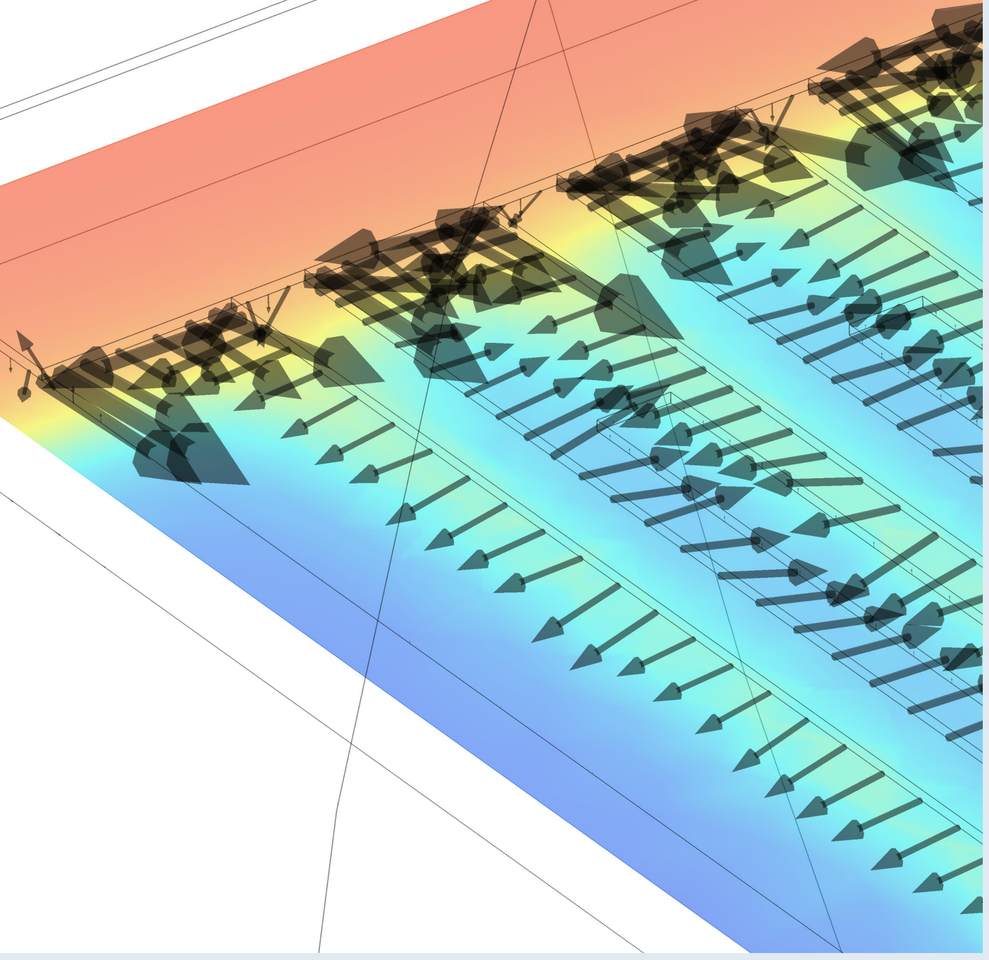

Simulating Ideal and Experimental Impedance Response of Interdigitated Printed Circuit Boards

Reverse solving for unknown material properties of experimental samples by use of simulations to better understand the trends in impedance response found under varying environmental conditions.

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Introduction

The objective of this study is to create a model that matches experimental results of interdigitated circuit boards of unknown material composition. Inferences are made using the impedance responses measured in the lab to predict and adjust towards accurate model parameters. The experimental samples were fabricated using copper leads printed on FR4 boards then insulated over the entire circuit using solder mask. Modifications made to built-in material properties highlight differences between the material composition of experimental samples and ideal samples. Lack of incongruencies in ideal response within simulations highlight defects that may have formed during fabrication or processing of the experimental samples. By analyzing the theoretical and ideal samples predictions for future printed circuit board (PCBs) will rise in accuracy.

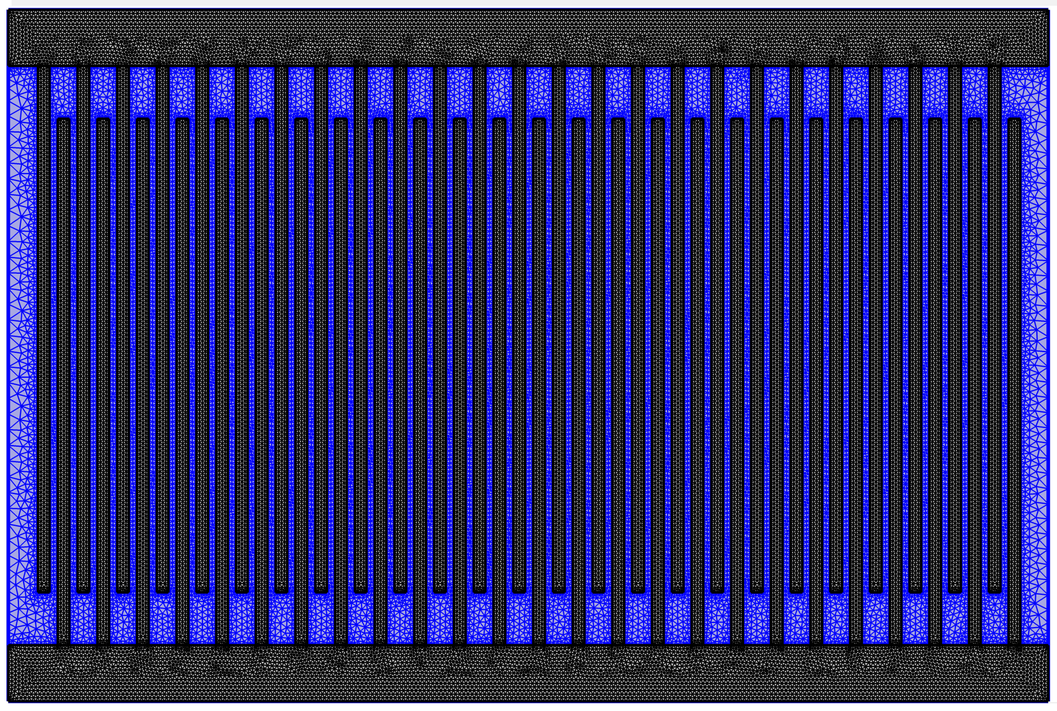

FIGURE 1. Fine mesh created for interdigitated combs, where FR4 material is highlighted in blue.

Methodology

Governing equation for solving electric potential:

$$-\nabla \cdot \left(\left(\sigma + \varepsilon_r \varepsilon_0 \frac{\delta}{\delta_t} \right) \nabla V \right) = 0$$

Where material properties of electrical conductivity and relative permittivity are primarily used. A voltage domain terminal applying 500 [mV] is assigned to top main electrode and its connected combs, and ground boundaries are applied to bottom main electrode and its connected combs.

Results

Frequency response broken down to low-, mid-, and high-frequency regions indicate variations in which experimental data matches more with the unmodified ideal response versus the modified ideal response.

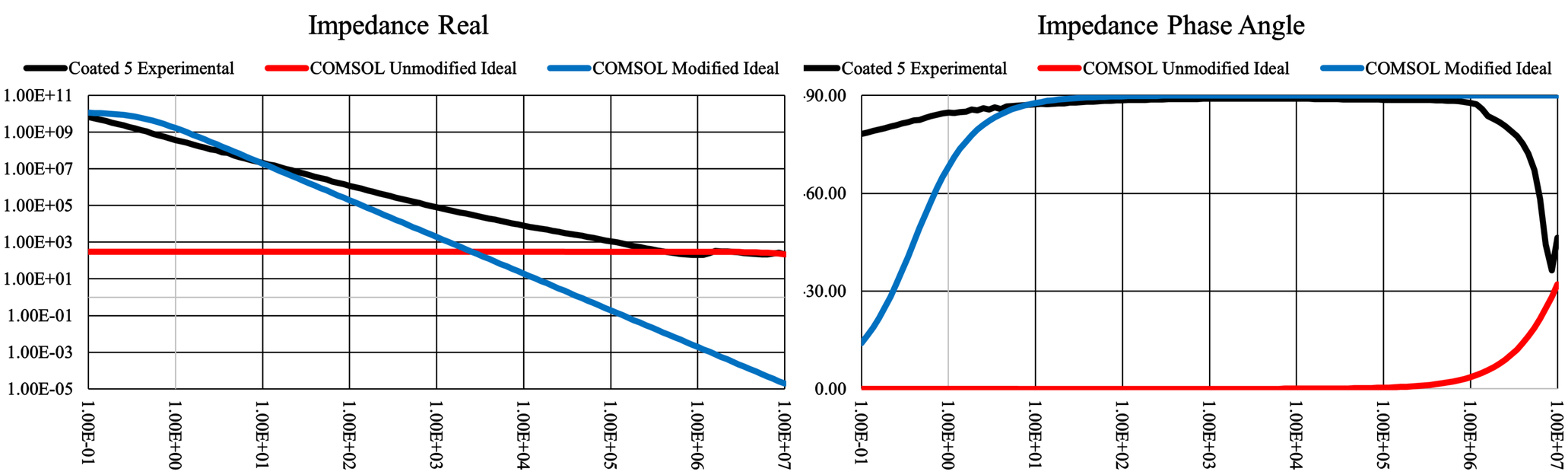

FIGURE 2. Comparison between experimental impedance response, unmodified ideal material response, and modified ideal material response. The top image is real impedance, middle is imaginary impedance, bottom is phase angle (degrees).

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