Microwave Materials Characterization Using a Waveguide Iris

Anna Case and Reza Zoughi, ECpE Department

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Objective

This work aims to use a waveguide iris for reducing finite flange error when estimating structure properties of thin, conductor-backed samples with finite extent.

Background

- Open-ended waveguide measurements are used for materials characterization, in which intrinsic electrical properties are related to other physical or chemical properties of interest.
- Finite flange error, which is created by waveguide flange and sample edges, can lead to subsequent property estimation error.
- A waveguide iris can be used to selectively change the wave incident upon a structure-under-test through changes in the iris size, location, and thickness.

Approach

- CST Microwave Studio® is used to simulate X-band (8.2-12.4 GHz) rectangular waveguide probes inspecting a thin (3.175 mm) and conductor-backed rubber \((\varepsilon_r = 4.8 - j0.17)\) coating.
- This probe is highly sensitive to flange and sample edges when inspecting thin and conductor-backed structures.
- The use of a 7 mm-square and 0.1 mm thick iris limits sensitivity towards the flange and sample edges but limits depth of penetration of the signal as well.

Simulated Results

- Reflection coefficient, \(\Gamma\), is measured as a function of frequency and finite flange error is computed:

\[
E(f) = \|r_{\text{infinite}} - r_{\text{finite}}\|_2
\]

- Sensitivity of the reflection coefficient with respect to changes in rubber thickness is higher for the rectangular waveguide probe as is the finite flange error. Iris dimensions should be optimized to maximize reflection coefficient sensitivity and minimize finite flange error.

Conclusion

This work has shown the potential efficacy for a waveguide iris probe to reduce finite flange error when inspecting a thin, conductor-backed structure.