scanning characteristic of the PNDP and methods of control over position of its electromagnetic beam. Test are executed in the environment of MATLAB with the use of mathematical model [1].

III. MATHEMATICAL MODEL

A mathematical model is built on the basis of the strict solution of the assignment for electrodynamic stimulation of the endless(along the coordinate of y) flat modulated dielectric plate, where the law of modulation of parameters of structure of plate is described by correlation (1)

$$Z(y) = Z_0 + Z_1 \sum_{n=-\infty}^{n=\infty} \mathrm{rect}\left(\frac{y - nd_1}{\Delta}\right) \qquad (1)$$

where: $Z_0 = b\varepsilon_{a0}$; $Z_1 = -\frac{\varepsilon_{aM1} b\Delta}{d_1}$; Δ- width, d – period of the following of nonuniformity. Distribution of the field $E(\theta^{\circ},\varphi^{\circ})$ of structure is described by correlation (2) [1]:

$$E(\theta^0,\varphi^0) = \Phi_0(\varphi^0)\xi_0(\theta^0)\xi_1(\theta^0) \qquad (2)$$

$$\Phi_0(\varphi^0) = \left|\mathrm{sinc}(\sin(\varphi^0))\right|;\ \xi_0(\theta^0) = \frac{\cos(\theta^0)}{\sqrt{(\sin(\theta^0)^2 - 1) - Z_0}};$$

$$\xi_1(\theta^0) = 1/(1 - Z_1 \frac{\Delta}{\lambda} \sum_{n=-\infty}^{n=\infty} \frac{\mathrm{sinc}(n\pi\Delta/d_1)}{\sqrt{(\sin(\theta^0) - n\lambda/d_1)^2 - 1 - Z_0}});$$

λ - wave-length, θ°and φ° - angular coordinates. Counting out of θ°and φ° is from a normal to the plane of structure.
In the environment of MATLAB on the basis (2) the computer model of the PNDP is deviced.

IV. CALCULATION RESULTS

Fig. 2 shows the results of the field calculation of the PNDP.

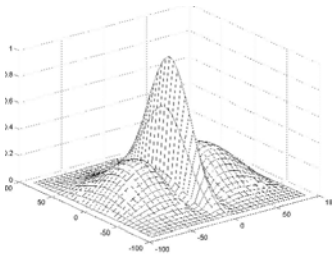

Fig.2. Field distribution PNDP for d=λ_{pw}

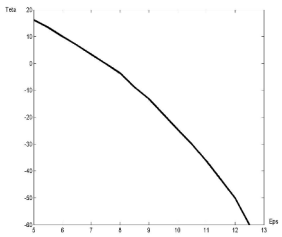

Fig.3. Scanning characteristic of PNDP

λ_{pw} - surface wave-length of the nonmodulated PNDP.

Fig. 3 shows chart of dependence of Δθ° from $\Delta\varepsilon_{a0}/\varepsilon_{a0}$: Δθ°- beam deflection of radiation of the PNDP from a normal to $\pm y$; $\Delta\varepsilon_{a0}/\varepsilon_{a0}$ a relative change of dielectric permittivity. Contol over the $\Delta\varepsilon_{a0}$ value is perfomed by a metallic screen, which periodically approaches PNDP with a help of actuator.

III. CONCLUSION

The tests and calculations confirm the dependence of beam deflection angle of radiation of periodically-nonuniform dielectric plate from the change of oscillation frequency of the source excitation and from the change of constant component value of dielectric permittivity, which has a great practical significance for the creation of the scanning antennas and optical devices with the improved characteristics.

REFERENCES

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