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Propagation Characteristics of Closed Shape Waveguides Due to Substrate Integrated Impedance Surface

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ABSTRACT

We have studied the substrate integrated impedance surface or any closed waveguide for modern communication and sensing systems. Theoretical study of substrate integrated impedance surface was made and analysed propagation characteristics of a substrate integrated impedance surface loaded substrate integrated waveguide. The results validated both full wave simulations of theoretical and experimental works. We have presented interconnected substrate impedance surface loaded substrate. Integrated waveguide eased and propagation loss enabled substrate integrated impedance surface loaded waveguide exhibited strong local field enhancement.

KEYWORDS Substrate integration, impedance, propagation.

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INTRODUCTION

Henry et al.[1] and Wang et al.[2] used an interconnect signal transmission, rectangular waveguides to electromagnetic components as antennas, filters, resonators, couplers and phase shifters. Usman et al.[3], Silavwe et al.[4] and Lobato Morales et al.[5] presented microwave sensor using substrate integrated waveguide. Kalimov[6] studied that molecules leaded for effective detection of single molecule fluorescence. Leng et al.[7] studied that superlattice longitudinal coherence exploited to create phase mismatch and reduced cross talk, its transverse coherence was also modified and disturbed to beam forming of the optical phase array. Kumar et al.[8] studied that sensing the cross density of states of the field lies at the core of induced coherence for spectroscopy based on induced coherence and showed generalized treatment to optimize the sensing performance. Ahumanda et al.[9] studied that calculation of correlation was made for qubits. Cai et al.[10] and Garbe et al.[11] studied the properties of highly correlated eigen states transitions, information processing and used in waveguide propagation.

METHOD

The two dimensional metasurface was considered. The equivalent surface impedance scatterers was used for the study. Compact substrate impedance surface, substrate integrated waveguide showed dispersion, distribution and used for many applications. The potential application carried waveguide dimensions, which produced slow wave propagation and this technique allowed the process. Substrate integrated impedance surface was ultrasensitive non-linear components. The derivation of substrate integrated impedance surface was made. Substrate integrated impedance surface loaded waveguide was used for calculation of results. We have considered a capacitive substrate integrated impedance surface having one dimensional subwavelength frequencies. Derived resonance method was used for TE_{10} mode as

$$\frac{-i\omega\mu_0}{2\sqrt{k^2-\beta^2}}\tan\left[\sqrt{k^2-\beta^2}\,\frac{w}{2}\right]+Z_s(\omega)=0$$

.

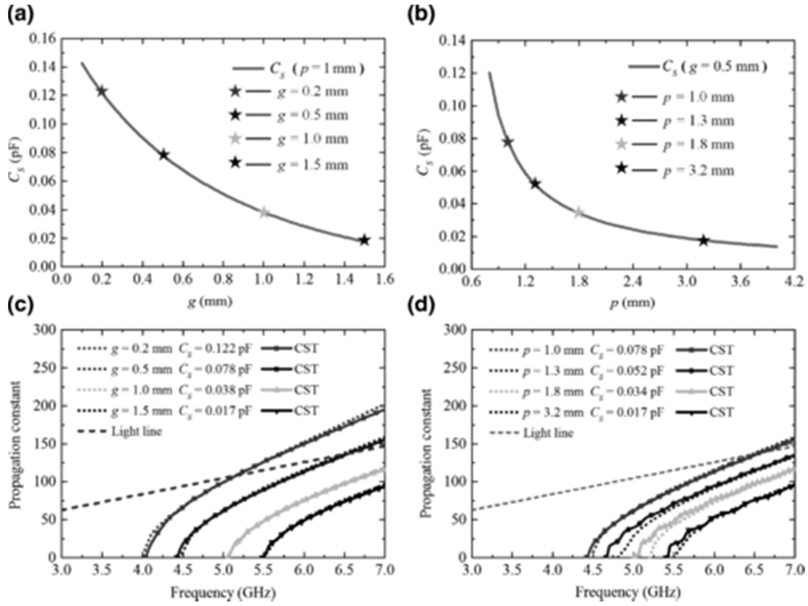
Where $k=\omega\sqrt{\varepsilon\mu_0}$, for substrate integrated waveguide, Substrate integrated waveguide exp $(-i\omega t)$ is the time convention adopted. The capacitive surface impedance is $Z_s(\omega_0)=\frac{i\omega_0\mu_0 W}{4}$ is the excitation propagation mode at the frequency ω_0. It is accurate explanation of arrays electromagnetic properties and periods are very small. Substrate integrated impedance surface given by

$$Z_s=\frac{E_{ext}}{J_s}-\frac{\eta}{2}=\frac{d_x d_y}{i\omega}\left(\alpha_{xx}^{-1}-C_{\text{int}}\right)-\frac{\eta}{2}.$$

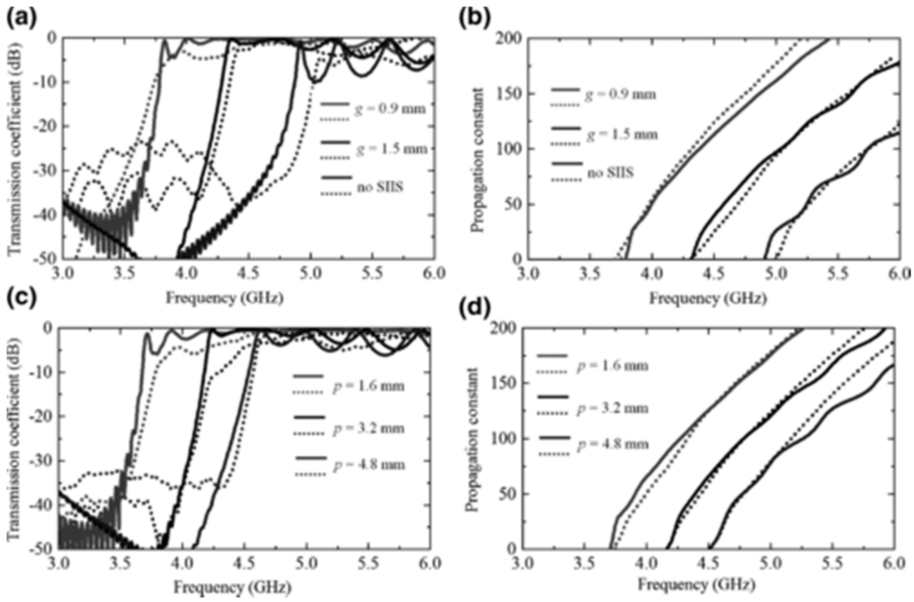
Where η is the intrinsic impedance.

RESULTS AND DISCUSSION

Graph (1) shows comparison of analytical and numerical results. Graph (1) (a) shows substrate integrated waveguide for which results were obtained. Graph (1) (c) shows the plot of analytical results and full wave simulation results. Graph (1) (a) also shows the equivalent surface capacitance of substrate integrated impedance surface were increased, which in term reduce the waveguide cut off frequency. Graph (1) (c) and (1) (d) show dispersion. Graph (1) (b) shows agreement with simulation results. It was found that propagation constant of substrate integrated impendence surface increased with frequency. Graph (2) shows the plot of standard substrate integrated waveguide. Graph (2) (a) also shows the plot of simulated and obtained results of transmission coefficients of standard and substrate integrated impedance surface loaded substrate integrated waveguides. Graph (2) (b) shows simulated and obtained results for substrate integrated waveguides. Graph (2) (c) and (2) (d) show the effect of cut off frequency period. It was found that when period *p* was decreased waveguide was down. We have fabricated several prototyped of the substrate integrated impedance surface loaded substrate integrated waveguides and have characterized their properties. The substrate integrated waveguide and substrate integrated impedance surface have been fabricated due to the standard printed circuit board process. We have made a theoretical work for equivalent surface impedance of particular substrate integrated impedance and analysed propagation characteristics of loaded substrate integrated waveguide. The obtained results were compared with previous obtained results of theoretical and experimental works and were found in good agreement.



Graph 1: Plot of comparison of analytical and numerical results.



Graph 2: The plot of substrate integrated impedance surface loaded wave guide having different geometric parameters and simulation results and comparison of standard substrate integrated wavelength vs substrate integrated impedance surface.

CONCLUSION

We have studied substrate integrated impedance surface. Dispersion and cutoff frequency of waveguide are essential parameters for operation. Integrated impedance surface wave were able to control propagation. It was found that substrate integrated impedance reduced cut off frequency of transverse wave. The loaded waveguide exhibited slow wave guiding properties and local field concentration. It was also found that the surface capacitance of substrate integrated impedance surface was increased due to reduced distance pitch. Negative permeability band and large insertion loss was found due to resonant absorption.

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