Microwave Dielectrometer

The RF technology and the electromagnetic-field simulation techniques were integrated, creating a breakthrough in technology. The highly precise dielectric measuring device which can measure "easily", "accurately" and "non-destructively" was conceptualized through our self-developed measurement resonator and program.

AET, Inc.

MW Dielectrometer

Applications ■Substrate materials for high-speed digital and microwave circuits ■New materials ■Semiconductor materials ■Thin film materials

A BREAKTHROUGH IN MEASUREMENT TECHNIQUES

The key to the successful development of highly efficient devices and systems used in modern broadband communication technologies, is to know the accurate electrical characteristics of materials to be used. In the past, microwave knowledge and experience in the operation of expensive equipment were required for conventional dielectric measurement. The Microwave Dielectrometer developed by AET, Inc does not require expensive equipments. It enables fast and non-destructive measurement of dielectric materials of various shapes, including thin-films, by using an evanescent mode of an open coaxial resonator. A built-in feedback oscillator circuit enables accurate measurements with an easy step-by-step operation. Accuracy is achieved by combining a high Q cavity, a highly accurate measurement algorithm and the 3D electromagnetic simulation software, “MW SUTDIO*” .

* MW STUDIO is a 3D electromagnetic-filed simulation software provided by CST GmbH.

Open Coaxial Resonator Type Microwave Dielectrometer

Feature

Measurement using an evanescent mode of an open coaxial resonator

If a sample material is placed on the probe, an evanescent electrical field leaks from the probe tip into the sample material. This electrical field changes with the dielectric properties of the material, which in turn changes the resonant frequency and the Q factor of the whole cavity. The dielectric properties are then calculated from the changed resonance.

Simple, accurate and non-destructive measurement

An open resonator enables the easy placement of the sample, and a fast, accurate measurement of its dielectric properties.

Stable measurement

A firm contact between sample and probe is obtained with a vacuum attachment.

(PATENT No. 3691812)

A system component used a network analyzer

Specifications (Provisional Figures)

- Frequency: 0.8GHz to 18GHz
- Frequency Point: 5 discrete frequency points or 1 point can be chosen
- Measuring range ε : 1-15 $\tan\delta$: 0.001-0.1
- Measurement Accuracy ε : ±1% $\tan\delta$: ±5%
- Sample shape: Arbitrary if there is a flat surface

(A dimension of more than 10mm x 10mm x 0.5mm are required.)

* The system doesn't include a PC.

A sample setting

Resonant Cavity Type Microwave Dielectrometer

Feature

Measurement by a resonant cavity

By inserting a sample into the resonant cavity, the electrical field changes with the dielectric properties of the sample material, which in turn changes the resonant frequency and the Q factor of the cavity. The dielectric properties are then calculated from the changed resonance.

Fast and easy measurement

The dielectric constant can be measured in a short time by inserting a sample into the resonant cavity.

A system component used a network analyzer

Specifications (Provisional Figures)

- Frequency: 2GHz to 18GHz
- Frequency Point: 1 point per a resonator
- Measuring range ε : 1-30 $\tan\delta$: 0.0001-0.1
- Measurement Accuracy ε : ±1% $\tan\delta$: ±5%
- Sample shape: a strip, a round bar, a square bar or a thin film

* The system doesn't include a PC.

A sample setting of a resonant cavity for a flat panel

A sample setting of 2-10GHz resonant cavity

Network analyzer is not necessary

AET's Microwave Dielectrometer has two types, which use either a synthesized sweep oscillator (an alternative to a network analyzer) or a network analyzer. The oscillator type consists of an oscillator, which includes a microwave signal generator and a detector, a measurement probe, a customized software, and accessories. This is a low cost type because it does not have expensive measurement devices. The network analyzer type sets up with your network analyzer to use. It consists of a measurement probe, a customized software, and accessories.

A system component used an oscillator

A system component used a network analyzer

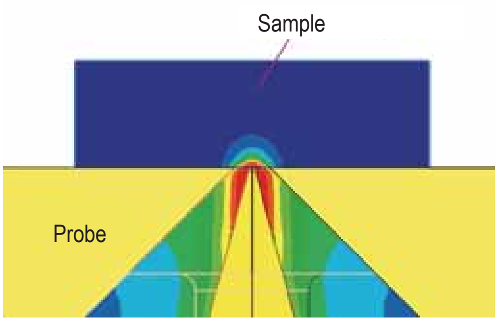
Fast and easy measurement

The biggest advantage of AET's Microwave Dielectrometer is its ease of use. The measurement is achieved by simply placing a material on the surface of a measurement probe. The evanescent field of this unique probe enables fast and non-destructive measurements of the materials of various shapes. The random error of the epsilon is estimated to be less than 1%, and the random error of the tangent delta is less than 5%. The absolute accuracy will be confirmed by calibrating with two different reference materials. By calculating the relative difference between measurement results of the references and the sample materials, external error sources (eg.room temperature, humidity, vibration, etc.) are eliminated.

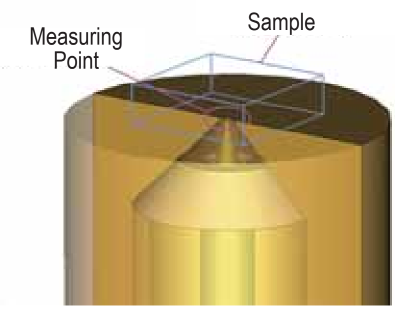
A sample setting

Unique & ideal measurement probe

AET's Microwave Dielectrometer employs a unique measurement probe called a "coaxial resonator." The measurement can be chosen at a five-point simultaneous measurement mode or single-frequency measurement mode. If a sample material is placed on the probe, the evanescent electrical field leaks from the probe tip into the sample material. This electrical field changes with the dielectric properties of the material, which in turn changes the resonant frequency and the Q factor of the whole cavity. The dielectric properties are then calculated from the changed resonance. The highly accurate measurement algorithm to compute the complex permittivity, uses the electromagnetic-field distribution and resonant characteristics of the evanescent mode computed by the 3D EM-field simulator, "MW STUDIO".



Electric field distribution near the measuring point



Coaxial resonator

Software

THE SELF-DEVELOPED HIGHLY ACCURATE MEASUREMENT PROGRAM

Coaxial Resonator Type

Step 1

Main Menue

Start the software program and chose the specific frequency from the “frequency setting” list on the main menu.

Main menu

Measurement wizard

Step 2

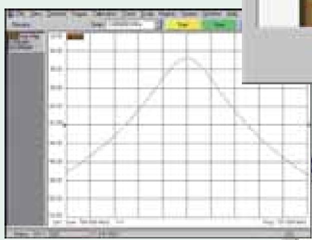
Calibration

Perform the calibrations through the measurement wizard.

First, measure the value of air (εr=1). Click the “Measure” button.

Next, place two different reference materials on the measurement probe, and click the “Measure” button individually.

Air measurement



Resonance peak by a network analyzer

Reference material measurement

Step 3

Actual Measurement

Place a sample on the measurement probe, and click the “Measure” button.

When the measurement is complete, click the “Show Result” button. The values of Epsilon and Tangent delta are displayed.

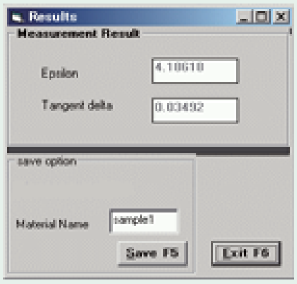
When the “Save button” is clicked, the measurement result can be saved in a CSV file.

Once a calibration is performed, repeat the measurement if possible.

When performing a repeat measurement, the measurement procedure for air and reference materials can be skipped.

Sample measurement

The results of a 5 point simultaneous measurement



The result of a 1 point measurement