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Transmission Tunnel

TECHNICAL BULLETIN 103

In addition to measuring the absorbing efficiency of materials in a reflection environment (See Technical Bulletin 101: NRL Arch Reflectivity), MAST performs transmission tunnel measurements to quantify the insertion loss of flat materials in a transmission environment. A transmission tunnel is a well-established, free-space measurement system for testing the absorbing efficiency of flat materials over a broad frequency range. The setup consists of one transmit and one receive antenna positioned vertically in line with one another and equidistant from the material under test, which rests over a known aperture that allows the signal to propagate through the material from transmit antenna to receive antenna. Pyramidal absorbing foam is used to coat reflective surfaces on the bottom of the tunnel to avoid interference. An overview of the test setup is depicted in Figure 1, below.

LEGEND	
- - →	Incoming signal (P_0)
- - →	Detected signal (P_1)

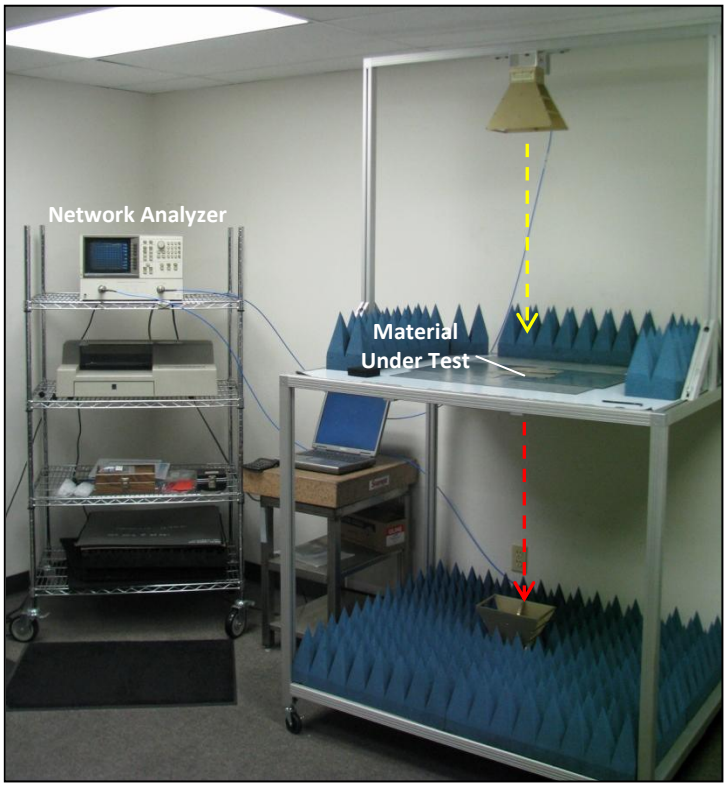

Figure 1. Overview of Transmission Tunnel Test Setup

The transmit antenna is connected to a signal generator that sends microwave energy toward the target (either the open aperture or the material under test resting atop the aperture), and the receive antenna is attached to a signal detector that measures the remaining microwave energy after transmission. In most cases, a network analyzer functions

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as both the stimulus and detector of the microwave signal. Calibration to the open aperture provides a baseline for perfect transmission, or zero absorption, in the system. Insertion loss is typically measured in decibels (dB), which relates the ratio of transmitted power to received power by the following equation:

$$dB = 10\log_{10}\left(\frac{P_1}{P_0}\right)$$

where P_1 is the received power and P_0 is the transmitted power. dB loss is plotted vs. frequency and the resulting curve shows the absorption efficiency of the material under test at every frequency within the specified range. A quick reference guide for the correlation between dB loss and absorption efficiency (in % power lost) is presented in Table 1, below.

QUICK REFERENCE GUIDE									
dB	**Absorption Efficiency**		**dB**	**Absorption Efficiency**		**dB**	**Absorption Efficiency**	**dB**	**Absorption Efficiency**
-1	20.57%		-11	92.06%		-21	99.21%	-31	99.92%
-2	36.90%		-12	93.69%		-22	99.37%	-32	99.94%
-3	49.88%		-13	94.99%		-23	99.50%	-33	99.95%
-4	60.19%		-14	96.02%		-24	99.60%	-34	99.96%
-5	68.38%		-15	96.84%		-25	99.68%	-35	99.97%
-6	74.88%		-16	97.49%		-26	99.75%	-36	99.97%
-7	80.05%		-17	98.00%		-27	99.80%	-37	99.98%
-8	84.15%		-18	98.42%		-28	99.84%	-38	99.98%
-9	87.41%		-19	98.74%		-29	99.87%	-39	99.99%
-10	90.00%		-20	99.00%		-30	99.90%	-40	99.99%

Table 1. Correlation between dB loss and Absorption Efficiency

MAST Technologies utilizes the transmission tunnel test set-up for the characterization and quality control of magnetic and dielectric absorbing materials. Currently MAST is able to test across the frequency range of 700 MHz to 20 GHz.