ECEN452: ULTRA HIGH FREQUENCY TECHNIQUE
LAB10
SAMBONG JANG
DR. HUFF

BACKGROUND:

Dielectric constant of substrate/material is one important measure in Ultra-High Frequency Technique. The real part of permittivity is a measure of how much energy from an external electric field is stored in a substrate. The imaginary part of permittivity is a measure of how lossy the substrate when an external electric field is applied.

PLOT:

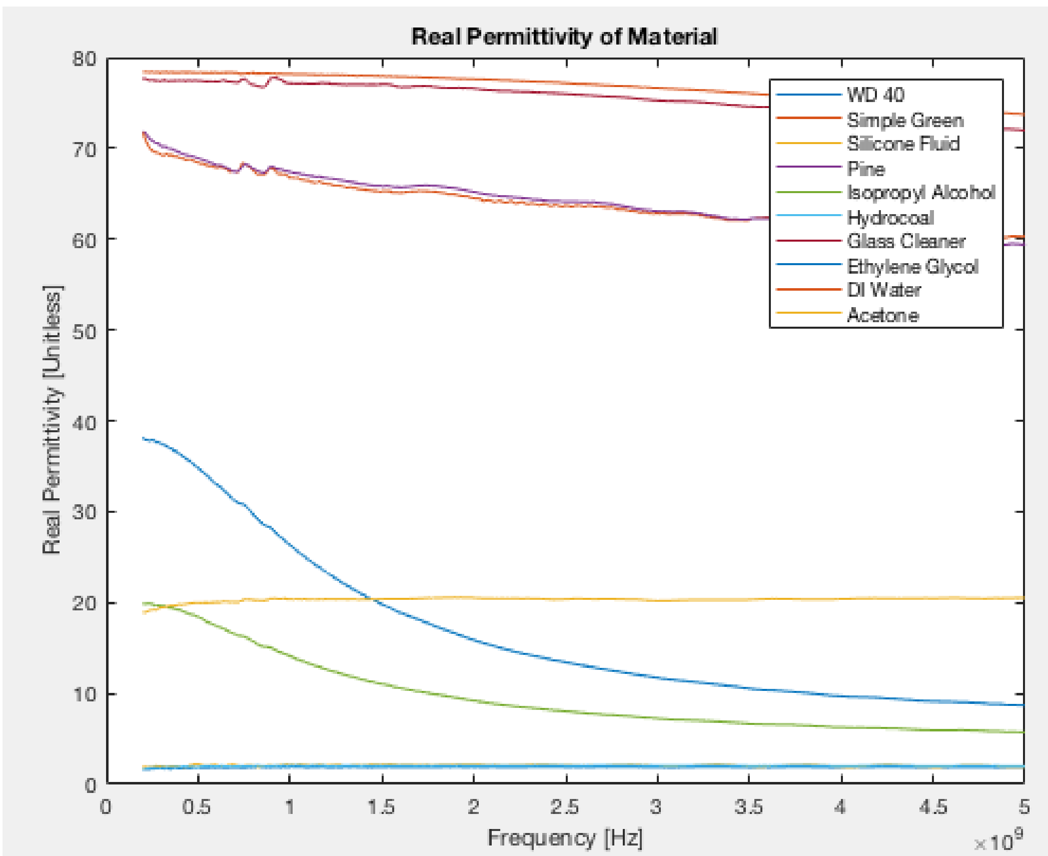

Figure. Real Permittivity Plot of Materials

Note that silicone Fluid shows decaying behavior as frequency increases. I thought this is something interesting.

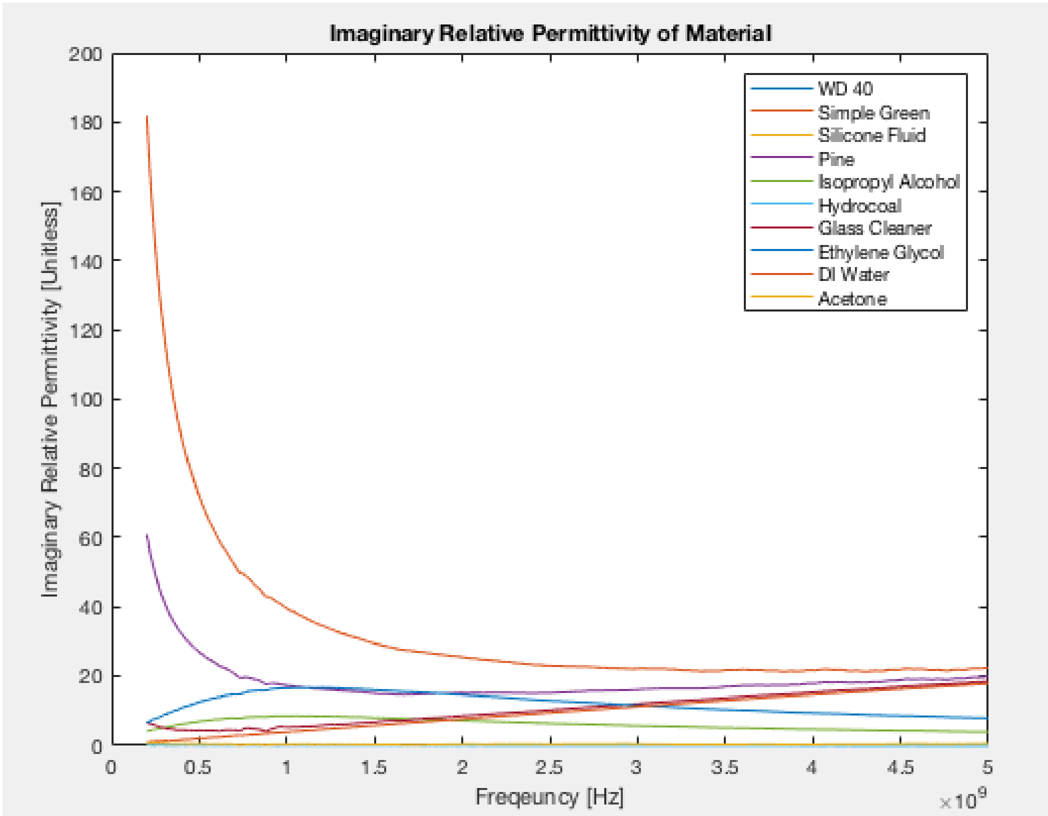

Figure. Imaginary part

Since there is no substance that has greater dielectric constant than DI water, we can use it as the standard to measure that of other materials. This is something similar to what we have done in TRL calibration process. Because we can make three different conditions, namely 'short', 'open', and 'water', we can complete the calibration process by removing the error terms.

In theory, the reflection coefficient expressions for the actual and measured cases:

$$\Gamma_m = e_d + \frac{e_r \Gamma_a}{1 - e_s \Gamma_a}$$

where

$$\Gamma_m = measured$$
$$e_d = directivity$$
$$e_s = source$$
$$e_r = Frequency\ Tracking$$
$$\Gamma_a = actual$$

Now, the actual reflection coefficient can be calculated:

$$\Gamma_a = \frac{\Gamma_m - e_d}{e_s(\Gamma_m - e_d) + e_r}$$

the calculation of the measured dielectric constant involves a reverse process where we assume that we are given with Γ.

I think we can improve the result by varying the thickness of M.U.T.(material under test) in order to make sure that there is enough fringing field from the probe.

At this point, we can generalize that most liquids have fairly high dielectric constant. What confused me before this lab, that salted-water would yield a very different result than just a normal water that contains nothing else. However, later on, it became clear when I recalled the fact that submarine communicates through sound wave under the sea because the sea water is lossy.