SYSTEMATIC DETERMINATION OF THE PROPAGATION CHARACTERISTICS OF COPLANAR LINES LAID ON SEMICONDUCTOR SUBSTRATE

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INTRODUCTION

Comprehensive studies of various devices such as electrooptic waveguide modulator, monolithic microwave integrated circuits (for example : phase shifter), and the knowledge of the propagation effects on power field effect transistor needs fine characterization of Schottky contact coplanar line. Up to now, only a few experimental results have been published for relatively low loss MIS line for frequencies up to 15GHz [1], [2]. In thiscommunication, we propose a systematic characterization of micronic Schottky contact coplanar line from 1GHz to 26GHz under drastic conditions, that is to say :

- very high slow wave factor λ_0/λ_g
- high attenuation
- very dispersive transmission line
- strong mismatching between feeding line and the device under test.

The topology of the structure is shown figure 1. In order to avoid problems which could be induced by hybrid mounting, we use a monolithic configuration, which consists of a succession of several lengths of different coplanar lines. The device under test (the Schottky contact micronic coplanar line) has been realized in our laboratory, using conventional GaAs technology. In order to obtain a Schottky contact coplanar line, a 1mm length semiconducting mesa was defined on the wafer. Then the different metallizations (ohmic contact, Schottky contact) were deposited. The Schottky contact lines are inserted between two feeding coplanar lines laid on the semiinsulating substrate, with characteristic impedance of about 50Ω. Then geometrical tapers allow us to connect the cascade microtech probes to the 50Ω coplanar line.

In fact, the main difficulties appearing to extract the propagation characteristics of the device under test, from measurements, are essentially due to the different discontinuities which exist for the considered structure. The first, is the one between the microwave probes and the coplanar lines laid on semi-insulating substrate. The second, the strongest one between semi-insulating coplanar lines and the Micronic Schottky contact coplanar line.

Indeed, although geometrical topologies for the two structures are similar, electric and magnetic energy configurations are quite different for each line. One line propagates a quasi TEM mode (semi-insulating coplanar line) while the line under test propagates a slow wave mode with a bigger slow wave factor [3]. These states induce strong mismatching between the two structures.

So systematic characterization requires precise and reliable experimental set up. In our case, we use an automatic network analyser HP 8510B, associated with Cascade Microtech System. In that measurement, the high attenuation of the line under test do not allow easily to determinate the different discontinuities by temporal analysis [4].

So, we work in the frequency domain taking into account the presence of the different mismatchings. In fact, the theoretical analysis of the transitions shown on figure 1 is quite a complex problem. So, it seems to be better in an engineering purpose, to determine an equivalent model for each discontinuity from the experimental data. To do so, we have used optimization search, using a very common software (EESOF's Touchstone).

However, in that microwave design software, neither very lossy coplanar line with complex characteristic impedance nor present discontinuities are included in its catalog (version 1.5, March 1987).

So we have modelized each discontinuity by a group of lumped elements. On the other hand, the lossy Schottky contact coplanar is simulated by cascading unit cells. The topology of each cell and the initial value of each element which composed it are defined and calculated by previous desktop computer model [3].

After the determination of the minimal number of elementary cells, in order to express the propagating phenomena in the lossy line, the different elements of each discontinuities and each cell are obtained by optimization procedure with the scattering experimental parameters as goal.

For structure shown figure 1, the presented methodology allow us to obtain a very good agreement between experimental data and theoretical results figure 2 for Schottky contact coplanar line defined figure 1.

CONCLUSION

We have presented in this communication a systematic measurement of the propagation characteristics of Schottky contact micronic coplanar lines. The association of optimization procedure and performing measurement setup allow us to obtain a good agreement between experimental and theoretical data on wide frequency range in spite of strong discontinuities and mismatchings between feeding line and device under test which exhibits a very high slow wave factor λ_0/λ_g and high attenuation.

REFERENCES

[1] V.M. HIETALA, Y.R. KWON, K.S. CHAMPLIN : "Low-loss slow wave propagation along a microstructure transmission line on a silicon surface", Electronics Letters, vol. 22, n°14, pp. 755-756

[2] Y.R. KWON, V.M. HIETALA, K.S. CHAMPLIN : "Quasi-tem analysis of "slow-wave" mode propagation on coplanar microstructure MIS transmission lines", IEEE Trans. on M.T.T., vol. MTT-35, n°6, June 1987, pp. 545-551.

[3] P. PRIBETICH, C. SEGUINOT, P. KENNIS : "Propagation characteristics of coplanar transmission lines laid on semiconductor substrate", Alta Frequenza, Special Issue "Focus on computer oriented design techniques for microwave circuits", part III, September 1988, pp. 417-430.

[4] C. BECCARI, U. PISANI : "Automatic discontinuity de-embedding in S-parameter measurement system", Alta Frequenza Special Issue "Focus on computer oriented design techniques for microwave circuits, part I, June 1988, pp. 249-259.

FIGURES CAPTION

Figure 1: studied structure

Figure 2a: Frequency behaviour of the propagation characteristic (slow-wave factor, attenuation constant) of Schottky contact micronic coplanar line (bias voltage:-8V)

Figure 2b: Frequency behaviour of the characteristic impedance of Schottky contact micronic coplanar line (bias voltage:-8V)

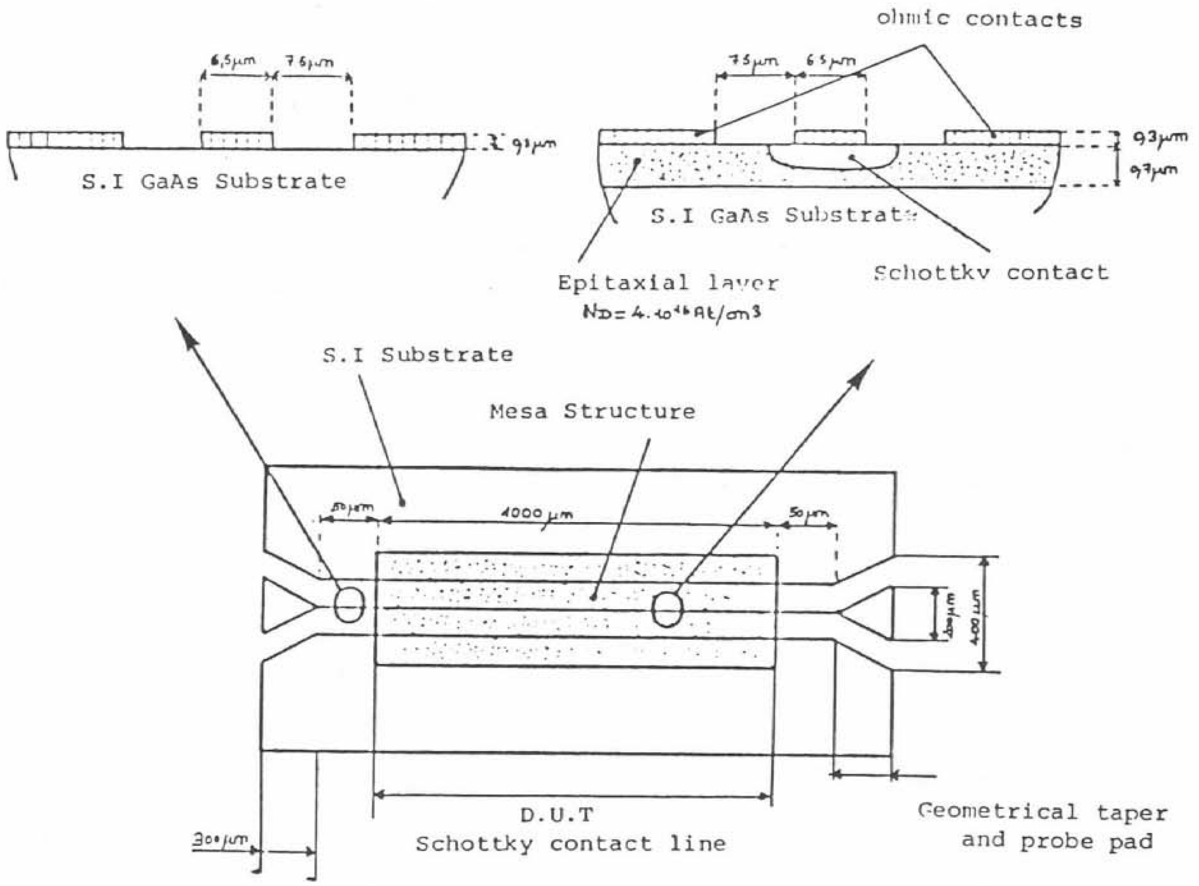

Figure 1

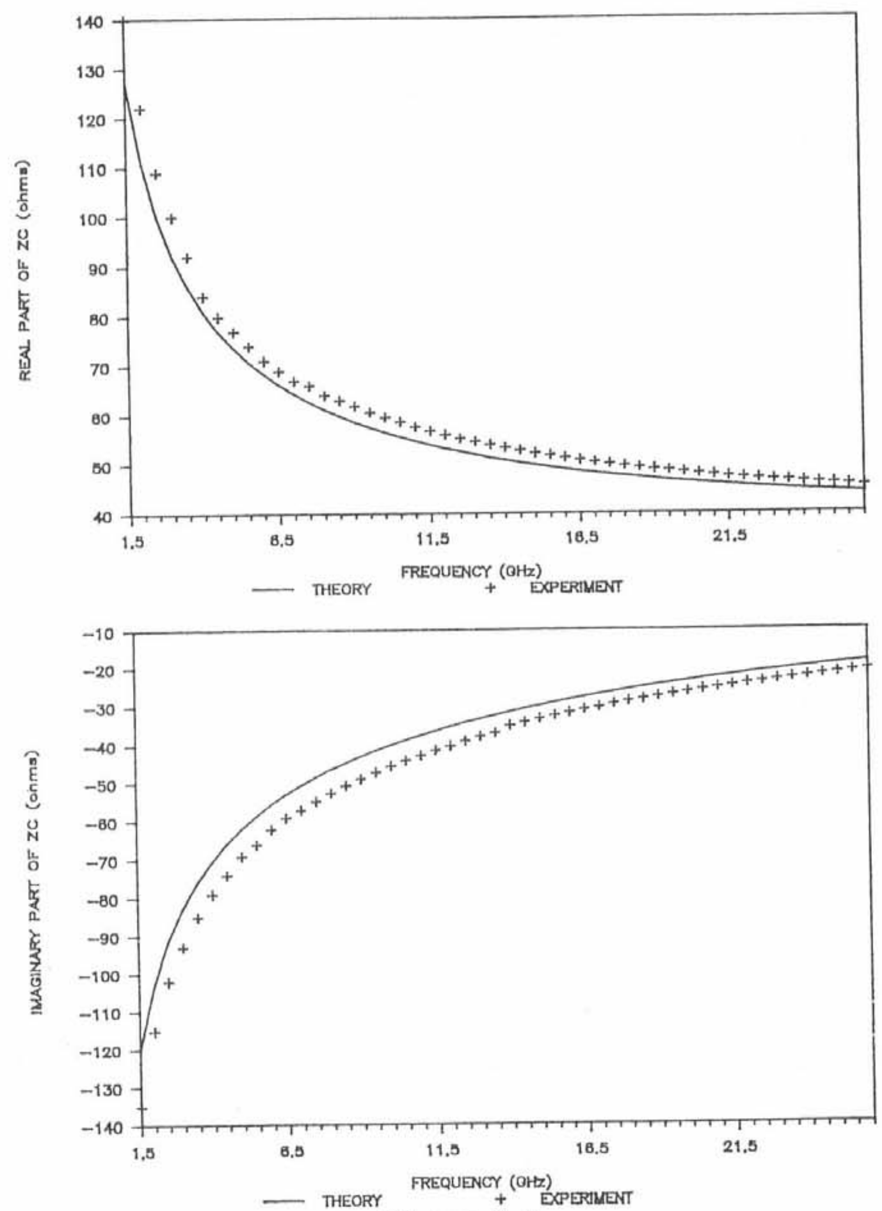

Figure 2.b

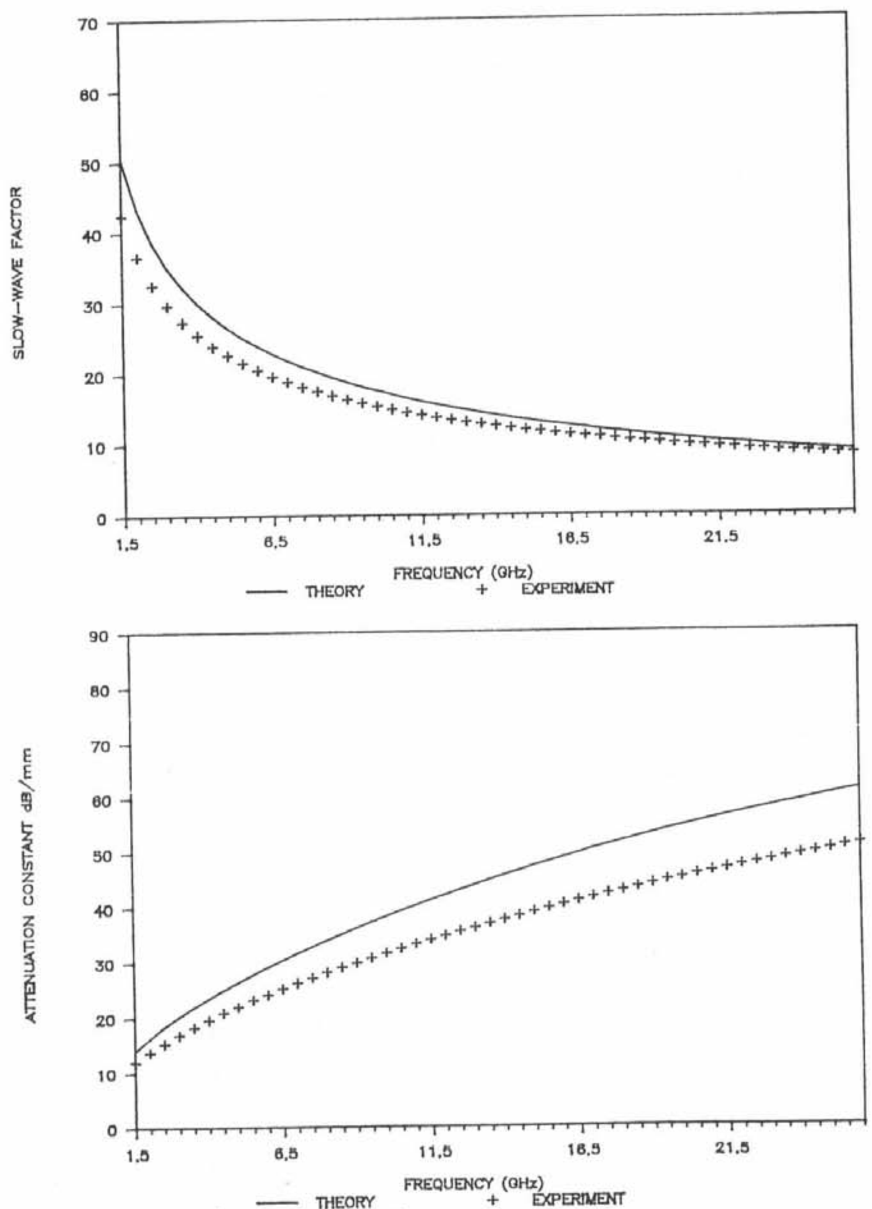

Figure 2.a