Feb/03/2017

Summary

# List of Papers:

## Investigation and performance evaluation of carbon black- and carbon fibers-based wideband dielectric absorbers for X-band stealth applications.[1]

## Measurement and Characterization of Flexible Absorbing Materials for Applications in Wireless Communication.[2]

## Microwave materials characterization using waveguides and coaxial probe.[3]

## Microwave properties of EPDM/PAni-DBSA blends.[4]

## Synthesis and microwave absorption characteristics of polyaniline/NiZn ferrite composites in 2–40 GHz.[5]

# WaveGuide Measurement Setup:

There are three papers (1.A, 1.B and 1.C) that present a characterization measurement with waveguide measurement setup. The advantages of waveguide setup include smaller sample dimension requirement, highly accurate measurement, ease for preparation of test sample, relative larger bandwidth. However, this measurement can perform only the normal incident wave to the sample.

For the characterization measurements, all three papers use rectangular waveguides setup which is divided into two methods: partially filled waveguide (PFWG) method and fully filled waveguide (FFWG) method.

## Partially filled waveguide setup

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Paper No. | Frequency(GHz) | Sample Dimension (mm) | | | Calibration Performance | Control Sample |
| L | W | H |
| 1.A | 8– 12.5 | Smaller than the length of holder | Small dimension of waveguide | 2 | Thru-Reflect-Line | No |
| 1.C | 6.6 – 12.9 | 9.61 | Thru-Reflect-Line | No |

## Fully filled waveguide setup

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Paper No. | Frequency(GHz) | Sample Dimension (mm) | | | Calibration Performance | Control Sample |
| L | W | H |
| 1.B | 1.72 – 2.61 | 109.2 | 54.6 | 2.06 | Thru-Reflect-Line (TRL) | No |
| 1.C | 6.6 – 12.9 | Smaller than the length of holder | Small dimension of waveguide | 5.11 and 9.61 | TRL | No |

# NRL ARCh measurement setup

The last two papers (1.D and 1.E) present a reflection measurement with NRL arch measurement setup. Paper 1.B also perform a NRL measurement for comparison with waveguide measurement result.

The advantages of this method is the possibility to measure with different incident angles to the sample. However, this measurement set up requires a large sample size, especially for the lower frequency range. The size of sample under test is recommended to be larger than 5 times wavelength each dimension for NRL arch measurement. For the low frequency rang (lower than 3 GHz), the recommended size for sample is minimum of 60 cm x 60 cm.

There are other disadvantages which are the flatness requirement for sample and chamber covered with some pyramid absorbing materials to prevent the reflections from other objects.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Paper No. | Frequency(GHz) | Sample Dimension (mm) | | | Arch radius(m) | Calibration Performance | Control Sample |
| L | W | H |
| 1.B | 1 – 2.65 | 600 | 600 | 2 | 2 | Measure reflectivity from metal plate to calibrate | No |
| 1.D | 8 – 12 | 150 | 150 | 1 and 3 | No mention | No |
| 1.E | 2 – 18and 18 – 40 | 180 | 180 | 2 | No mention | No |

Note: Paper 1.A also presented a free-space measurement directly using 2 horn antennas with lens to focalize the wave. The sample with dimension of 150 x 150 x 2 (mm) is placed at the common focal plane of the two lens.

# Extraction algorithm and simulation method

|  |  |  |  |
| --- | --- | --- | --- |
| Paper No. | Extraction Algorithm | Extraction Software | Simulation Method |
| 1.A | Presented in paper | MATLAB based on presented algorithm | CST microwave studio |
| 1.B | Nicolson Ross Weir algorithm | Agilent 85071E | Perform but no name mentioned |
| 1.C | Nicolson Ross Weir algorithm | No | Comsol Multiphysics |
| 1.D | No calculation for permittivity and permeability | No | No |
| 1.E |

# Reference:

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[2] Tian Zhou\*, D. Wel, S. Yang, G. Xu, and C. J. and Z. Zhao</p>, “Measurement and Characterization of Flexible Absorbing Materials for Applications in Wireless Communication,” *J. Sci. Ind. Metrol.*, 2016.

[3] Christos Tsipogiannis, “Microwave materials characterization using waveguides and coaxial probe.” [Online]. Available: http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=3359623&fileOId=3359627. [Accessed: 30-Jan-2017].

[4] R. Faez, I. M. Martin, M. A. de Paoli, and M. C. Rezende, “Microwave properties of EPDM/PAni-DBSA blends,” *Synth. Met.*, vol. 119, no. 1–3, pp. 435–436, Mar. 2001.

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