EXPERIMENTAL INVESTIGATION OF A PLANE-LAMELLAR MEDIUM WITH CONTROLLABLE POLARIZATION OF THE REFLECTED ELECTROMAGNETIC WAVE

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Devices for controlling the forms of polarization of a reflected plane electromagnetic wave are well known in microwave engineering. A common feature of well-known devices is the necessity of obtaining the polarization parameters of the reflected wave via the mechanical setting of the required electrodynamic parameters. It is of practical and scientific interest to develop devices which would accomplish the required conversion of the polarization and modulation of the parameters of the reflected wave due to the action of an electrical signal. Such devices may find extensive application in the engineering of physics experimentation, microwave engineering, information transmission devices and radio-communications systems, since compared with well-known devices they offer such advantages as fast (due to electrical switching) adaptation to the polarization of the incident radiation, and the provision of any deterministic or stochastic time distribution law governing the polarization.

In the general case, the principal requirements for devices of this type may be written mathematically in the form

$$E = [X_0 E_x \Gamma_x(u) e^{i\Phi_x(u)} + Y_0 E_y \Gamma_y(u) e^{i\Phi_y(u)}] e^{i\omega t + \varphi_0};$$
$$\Gamma_x(u) = M(\cos\varphi + i\sin\varphi)\Gamma_y(u); \qquad \varphi = \varphi_x - \varphi_y;$$
$$0 \leqslant M < \infty; \qquad 0 \leqslant \varphi < 2\pi,$$

where Γ_x, Γ_y, M, ϕ are the moduli, the ratio between the moduli, and the phase difference for the coefficients of the reflection of the X and Y components of the electric field intensity vector from the plane-lamellar medium (PLM); X_0, Y_0 are unit vectors in the chosen rectangular coordinate system; ω is the angular frequency; u is the control voltage.

Thus, an artificial medium must have an electrically controllable anisotropy in the microwave range of wavelengths. Drawing an analogy with media having a controllable anisotropy in the optical range, it is not difficult to draw the conclusion that in the microwave range such media must have artificial anisotropic controllable lattices which are analogous to crystal lattices. Such artificial media, which could implement the possibility indicated, include controllable PLM. In the general case, they consist of contiguous dielectric layers, noncontrollable conducting periodic grids, and controllable layers. The latter are implemented (Fig. 1) from two-dimensionally periodic grids of conducting strips or rods 1 having a period *a* and a diameter D which are loaded by controllable semiconductor elements 2 of various types: parametric diodes, p-i-n diodes, Gunn diodes, and avalanche-drift diodes.

For purposes of independent control of the amplitude and phase of the reflected signal relative to the X, Y axes, the mutually perpendicular components of the grids must be isolated with respect to the low frequency of the control signal (Fig. 1a). It is obvious that the control grid shown in Fig. 1b offers lesser possibilities in terms of control of the polarization parameters than does the grid shown in Fig. 1a, since it does not provide the possibility of controlling the electric field vector component E_y.

For the purpose of proving the possibility of electrical control of the polarization of a reflected electromagnetic wave by means of controllable PLM, the present work has performed an investigation of various mockups of media that have been developed.

Three mockups of electrically controllable PLM having controllable layers based on two types of grids (Fig. 1) have been investigated; these PLM contain conducting GA402G parametric diodes whose elements have been

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