MODELING OF TRANSIENTS IN CYLINDER WITH TIME-VARYING PLASMA

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The strong interest in the interaction between electromagnetic waves and plasmas is due to their wide range of potential applications. Tuning of resonant characteristics of microdisk resonators by free carrier plasma injections has a wide range of potential applications including active switchers or tunable filters [1]. Transient phenomena in plasma lead to the frequency up-shifting possibility and the wave generation [2,3]. Using resonators composed of negative permittivity materials such as plasma can form the basis of effective small antenna elements [4]. Plasma is used in a light-modulated photo-induced method for the creation of a non-mechanical millimeter wave scanning technique [5].

Therefore accurate time domain modeling for investigation of electromagnetic field with time-varying plasma is of great importance. In this paper we investigate the transformation of the incident wave due to change of plasma frequency in the cylinder. The main interest is in the transient response, evaluation of the transition time and the transformed diffraction pattern in the steady state regime.

The solution is obtained in a robust mathematical manner. For this we apply the Laplace transform directly to the wave equation and include the initial conditions that involve continuity of the electric field displacement and its derivative at zero moment of time. We generate the analytical solution in the Laplace transform domain in the form of the eigenfunctions expansion that satisfies the boundary conditions requiring continuity of the tangential components of the electric and magnetic field. We obtain the inversion of the image function by virtue of the evaluation of the residues in singular points and integrals along branch cuts of the complex plane.

The simulation data presents the near field pattern of the electromagnetic field of the linear source during the transient period at fixed moments of time. It begins after change of normalized plasma frequency from the value $\omega_p \rho_0 c^{-1} = 8.5$ to the value $\hat{\omega}_p \rho_0 c^{-1} = 10$. Here ρ_0 is the radius of the resonator and c is the velocity of light in vacuum. The source is located at the distance $\rho_1 = 2.5\rho_0$ from the center of the resonator and its normalized radiation frequency is $\omega \rho_0 c^{-1} = 10.1$. Figure 1 shows the field patterns at fixed normalized moments $T = ct\rho_0^{-1}$, where t is real time.

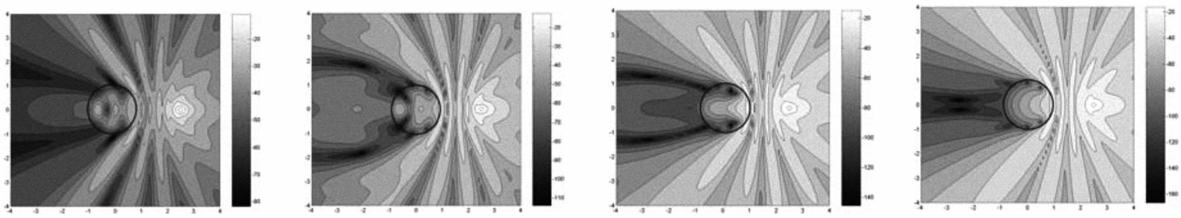

Figure 1. The near field pattern of the electromagnetic field during the transient period at fixed moments of time. (1) T<0, (2) T=4, (3) T=8, (4) T>40 (steady state regime)

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