Analysis of Planar Structure with Patch Superconductor Material and PBG Substrate

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Abstract- The analysis of the resonance frequency, efficiency, quality factor and pattern fields of microstrip antennas array, with superconductor patch for high critical temperatures, and PBG (Photonic Band Gap) substrate, are presented. The concise full wave Transverse Transmission Line (TTL) method is used in the analysis. New results of the resonance frequency, efficiency, quality factor and pattern fields of microstrip antennas array are presented.

In this work microstrip antennas array using superconductors patch and photonic band gap substrate are used.

The type of substrate changes the parameters of the antenna. PBG (Photonic Band Gap) materials can be used as substrates, to improve irradiation, thus reducing the occurrence of surface waves and the resulting diffraction edge, responsible for radiation pattern deterioration [1] - [3].

In the TTL analysis, using the Maxwell's equations, after various algebraic manipulations, the general equations for the antenna are obtained, in the FTD - Fourier Transformed Domain, for the x and z directions as functions of the y variable [2],[4]:

The solutions of the electromagnetic field in y, $\tilde{E}_y$ and $\tilde{H}_y$ are obtained through the solutions of the Helmholtz wave equations [15], in the spectral domain, were:

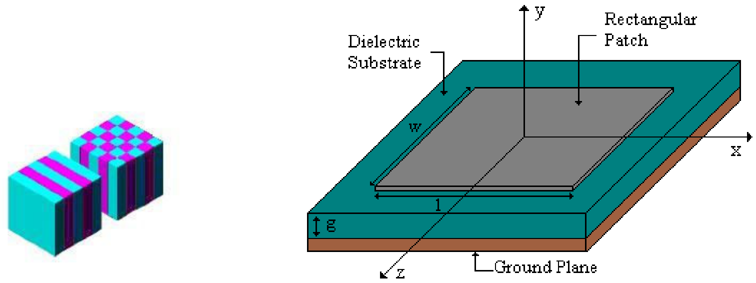
$$\tilde{E}_{x1} = \frac{1}{\gamma_1^2 + k_1^2}\left[-j\alpha_n\gamma_1 A_{1e} senh(\gamma_1 y) + \omega\mu\beta_k A_{1h} senh(\gamma_1 y)\right] \quad (1)$$

$$\tilde{E}_{z1} = \frac{1}{\gamma_1^2 + k_1^2}\left[-j\beta_k\gamma_1 A_{1e} senh(\gamma_1 y) - \omega\mu\alpha_n A_{1h} senh(\gamma_1 y)\right] \quad (2)$$

$$\tilde{H}_{x1} = \frac{1}{\gamma_1^2 + k_1^2}\left[-j\alpha_n\gamma_1 A_{1h} \cosh(\gamma_1 y) - \omega\varepsilon_1\beta_k A_{1e} \cosh(\gamma_1 y)\right] \quad (3)$$

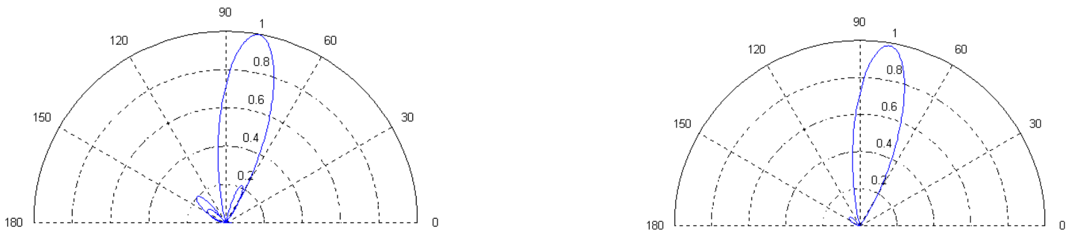
$$\tilde{H}_{z1} = \frac{1}{\gamma_1^2 + k_1^2}\left[-j\beta_k\gamma_1 A_{1h} \cosh(\gamma_1 y) + \omega\varepsilon_1\alpha_n A_{1e} \cosh(\gamma_1 y)\right] \quad (4)$$

where i = 1, 2 are the dielectric regions of structure, $\gamma_i^2 = \alpha_n^2 + \beta_k^2 - k_i^2$ is the propagation constant in **y** direction, α_n is spectral variable in **x** direction, β_k is spectral variable in **z** direction, $k_i^2 = \omega^2\mu\varepsilon = k_0^2\varepsilon_{ri}^*$ is the wave number of the dielectric region, and $\varepsilon_{ri}^* = \varepsilon_{ri} - j\dfrac{\sigma_i}{\omega\varepsilon_0}$ is the relative dielectric permittivity of the complex material.



(a) (b)

Figure 1 a) One and Two-dimensional Periodic Structures. b) Photonic-superconducting microstrip antennas with patch of width, w, thickness, g, and length, *l*.



(a) (b)

Figure 7. Pattern fields for a planar array with superconductor patch at Tc = 212 K and θ = 80°, for plane-E (a) and plane-H (b).

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