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A DETAILED STUDY, STRATEGY, AND SIMULATION OF MEMS GUIDED MEDIA: MICROSTRIP LINE

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ABSTRACT-

Some design challenges of the Microstrip line, one of the planar-guided media, have been presented in this work. This paper's primary goal is to investigate the fundamental transmission characteristics of the microstrip line while taking into account variations in the line's length, the materials utilised in device development and fabrication, and its greatest operating frequency. The paper is primarily divided into two sections; the first section deals with the theoretical portion because it is important to understand how geometrical factors, the electronic characteristics of the substrate and conductors used, and the frequency affect the characteristic impedance, phase velocity, and attenuation constant of the dominant mode of microstrip. The TEM mode cannot be supported in this "mixed" dielectric system, so the second part of the inquiry focused on the impact of changing the line's length and frequency on its RF performance. Although there are numerous articles on this subject, the concerns discussed in this paper have a somewhat distinct perspective.

Key Words *:* RF MEMS, TEM mode, HRS, TFMLs.

I. INTRODUCTION

Radio frequency integrated circuits (RFICs) technologies have recently come to recognise integrated circuit passive components as high-performance and inexpensive components of deep submicron BiCMOS circuits [1]. The development of active transistor technology is important, but so is the integration of a large number of passive components, such as the individual passive devices of transmission lines, inductors, capacitors, or fundamental passive devices of filters and antennas with low loss and minimal cross-talk [2,3]. However, the substrate's low resistivity Due to the high lossy performance of the silicon substrate, typical CMOS processing for the majority of RFICs has restricted the integration of high quality passive components [3].

The issue of lossy silicon substrates has been addressed in some ways. The first technique is to integrate the passive parts as high up on the lossy Si substrate as feasible, on top of the thick dielectric layer [4]. The second strategy is to reduce carrier transmission in the substrate by using high-resistivity silicon (HRS, >5000 cm) [5]. Thirdly, low-resistivity silicon (LRS) can be changed into high-resistivity silicon (HRS) via high electron voltage (MeV) portion implantation, which improves the quality Q(f) of portion-implanted passive devices [6]. Utilising micro-electromechanical technology is the fourth strategy for lowering substrate loss [7-9]. However, the incompatibility of HRS technologies with common CMOS procedures is one of its main drawbacks. Polymides have historically been employed as low loss, low K dielectrics that enable faster propagation speeds, which are required for high-speed circuits. They can produce superior step coverage and dielectric insulators. As a result, polymide is widely employed to create different RF and microwave packages. Low dielectric constant (K) thin film microstrip devices lines (TFMLs) have recently been proposed as a promising choice for integrating the passives on RFICs up to 50 GHz in order to produce low cost, high density, and completely integrated interconnects for RF front end communication systems [10]. But since gold is used as the principal conductor in typical MEMS production, these are problematic. MEMS technology has advanced enough to address issues with poor mechanical strength, challenging manufacture, and limited lifespan.

II. THEORETICAL DESCRIPTION

The microstrip line is a transmission line geometry with a single ground plane and conductor trace on opposing sides of a dielectric substrate [Figure 2]. Therefore, a microstrip line's electromagnetic wave resides in both the dielectric substrate and the air above it. As a matter of course, the microstrip structure can be regarded as loss-less, when the conductivity of the semiconductor decreased. This is where the interest of earlier researchers in the field of planer transmission lines [11-14] was mainly focused. However, the IC design may not always realise this circumstance. Therefore, generally speaking, the influence of the substrate's finite conductivity .Any little disturbance to lossless instances should be anticipated. There are three basic modes: the slow wave mode, the skin-effect mode, and the dielectric quasi-TEM mode. The substrate behaves as a dielectric when the ratio of frequency to resistivity is high enough to result in a small dielectric loss angle. As long as the wavelength is substantially more than the wafer thickness, the fundamental mode would closely match the TEM mode. The standard TEM approach is inappropriate when the frequency rises further, and the mode would disperse. The line may be treated as a microstrip line on an imperfect silicon "ground plane" when the product of the frequency and substrate conductivity is significant enough to produce a modest penetration into the wafer. In this case, the line will act like a lossy conductor wall. When the resistivity is moderate and the frequency is not excessive, the substrate behaves neither like the one described above nor the other, and a slow surface wave propagates along the line.

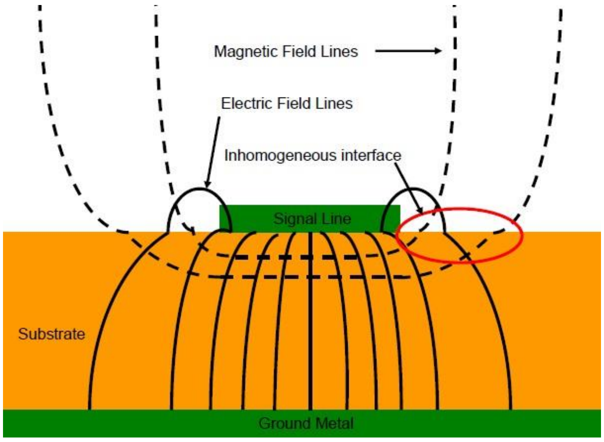

Figure 1. 2 D view of Microstip Line with its EM field Distribution

III. SIMULATION STUDY OF MICROSTRIP LINES

A. Variation of Insertion loss with length and frequency

The propagation characteristic of the microstrip line will change in accordance with the increasing length of the line. It is not difficult to draw the conclusion that the insertion loss will similarly increase in a linear fashion in proportion to the growing length of the line. The value is at its lowest at a distance of 500 metres and at its highest for a distance of 4000 metres. It is also obvious that there is a greater rise in insertion loss at higher frequencies as compared to lower frequencies. This is something that can be observed. The relationship between frequency and the amount of insertion loss seen in microstrip lines ranging in length from 500 m to 4000 m is seen in Figure 2. When operating at frequencies lower than 10 gigahertz, the insertion loss of a microstrip line with a length of 500 micrometres is less than –0.02 decibels.

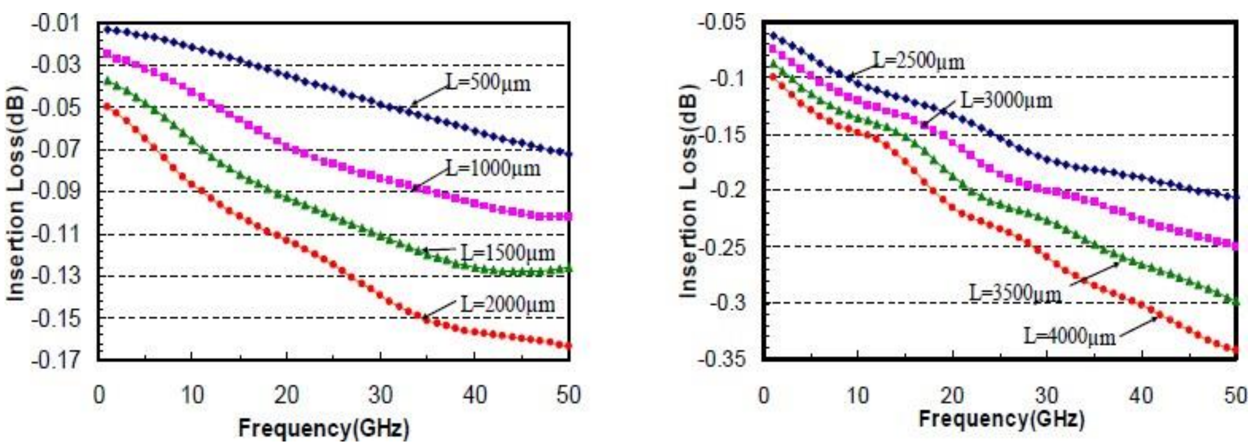

Figure 2. Comparison of insertion loss of microstrip lines with frequency having different lengthsfrom 500μm to and 4000μm

B. Variation of Return loss with length and frequency

Variation of return loss with increasing frequency and length is shown in figure 3. One interesting fact about return loss curve is that there exist return loss dips, which are actually resonance dips. As the length of line increases the resonance dips appears more frequently.Resonance dip for 500µm appears at highest frequency of more than 50GHz whereas the resonance dip for 4000µm occurs only at 14GHz and again occurs at 28GHz. Other interesting fact about resonance dips is that secondary resonance peaks occurs at nearly integral multiple of frequency of first resonance peak.

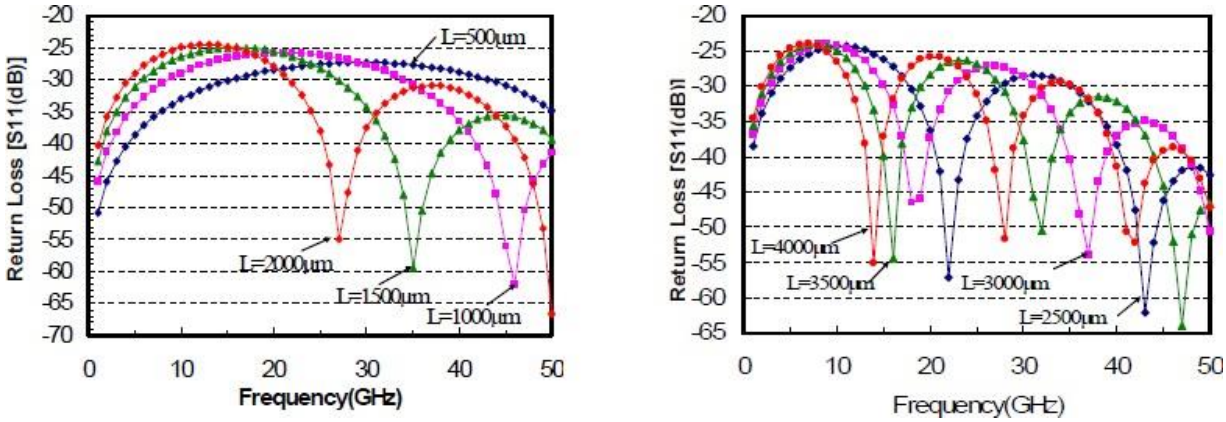

Figure 3. Comparison of Return loss of microstrip lines having different lengths from 500µm toand 4000µm

C. Variation of losses of line with highest frequency of operation

Next parameter for which microstrip line is studied is highest frequency of operation; both insertion loss and return loss variation are studied. The only important factor, which is noticeable,is that frequency of resonance dip increases with increase in the highest frequency of operation means possibility of reoccurrence of resonance dips decreases with increase in the highest frequency of operation whereas there is slight increase in the insertion loss with highest frequency of operation.

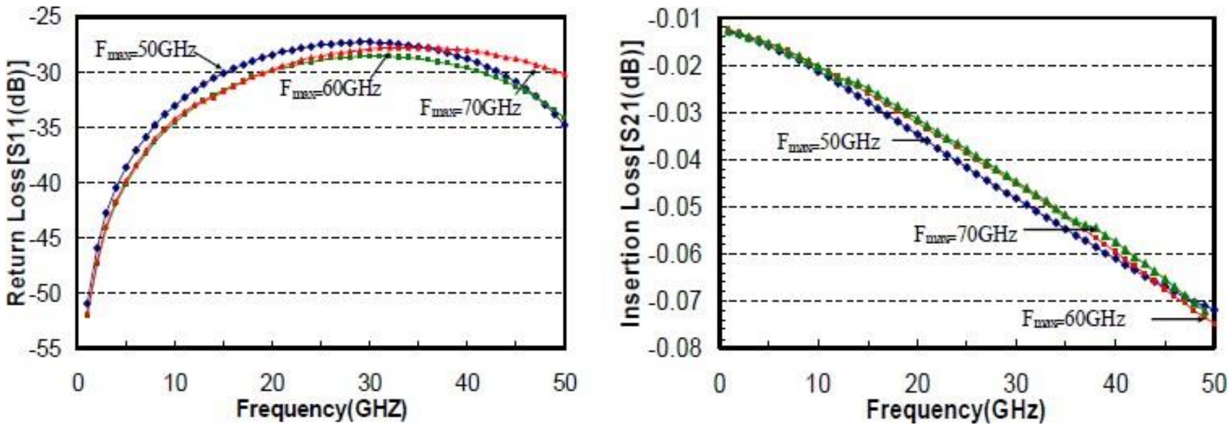

Figure 4. Return loss of microstrip lines simulated for different highest frequencies from 50GHz to 70GHz (length=500µm)

IV. CONCLUSION

On a silicon wafer with a resistivity of 5000, I constructed, studied, and simulated the MEMS microstrip transmission line for this paper. Several simulation experiments have been performed, each focusing on a different frequency and adjusting a distinct set of parameters. The low loss of developed microstrip line that is given here is encouraging. It has an insertion loss of only –0.02dB at frequencies lower than 10GHz. According to the performance of the suggested MEMS Transmission line, further advancement in the performance of RF devices is likely.

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