Comparing Coax Launcher and Wafer Probe Excitation for 10mil Conductor Backed CPW with Via Holes and Airbridges

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ABSTRACT

This paper presents an experimental comparison of coax launcher versus wafer probe excitation of 10mil conductor backed CPW. It was found that conductor backing of a CPW can cause serious moding problem when a coax launcher is used. Introducing via holes can eliminate this problem to some degree. In comparison, wafer probe excitation shows generally a better response but also here the backmetallization causes some moding problems. The transition effect from the coax launcher onto the CPW has been modeled numerically and good agreement was found with measured data.

Introduction

Miniature Hybrid Microwave Integrated Circuits (MHMIC's) are an attractive alternative to ordinary hybrid MIC's, particularly where the volume does not justify the use of MMIC's or where better performance than normally obtainable from MMIC's is required. Coplanar waveguides (CPW) are the basic building block in this technology [1 - 4]. In particular CPW on 10 mil alumina substrate with backmetallization is of practical importance. The backmetallization, on the other hand, causes a number of problems which are directly related to the kind of excitation used: Whether a coax launcher or a wafer probe excitation is used to feed the RF signal into the CPW can make a significant difference in terms of the performance of the transmission line. The coax launcher excitation is often used in practice because test fixtures are commercially available and they are lower in cost than wafer probe stations. However, coax launchers can introduce a microstrip mode into the CPW in particular if a backmetallization is used and if the substrate material is relatively thin (i.e. in the order of the strip/slot dimensions). The field orientation of this microstrip mode can also excite parallel plate line modes and if no measures are undertaken to eliminate this mode the electrical performance of the transmission line deteriorates significantly for frequencies higher than 20 GHz.

In earlier papers [3,4,5] we have shown that by using a coax launcher the transmission properties of conductor backed CPW (CBCPW) are significantly improved when via holes are used and when they are located very close to the slots. How many via holes are necessary and at what distance from each other they should be placed has not been investigated so far. Also, no comparison has been published yet showing, side by side, the effect of a wafer probe and coax launcher excitation. Therefore, in this paper we will investigate the effect of via holes in conjunction with a coax launcher excitation and compare the results with a wafer probe excitation utilizing airbridges to suppress the even CPW mode. The CPW's considered in this paper are all on 10mil alumina substrate.

Furthermore, the measured results for the coax launcher excitation will be analyzed using a full wave technique [6]

Measurement Results

The vector network analyzer (VNA, WILTRON 360) was calibrated using the Line-Reflect-Line Technique and CPW standards on 10mil alumina (ε_r=9.6) with conductor backing. The first measurement was done with a coax launcher (WILTRON test fixture) and a CBCPW through line with no via holes but a single airbridge to exclude any effects from the even CPW mode. The center conductor of the CBCPW was 0.2mm in width to accommodate the coax launcher center pin. For the same reason (distance between coax center pin and ground ring) the slot width was chosen 0.15mm. These dimensions correspond to a characteristic impedance of 50Ohms.

Fig.1(a) shows the S-parameters which start to deteriorate significantly from 20 GHz on. As expected, this is mainly due to the parallel plate line mode which is excited by the coax launcher and which is bound by the groundplane and the backmetallization [3]. Measurements on the same line but without the airbridge have shown similar results as in Fig.1(a), which indicates that the even mode is not a problem in this case. The same through-line, but the airbridge replaced by three via holes, is shown in Fig.1(b). In comparison to the airbridge version, the parallel plate line mode seem to be affected but not significantly. However, an increase in the number of via holes shows a significant improvement as Fig.1(d) illustrates. Here eleven via holes are used over a distance of 10 mm of CPW through line. This corresponds to a distance between the via holes of 0.7mm. In this case the row of via holes on both sides of the CBCPW can be

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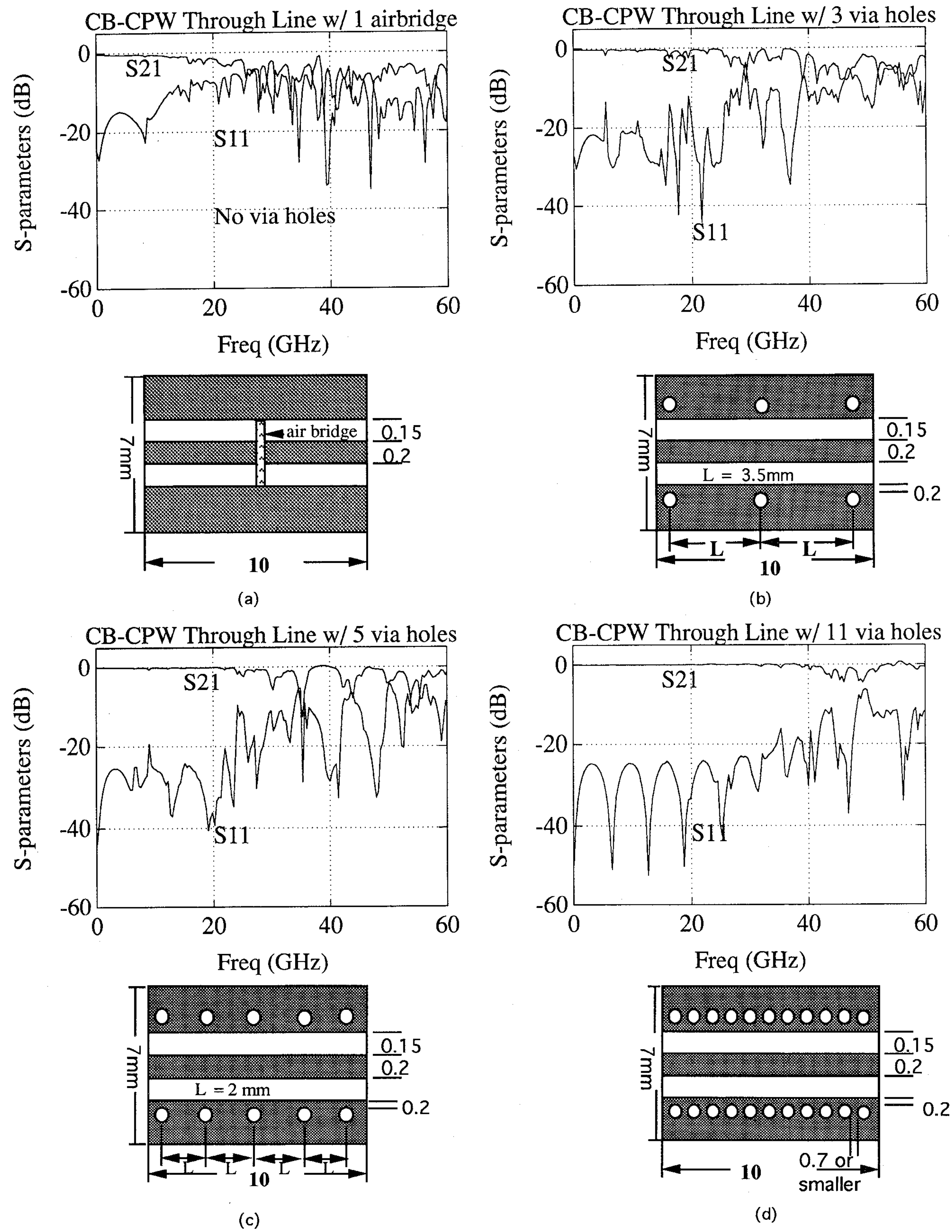

Fig.1 Measurement results of CBCPW from a coax test fixture

interpreted as the side walls of a rectangular waveguide with two slots in the top broadwall. The side walls are 0.9mm apart which allows a fundamental waveguide mode to start propagating at about 55GHz. This is approximately the frequency at which the measured performance of the CBCPW deteriorates (Fig.1(d)).

Fig. 2 illustrates the through-line performance by using a wafer probe excitation. In this case the slot width was chosen as 0.05mm while the center conductor was 0.1mm. This corresponds to a characteristic impedance of 50Ohms, Without an airbridge the electrical performance with and without back-metallization is similar (Fig.2(a)), although the results for the backmetallization indicate also here some moding problems. Utilizing an airbridge improves the through-line performance (Fig.2(c)), but still the data for S11 and S21 does not behave smoothly over the frequency. The number of spikes in the response is much larger in case of the backmetallization than in the case where the backmetallization has been removed (Fig.2(d)).

A direct comparison between the coax launcher and the wafer probe results is not easily possible because the circuit dimensions are different. Due to the smaller slot width in Fig.2, the CPW mode is easier to maintain than in the case of Fig.1, where the CPW mode and the microstrip mode may exist simultaneously. Furthermore, the wafer probe excites a CPW mode while the coax launcher excites a microstrip mode as well. However, for the coax launcher we have also investigated a tapered CBCPW in which the slot width was reduced down to the same value as that used in Fig.2. Although one would expect that due to the small slot width the electric field of the microstrip mode would be drawn into the slot area, eliminating the microstrip mode, this was not the case. Effects similar to the ones shown in Fig.1 could be observed.

For numerical analysis the coax launcher transition was approximated as an abrupt transition between a microstrip and a CBCPW. This analysis was performed using the frequency-domain TLM method [6]. As illustrated in Fig.3, the theoretical and measured results are in close proximity and even compare well for different numbers of via holes.

References

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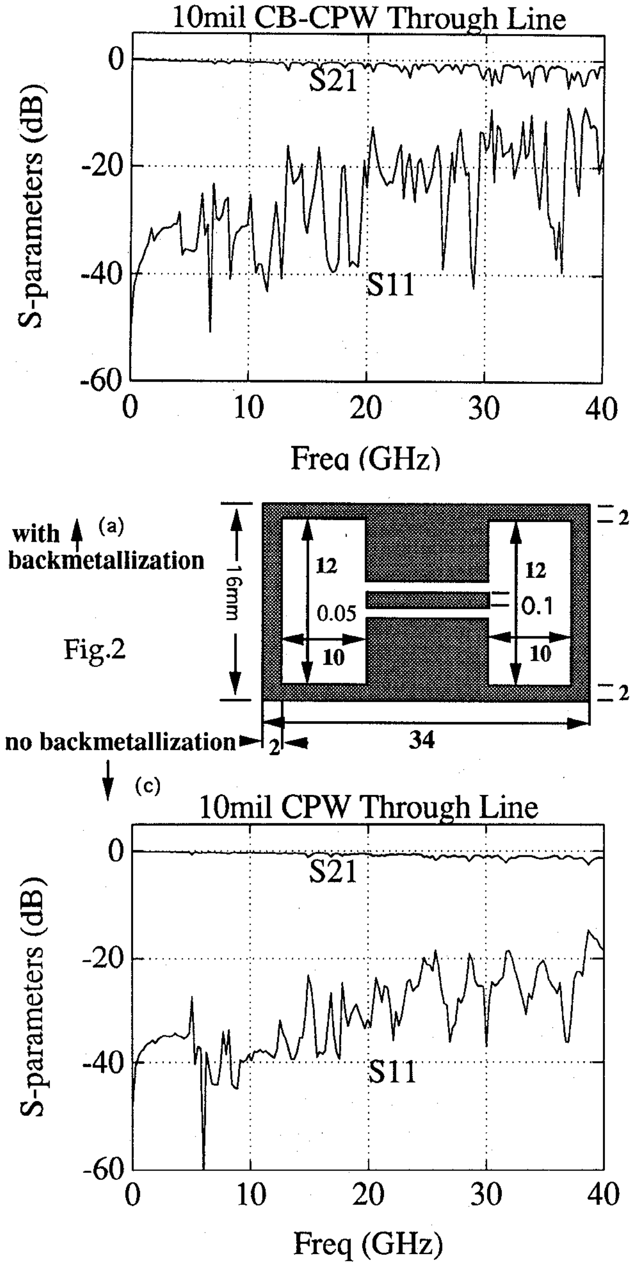

Fig.2

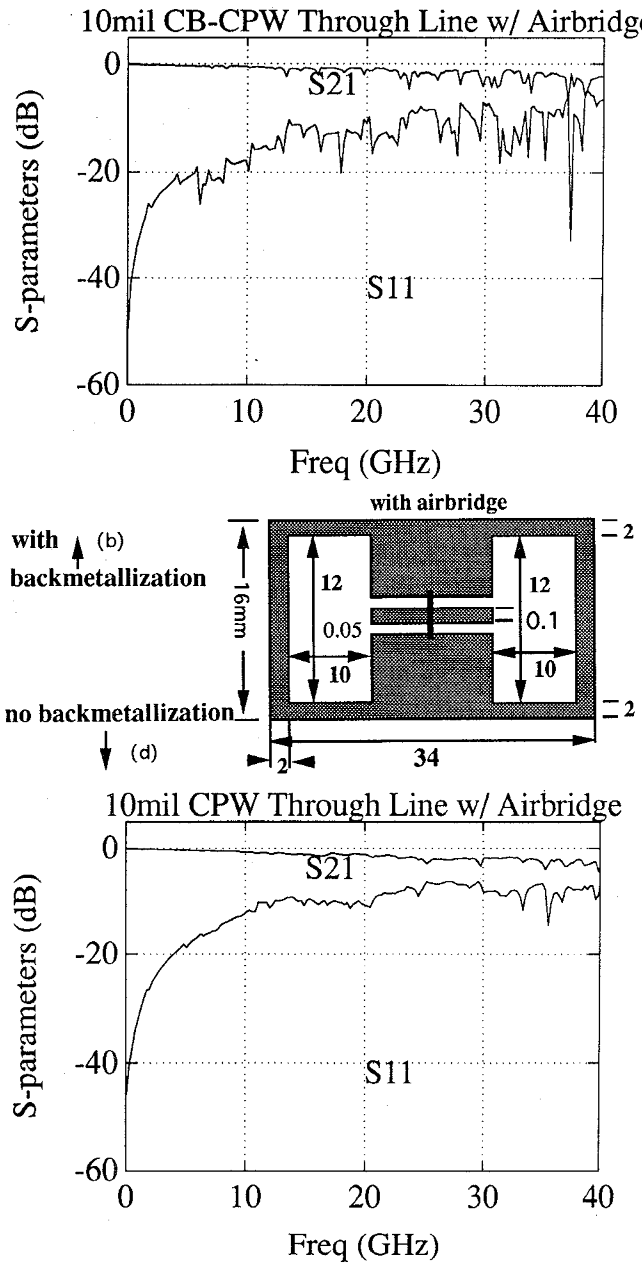

Fig.2 Measurement results of CPW from a wafer probe excitation

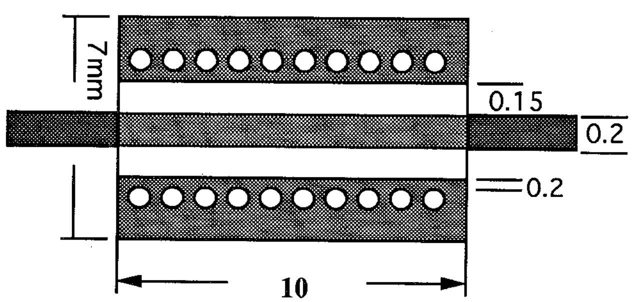

Fig.3(a) Excitation simulation

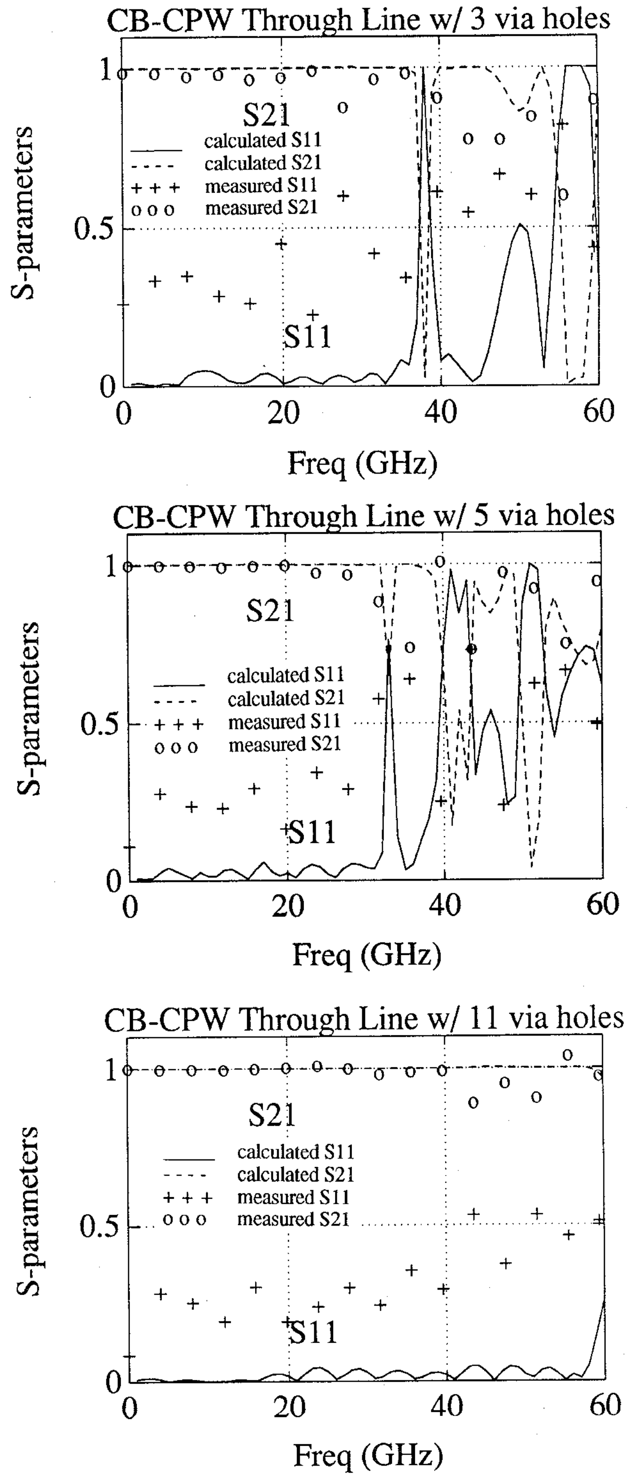

Fig.3(b) Measured and calculated results of CBCPW with via holes