Dielectric Sheets Broadband Characterization Using Short-ended Coplanar Waveguide

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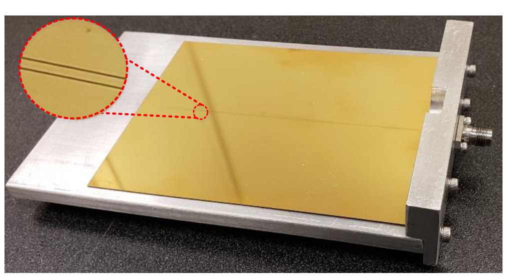
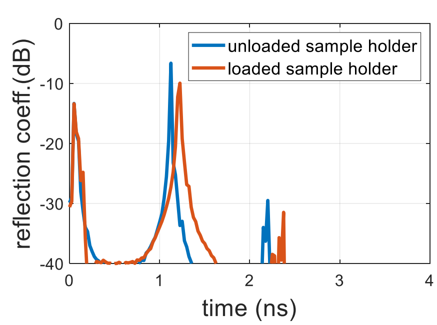
Broadband material characterization is often performed through loading a transmission line which operates in the TEM mode, e.g. coaxial line, with the unknown material and measuring reflection and transmission coefficients. This technique requires very fine machining of the dielectric samples to fit within the sample holder. Besides, to perform these measurements at frequencies beyond 30 GHz, the dimensions of the line become very small and preparing samples becomes very difficult. However, open transmission line structures, such as microstrip or coplanar waveguides (CPW), do not pose much difficulties.

A broadband (1-40 GHz) reflection technique using a CPW line sample holder for low loss dielectric sheets is presented here. The technique relies on a short-ended CPW line with 50 Ω characteristic impedance, minimizing the width and the gaps of the line allows the measurements to exceed 30 GHz. The CPW line is fabricated using gold deposition on a very flat Quartz substrate in order to have as fine line dimensions as 40 μm gap and a low loss substrate. The procedure is divided into characterization of the sample holder before, Fig. 1(a), and after loading. The very broadband measurements, through the inverse Fourier transform of the measured $S_{11,}$ allows an accurate estimation of the effective dielectric constant through calculating the time difference between the reflection due to the connector mismatch and that due to the short circuit as shown in Fig. 1(b). Gating the short circuit reflection in the time domain, transforming it back to the frequency domain and removing the effect of the connector reflection can be used in calculating the round trip loss. Additional simulation steps is performed to link the dielectric constant of the unknown dielectric with known thickness to the measured effective dielectric constant.

A practical support structure is fabricated to support the quartz substrate, handle the pressure resulting from loading the quartz and ensure connectivity between the 2.4 mm connector and the gold CPW line. Soldering the connector on the gold is a tough operation due to its small thickness, the support structure achieves that connection through applying pressure without any soldering. Measurements of known materials shows the accuracy of the broadband dielectric measurement system. Complex dielectric constant of unknown glass and plastic samples will be reported.



(a)



(b)

Figure 1. (a) Unloaded CPW line on support structure. (b) IFT of S_{11} of the measured data before and after loading.