Low Loss Microstrip Transmission-Lines using Cyclic Olefin Copolymer COC-substrate for Sub-THz and THz Applications

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***Abstract*—We describe low loss microstrip transmission line with compact coplanar waveguide transitions for sub-terahertz application. The conducting transmission line is fabricated on the surface of a thin cyclic olefin copolymer dielectric layer. A vector network analyzer (VNA) has been used to obtain the transmission parameters and to validate our simulation results.**

I. Introduction And Background

Terahertz spectrum, which deals with electromagnetic waves in the 0.1THz–10 THz frequency band, is now known to be of great interest in recent years. Many applications involving biochemistry, spectroscopy, security screening, medical imaging, etc., have been proposed or demonstrate. However, some of these applications require developing of low loss broad band transmission lines. Of the various guided wave structures used in the transmission of terahertz signals, the microstrip line (MSL) is probably the most popular because of its simple geometry, small size and the ease with which it can be integrated, all very desirable properties in modern technology. In order to be able to design MSLs having the desired properties in a given application, certain parameters must be known and controlled such as, length, thickness, width, material conductivities, permittivity, and permeability, etc [1].

In this paper, we present novel MSL architecture consisting on transition from Coplanar Waveguide (CPW) and that was fabricated on a thin COC-layer of 10µm. The ground plane made of gold on silicon substrate has also a special shape that was optimized for the conversion efficiency from CPW-to MSL.

II. Broadband CPW-to-Microstrip Transitions

We have fabricated a 50/450-nm-thick Ti/Au MSL on a 10 µm thick Cyclic Olefin Copolymer (COC) dielectric layer. The ground planes are fabricated on Silicon wafer and we deposit the COC layer by spin-coating technique. Figure 1 (a, b, c, d) illustrates experimental photos of the fabricated structures at each step. To obtain a highly sensitive MSL design, simulations as well as experimental studies were carried out. The transmission parameter for various lengths of lines and for different CPW transitions is measured and compared to the experimental setup. The CPW structure was already described in detail, and herein it was designed to carry out the measurements at the sub-terahertz frequencies. On Fig. 1 (e) we present measurements results as an example and we can see the influence of the strip line length on the transmission parameters. The width of the MSL was kept to be 29µm, but two different lengths of transmission strip lines have been investigated.

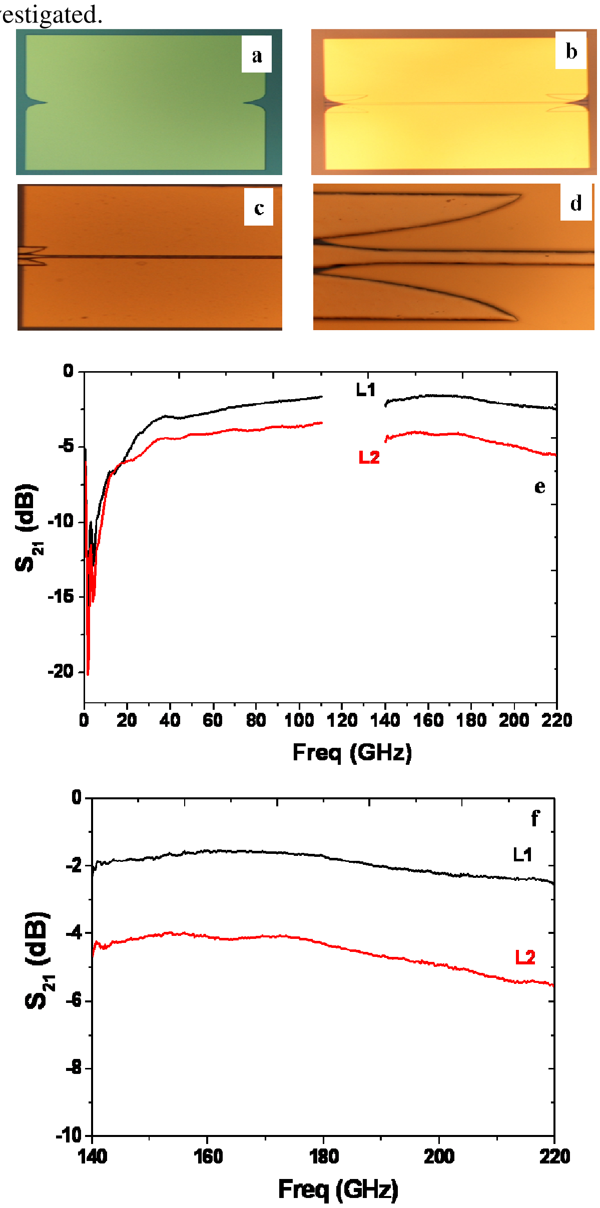

Figure 1 Photos of MSL structures at different steps of fabrication process, (a) gold plane metal coated on Si wafer, (b) developed polymer resist on COC layer, (c) metallic gold MSL embedded inside CPW, (d) zoom image on the transition
(e) Measured S_{21} transmission coefficient obtained with a vectorial network analyzer along 0-220 GHz, (f) Zoom of (e).

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The lengths were L1 = 1.96mm and L2 = 4.96 mm. One can observe the transmission loss of L1 is approximately -2 dB along 140-220GHz frequencies band. For frequencies lower than 180GHz, this transmission loss increases to -4.5 dB when the length of MSL is 4.96 mm. In comparison the S_{21} parameters of MSL with lengths of L1 and L2, at first approximation the insertion loss of our MSL is about -0.7 dB/mm at 180GHz and the losses are in the same range in the whole band. This value can be improved by adjusting certain parameters. We can also include resonators along the strip to obtain different kind of microstrip filters as we have already demonstrated with Planar Goubau Lines (PGL) [2]. We will present measurements in the 0-325GHz band during the conference and compare two different kind of electromagnetic CPW-to-MSL transitions. Note that we don't need any via hole in our approach and this be used at higher frequencies around 1THz. The on-wafer characterization can be done up to 750GHz and beyond [3-4]

III. Conclusion

We have demonstrated ultrabroadband CPW-to-Microstrip transitions without any via hole and on a very thin polymer substrate. This structure is a fundamental brick for THz applications like wireless communications for which filters and antennas and required

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