

Dielectric Parameter Estimation of Wood Materials

Determination of the dielectric permittivity of materials from simulation and measurement using open-ended probes

Student



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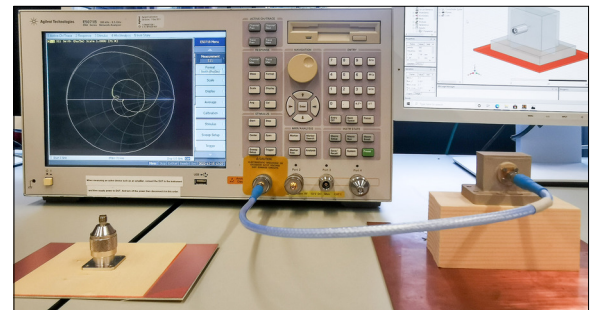
Introduction: Although wood is not typically the first choice for RF designs, recent projects have demonstrated that it can be an interesting and sustainable alternative to standard dielectric materials, at least for some applications. However, to enable such RF applications, the dielectric properties of these materials must be known with sufficient accuracy. The goal of this project is to develop and implement a measurement setup based on established best practices to determine the dielectric properties of both veneers and solid wood samples.

Approach: Various measurement methods are described in the literature. They generally differ in the applicable frequency range, the sample size and whether the sample has to be modified for the measurement. To cover a wide frequency range, two separate setups are used: an open-ended coaxial probe for low frequencies up to 3 GHz and an open-ended waveguide probe for the frequency range from 5 to 8.5 GHz. For both measurement setups, the reflection coefficient is measured using a vector network analyzer (VNA). As shown in Fig. 2, both methods rely on an accurate simulation model that is used to estimate the dielectric properties by fitting the simulated reflection coefficients to the measurement results using a multivariate optimization algorithm.

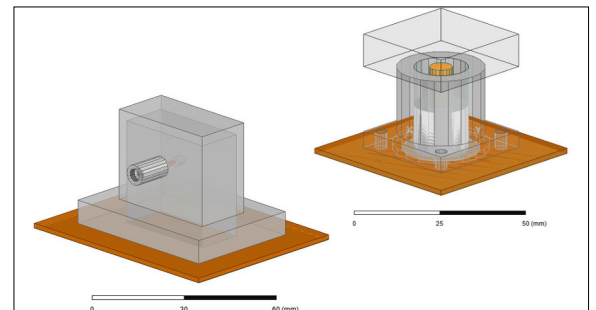
Result: The two aforementioned setups are realized and tested. For the open-ended coaxial probe, an ordinary N-type connector is modified for panel mounting. For the open-ended waveguide probe, a standard waveguide-to-coax adapter is used. The measurements have shown that the estimated parameters strongly depend on the air gap between the probe and the sample, especially for the open-ended coaxial probe. Therefore, a very accurate simulation model is required for reliable parameter

estimation. The results of the dielectric parameter estimation using the prepared probes are compared with the SPEAG Dielectric Assessment Kit (DAK) using the 3.5 mm open-ended coaxial probe to verify the validity of the method and the accuracy of the obtained results.

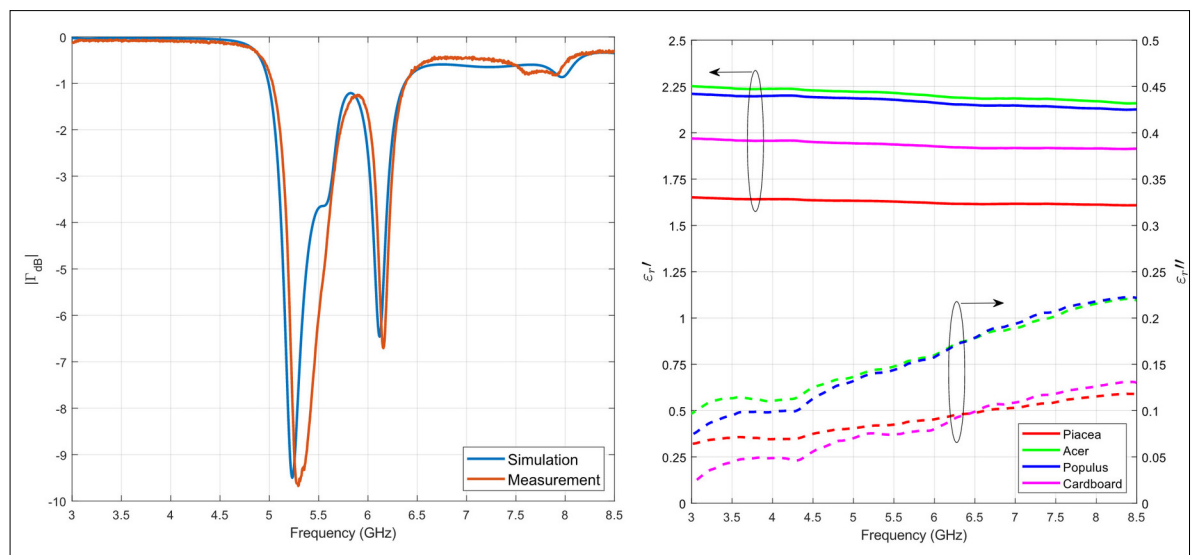
Measurement setup with VNA and probes.
Own presentation



Open-ended coaxial and waveguide probe simulation models used for parameter extraction.
Own presentation



Fitted simulation of the reflection coefficient (left) and several wood permittivities extracted with the DAK (right).
Own presentation



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Subject Area

Wireless Communications

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