FINITE ELEMENT ANALYSIS OF SLOW-WAVE SCHOTTKY PRINTED LINE

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ABSTRACT

The Schottky contacted slow-wave structure is analyzed for the first time without use of a layered model approximation for the localized depletion region. A general finite element code is developed for the analysis. Both microstrip and coplanar configurations are studied.

ITRODUCTION

The objective of this paper is to study the effect of the size of the depletion region in a Schottky contact slow-wave printed transmission line. To date, both the MIS and Schottky contact slow-wave structures have been analyzed by a number of techniques (Figure 1)[1,2,3,4]. In such analyses, however, it is assumed that the depletion region can be replaced with a lossless insulating layer. Hence, these analyses are valid for MIS structures, but their accuracy as applied to the Schottky structure is unknown.

In this paper, a finite element analysis program is developed and applied to these slow-wave structures. The program is used for calculations of slow-wave factors and attenuation constants for the layered structures and the localized depletion region models.

COMPUTATION ALGORITHM

The finite element method for waveguide analysis is well known [3,4,5]. A symmetrical coupled matrix equation of order N by N satisfying Dirichlet boundary conditions is derived based on weighted residual integral, where N equals to 2*(the number of nodes of the finite element meshs)-(the number of the sum of nodes on electrical and magnetic walls). The four-noded isoparametric bilinear element is employed for interpolating functions. The integration over each finite element mesh is carried out by 3 by 3 Gaussian quadrature rule. No substantial improvement is evidenced by applying higher order Gaussian integration rule. The magnetic wall is located at the center of the structure due to the even symmetry of the structure. The nodes on the electrical wall are located on the enclosure. Twenty five elements and thirty six nodes are assigned here. The complex propagation constant is obtained by setting the determinant of the matrix equation equal to zero for non-trivial solution. The real and imaginary parts of the propagation constant gives the attenuation and phase constants.

NUMERICAL RESULTS

Figure 2 compares the present results with those reported in literature[4]. Agreement between two results is reasonable when considering the fact that different discretizations in finite element method substantially influence the results. Further, we applied the present method to the lossless printed line structures and excellent agreement has been obtained with the data reported in literature [6].

Since accuracy of the algorithm has been established, it has been used for studying the effect of localized depletion region on the slow wave characteristics. In Figure 3, the slow wave factor and attenuation constant are plotted for the slow wave structures with a layered insulator and with a localized depletion region. In this figure, little difference exists between two models. Hence, the layered model is a good approximation for a Schottky contacted slow wave microstrip line with a reasonably wide strip. It has been observed, however, that substantial increase of attenuation constant exists in the coplanar line with a localized depletion region.

CONCLUSIONS

A finite element program has been developed for analyzing a printed waveguide with various cross sections. The program has been applied to slow wave structures with a layered insulator and with a localized depletion region to study the difference in the propagation characteristics.

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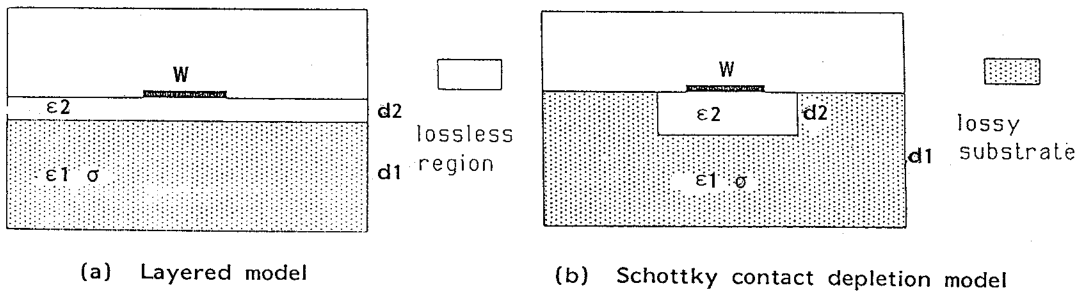

Fig.1 Cross section of slow-wave microstrip

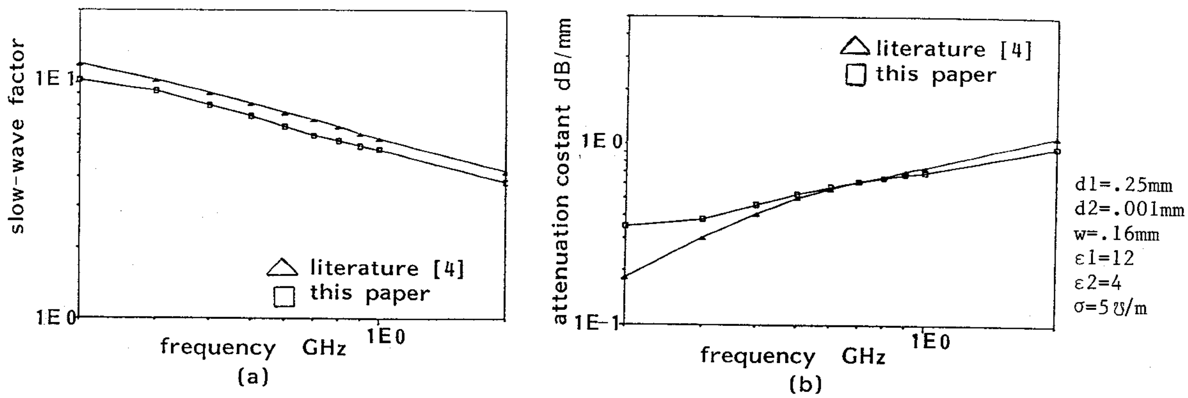

Fig.2 Comparison of Results with Literature [4]

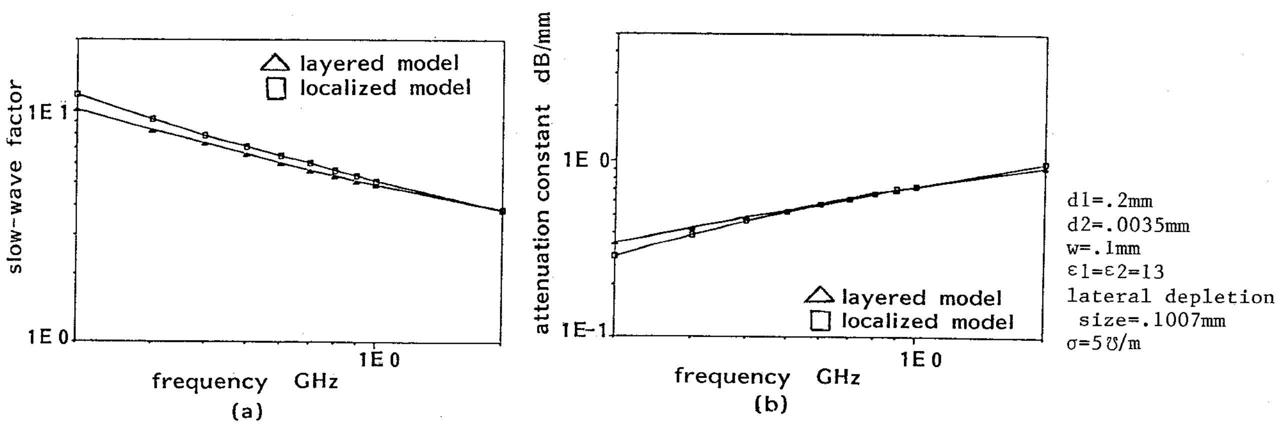

Fig.3 Comparison of Layered and Localized Models