Measurement for Complex Permittivity Tensor Based on Free-space Transmission Method in Millimeter-wave Band

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Rubber sheets mixed with carbon particles can be applied to wave absorbers. However, these materials usually have anisotropy which comes from the rolling method of manufacturing, because the carbon tends to be aligned along the rolling direction. So, it needs to measure complex relative permittivity tensor for the design of wave absorber in consideration of anisotropy. In this study, a measurement method which rotats sample to calculate complex relative permittivity tensor based on free-space reflection method using focusing lens and vector network analyzer is proposed.

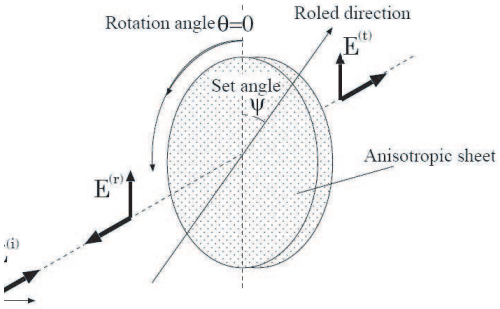

Figure 1: Analytical model.

In order to obtain the permittivity tensor of an anisotropic sheet, the transmission coefficients from these sheets must be analyzed. And the vector value of the transmission coefficients must be measured at each angle,from 0° to 180° as shown in Fig. 1. Then the permittivity tensor can be calculated by comparing the analyzed transmission coefficients with the measured values. For measurement, an anisotropic rubber sheet containing carbon particles was prepared. It was set at sample holder with rotating device and we measured the transmission coefficients in the range of 26.5 GHz to 40 GHz at only three points for each frequency.

Using above method, the values of the tensors are obtained as shown Fig. 2 and Fig. 3. It shows relativity of number of measurement points and permitivitty tensor. Then we calculate error of permittivity tensor and principal direction of tensor assuming the measurement sample theoretically. As the result, we verified that the proposed method can be used to measure permittivity tensor and principal direction of tensor.

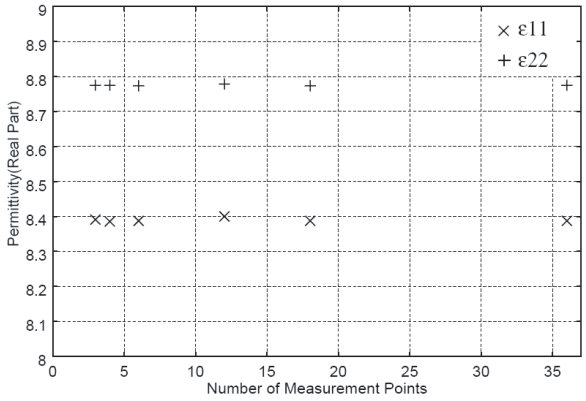

Figure 2: Real part of permittivity tensor.

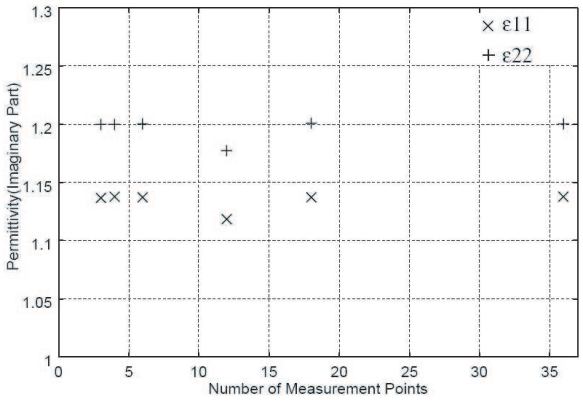

Figure 3: Imaginary part of permittivity tensor.