Improving Probe Tip Calibration Accuracy at mm-Wave Frequencies

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Accurate calibration of RF and microwave wafer-level measurement setup is a crucial part of the device characterization process. Its success strongly depends on calibration method and precision of calibration standards used.

Recommendations for characterizing and improving performance of planar standards have been previously published e.g. [1-4]. This paper presents the results of investigations of the influence of calibration substrate boundary conditions on the propagation characteristics of CPW lines. A new configuration is suggested that significantly decreases the coupling of the unwanted substrate modes with the CPW standards beyond 50 GHz.

Traditionally the calibration substrate thickness is in the 0.25 to 0.625 mm range. As described in [2] at higher frequencies the substrate can support Transverse Electric (TE) modes and Transverse Magnetic (TM) surface wave modes, that can couple to the CPW transmission line mode at critical frequencies. These critical frequencies are a function of mode number, substrate thickness and substrate boundary condition. Other important effects are parallel-plate modes and radiation.

Different calibration boundary conditions were investigated: the commonly used methods to place the substrate on the metal chuck and absorbing holder [3]. A new method of using a thick ceramic support is proposed.

The propagation constant and the characteristic impedance of the experimental CPW lines were found using the method from [5]. This method was originally developed for GaAs applications and later proven suitable for commercially-available alumina calibration substrates [4].

It was shown that the new method significantly reduces the impact of higher modes, and at the same time does not negatively influence the characteristics of a CPW line, such as its propagation constant and the characteristic impedance (Fig. 1). As a result, the calibration and measurement accuracy is improved.

Summarizing, the use of the new method – the ceramic support chuck instead of metal or an absorber – has demonstrated characteristics, such as more ideal CPW characteristics, that should facilitate improved calibration and measurement accuracy for mm-wave frequency applications.

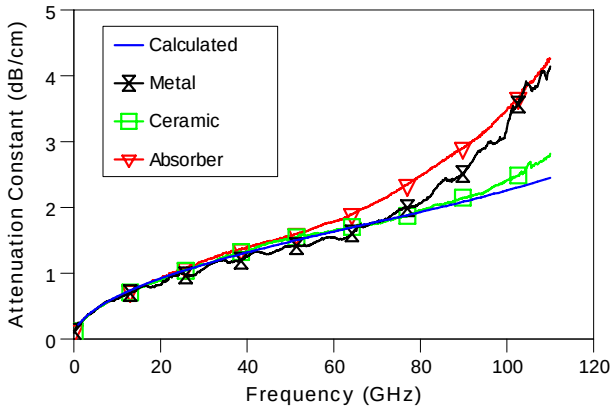

Fig. 1. The extracted attenuation constants of the same CPW line from the 250 µm thick substrate for three measurement boundary conditions: direct on the metal chuck, on absorber, and on ceramic chuck vs. analytically calculated results.

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