Modelling of Collimator on the Basis of Disk Metal-Dielectric Structure with Spiral Nonuniformity in Matlab

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Abstract - **In this paper simulation method is worked out and effect of focusing of the electromagnetic field by a metal-dielectric disk with spiral nonuniformity is tested in the environment of Matlab. Results have a practical significance for the creation of the collimators on the basis of surface-wave structures.**

Keywords – **metal-dielectric disk, collimators for the submillimeter and optical ranges waves.**

I. Introduction

Collimators for the submillimeter and optical ranges waves have a wide application for medico-biological, infocommunicational, and technological needs. The mathematical model (MM) of disk metal-dielectric structure (DMDS) with spiral nonuniformity is worked out in publication [1]. The novelty of this work is research on DMDS MM in the environment of Matlab and physical interpretation of the results.

II. Object and Subject of Research

DMDS stimulated by a zero harmonic of radial surface wave is chosen as an object of the present research (fig. 1).

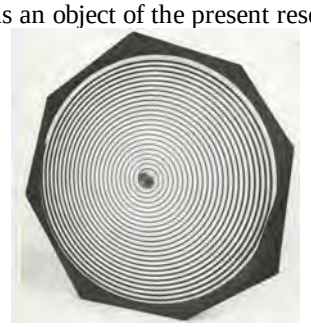

Fig.1. Disk metal-dielectric structure with spiral nonuniformity

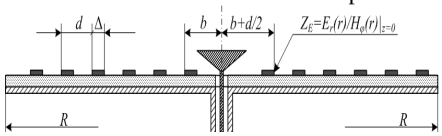

Fig.2. Cross section of the DMDS

The subject matter of the present research covers spatial distribution of the field of the DMDS. Test are executed in the environment of MATLAB with the use of mathematical model [1].

III. Mathematical Model

MM is built in an impedance approximation for the law of modulation of radial distribution of surface impedance of the structure that is described by correlation (2) and fig. 3.

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$$Z(s) = Z_0 + Z_1 \sum_{n=-\infty}^{n=\infty} \mathrm{rect}\left(\frac{r - nd_1}{\Delta}\right) \qquad (2)$$

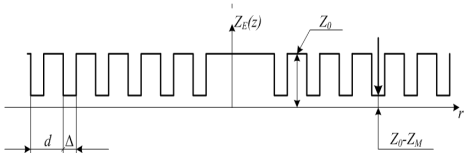

Fig. 3. Graph of DMDS.

Mathematical model of the field distribution of the DMDS:

$$\xi_1(\chi) = \Phi_0(\chi)\varphi_0(\chi)\varphi_{1,\Delta}(\chi)$$

where: $j_0(c) = 1/(\sqrt{c^2 - 1} - Z_0)$;

$$j_{1,\Delta}(c) = 1/(1 - Z_{M_1}\frac{\Delta}{d_1}\sum_{n_1=-\infty}^{n_1=\infty}\frac{\mathrm{sinc}(n_1 p\Delta / d_1)}{\sqrt{(c - n_1 l / d_1)^2 - 1} - Z_0})$$

where: $T_1 = \lambda / d_1$; $\Phi_0(\chi) = 1$. (3)

For the construction of the radiation patterns in the field of "visible corners" ($-90^0 \le \theta^0 \le 90^0$) it is considered, that $F(\chi) = (\sqrt{\chi^2 - 1})\xi_1(\chi)$; $\chi = \sin\theta^0$; θ° - a corner which is counted from a normal to a surface of structure.

IV. Calculation Results

Fig. 4 shows the results of the field calculation of the DMDS.

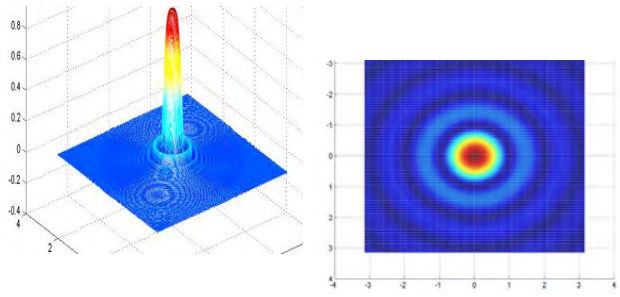

Fig.4. Field distribution PNDP for $d=\lambda_p$ (λ_p - wave-length).

V. Conclusion

It is shown that DMDS with spiral nonuniformity has behaviours of collimator, i. e. to focus near-omnidirectional radiation in narrow-beam.

References

[1] Hoblyk V.V. Symmetric excitation concerning an axis of the modulated impedance disk // International scientifically modulated impedance disk. // Proc. Intl. Conf. TCSET'1998. - Lviv-Slavsko, Ukraine, 1998. - p. 8-9.(in Ukrainian).

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