

Advanced Algorithm for Extrapolating Electromagnetic Properties of Materials

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The accurate characterization of electromagnetic properties across wide frequency ranges is critical for the design and optimization of advanced materials in stealth and electromagnetic applications. This study presents a novel algorithm tailored for the extraction and extrapolation of electromagnetic properties from 500 MHz to 4 GHz, using a hybrid approach combining experimental data with computational electromagnetics. This parametric modeling is a widely used approach for estimating and extrapolating the permittivity of materials with frequency-dependent properties. The proposed methodology combines the Debye model for frequency-dependent permittivity with the Lorentz model for complex permeability [1], enabling precise parametric modeling of both lossless and lossy materials. A low-frequency material characterization system (Epsilon Measurement Probe) was used to measure the complex dielectric permittivity of the material sample from 30 MHz to 500 MHz, while a Free Space -Focused Beam System was used to measure the EM properties of the material sample from 4 GHz and above. Fig. 1 below shows the complex permittivity of the Teflon sample as the first sample has been used to evaluate the algorithm. After plotting the experiment data, a mathematical regression analysis will be used to provide a visual representation of the relationship between a set of data points based on the line of best fit. The model will be trained in a variety of materials including loss-less and lossy dielectrics. Validation results demonstrate accuracy and computational efficiency, making this approach a robust tool for designing materials with tailored electromagnetic properties. The approach offers a significant advancement in materials science, with potential applications in stealth technology, and other electromagnetic systems.

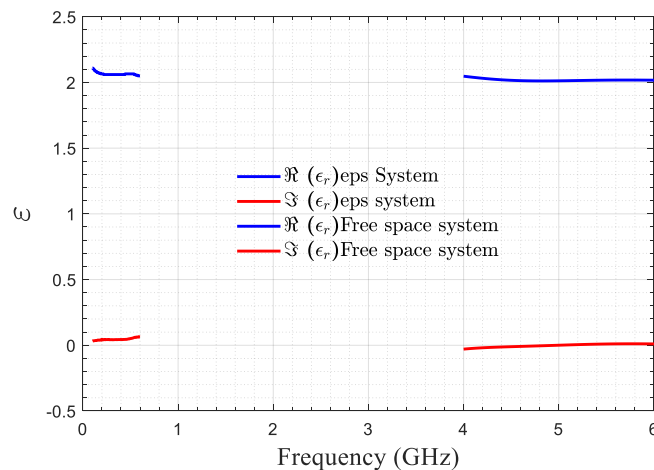


Figure 1. The real and imaginary permittivity of the Teflon sample.

Reference:

- [1] I. Zivkovic and A. Murk, 'Free-Space Transmission Method for the Characterization of Dielectric and Magnetic Materials at Microwave Frequencies', in *Microwave Materials Characterization*, S. Costanzo, Ed., InTech, 2012. doi: 10.5772/51596.