

PBAR Note 599
Measurement Results of Permittivity/Permeability/Loss Tangent of
Several Microwave Absorbers

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This report is a document of recent measurement results of permittivity/permeability/loss tangent of the several microwave absorbers. The technique used in these measurements has been described before (P-bar note 555). The samples filled a section of a waveguide (WR159). The length of the waveguide is 0.752 inch. The positions of the samples were controlled carefully to ensure accuracy. S21 and S11 parameters were simultaneously measured. The permittivity, permeability and loss tangent were deduced from S parameters.

Measured samples are listed in table 1.

Table 1. List of Measured Samples

Sample	Description	Manufacture	Thickness (inch)
Ferrite-50	NiZn ferrite, ceramic-like	Trans-Tech, Inc.	0.038
TT2-111R	NiZn ferrite, ceramic-like	Trans-Tech, Inc.	0.038
AlN-40%SiC	AlN and SiC, hot pressed,	Ceradyne, Inc.	0.048
SiC	CN-163, hot pressed	Norton, Inc.	0.095
MF190	Iron powder and epoxy	Emerson&Cuming, Inc.	0.060
Plastic Glass	Plastic Glass		0.115

Results of Ferrite-50 are shown in Figure 1 - 4.

Results of TT2-111R are shown in Figure 5 - 8.

Results of AlN-40%SiC are shown in Figure 9 - 12.

Results of SiC (two samples) are shown in Figure 13 - 20.

Results of MF190 are shown in Figure 21-24.

Results of Plastic Glass are shown in Figure 25-28.

Results of Air are shown in Figure 29-32.

Plastic Glass and Air are used to check possible systematic error and what kind of accuracy can be expected. The results of air (Figure 30 and 32) show that the accuracy for loss tangent data may be 0.005 (+/-). Figure 27 and 31 show that there was a systematic error on permeability data: about 2-3 % lower at low frequency end.

The data of MF190 are checked with the data supplied by the manufacture. They are in relatively good agreement.

Magnetic loss tangent of TT2-111R and Ferrite-50 at lower frequency seem to be erroneous. This is due to very small value of real part of permeability plus the aforementioned systematic error. The imaginary part of the permeability actually are

reasonable. Since the magnetic loss tangent was deduced from real and imaginary part of permeability, it should not be a problem as long as imaginary part of permeability are reasonable.

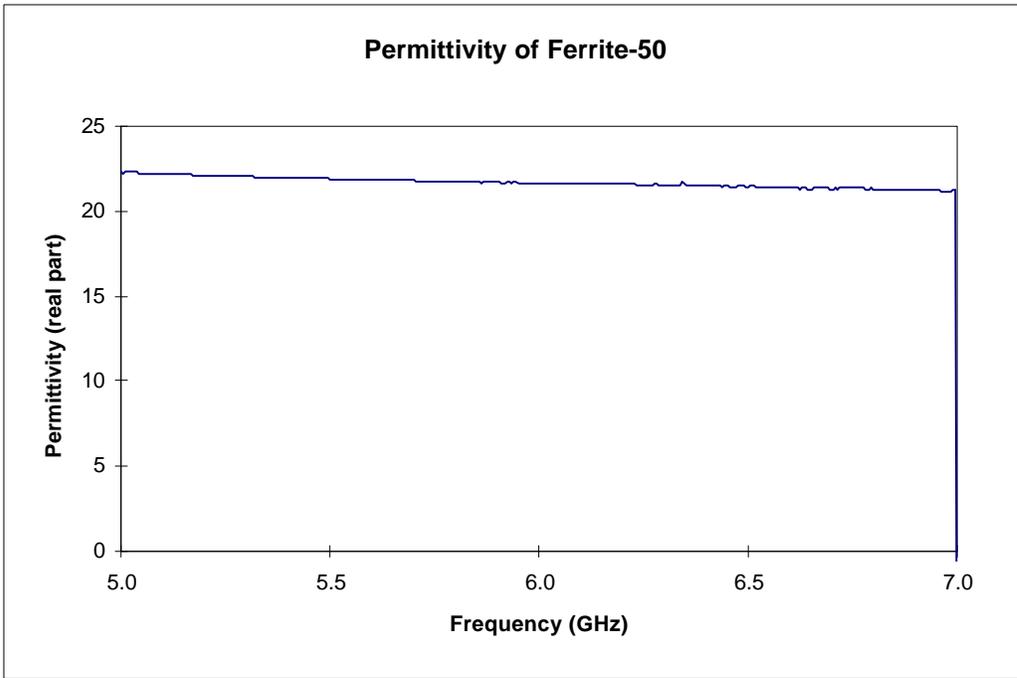


Figure 1. Permittivity of Ferrite-50

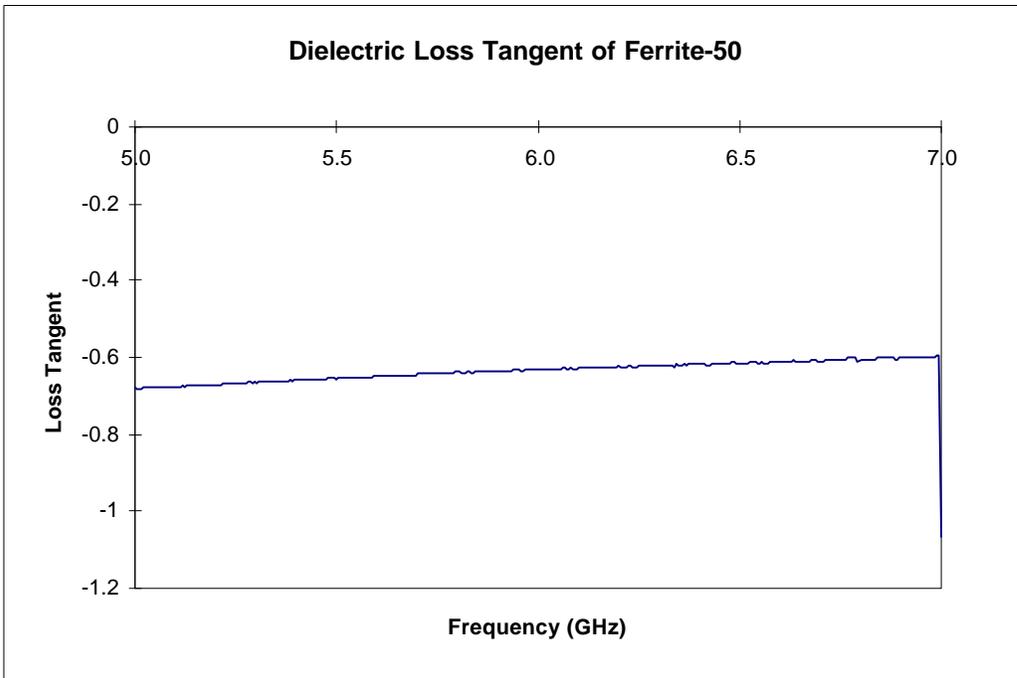


Figure 2. Dielectric Loss of Ferrite-50

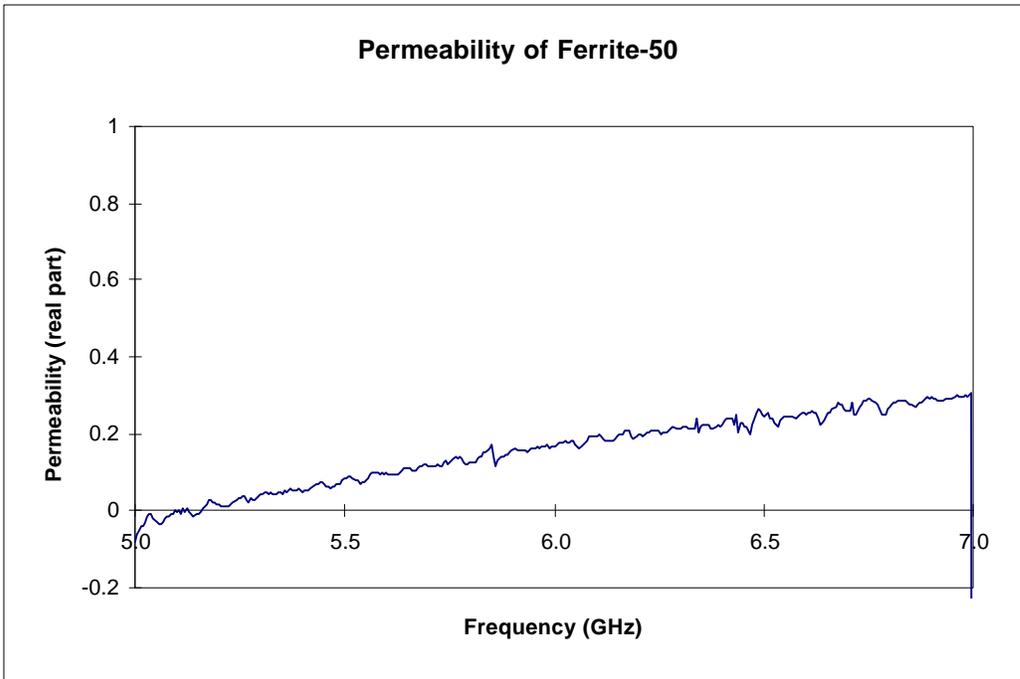


Figure 3. Permeability of Ferrite-50

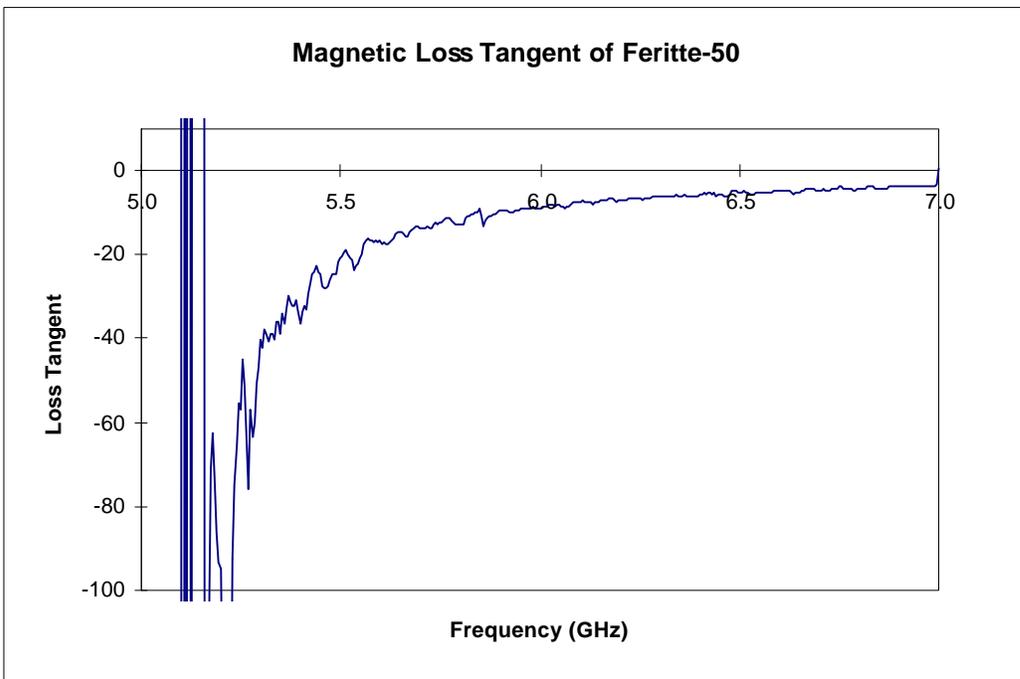


Figure 4. Magnetic Loss Tangent of Ferrite-50

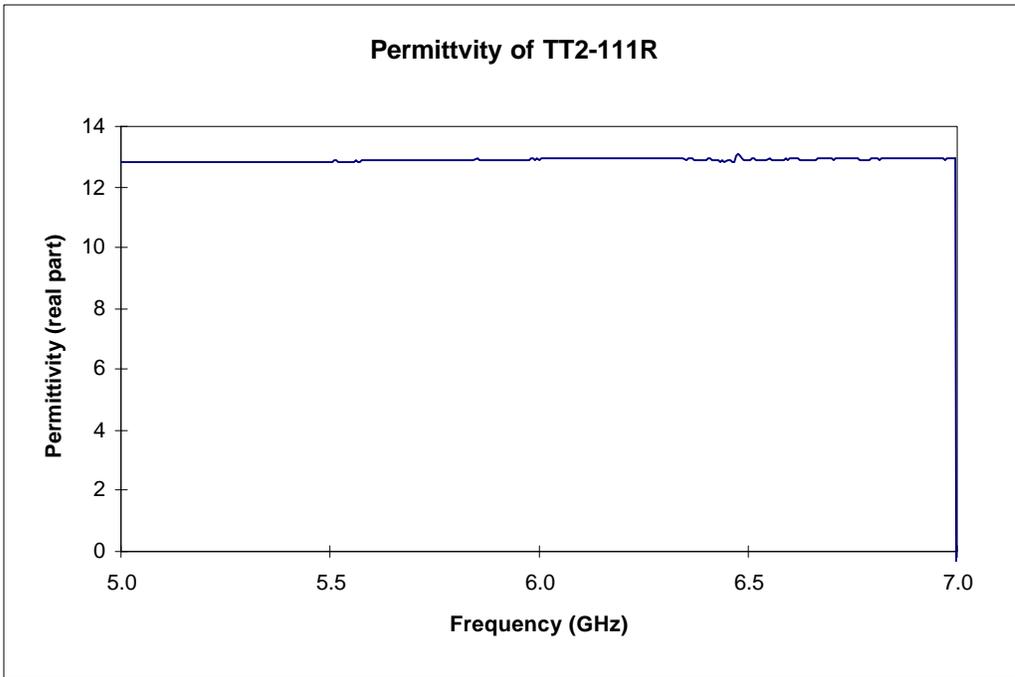


Figure 5. Permittivity of TT2-111R

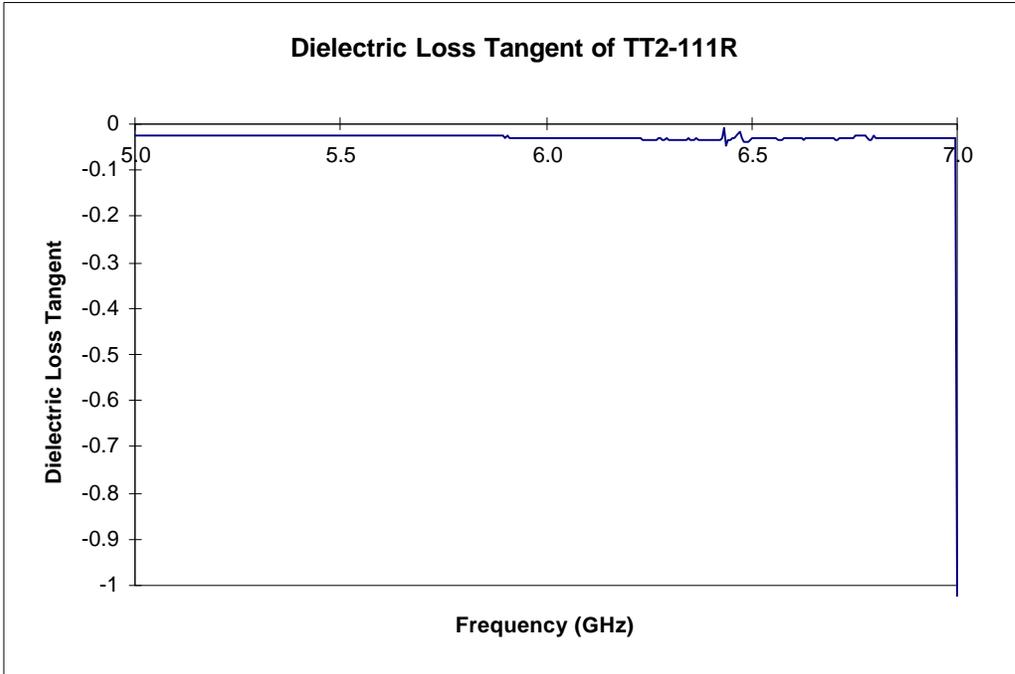


Figure 6. Dielectric Loss Tangent of TT2-111R

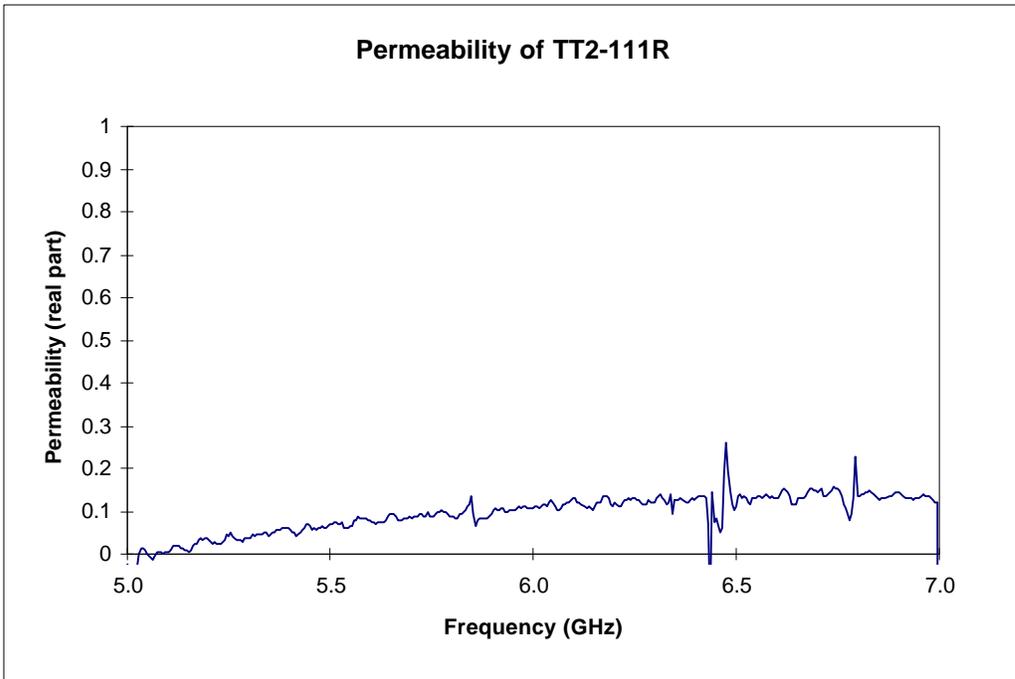


Figure 7 Permeability of TT2-111R

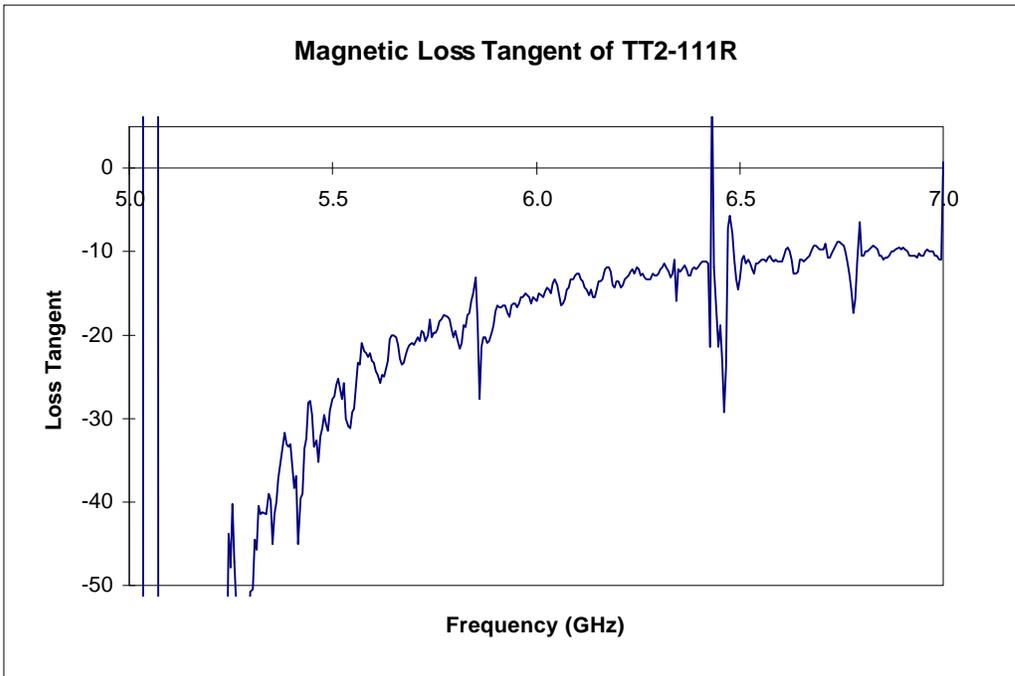


Figure 8. Magnetic Loss Tangent of TT2-111R

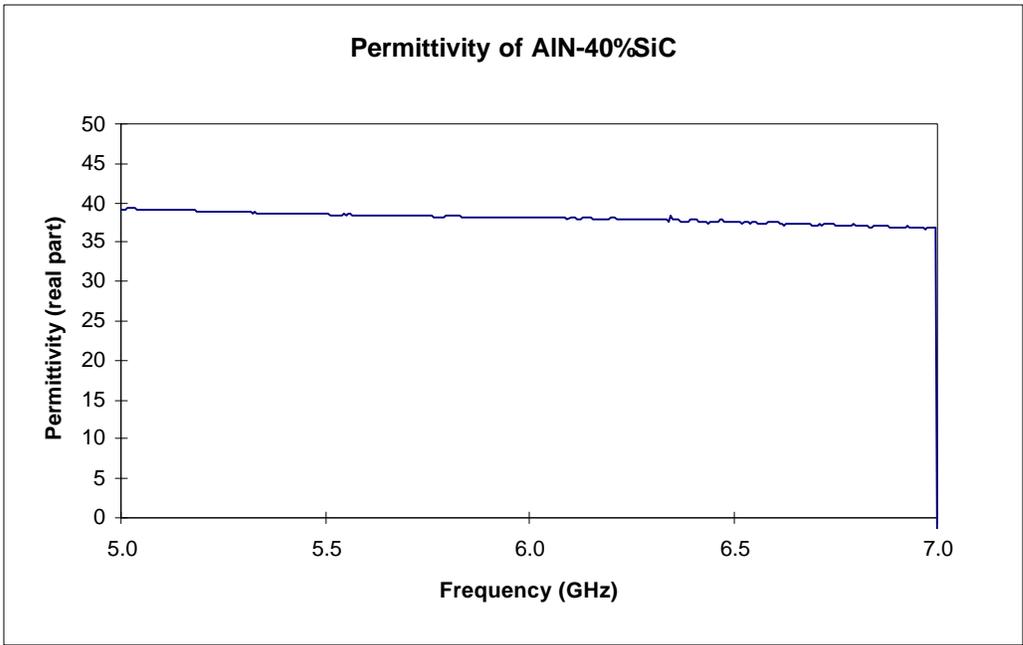


Figure 9. Permittivity of AlN-40%SiC

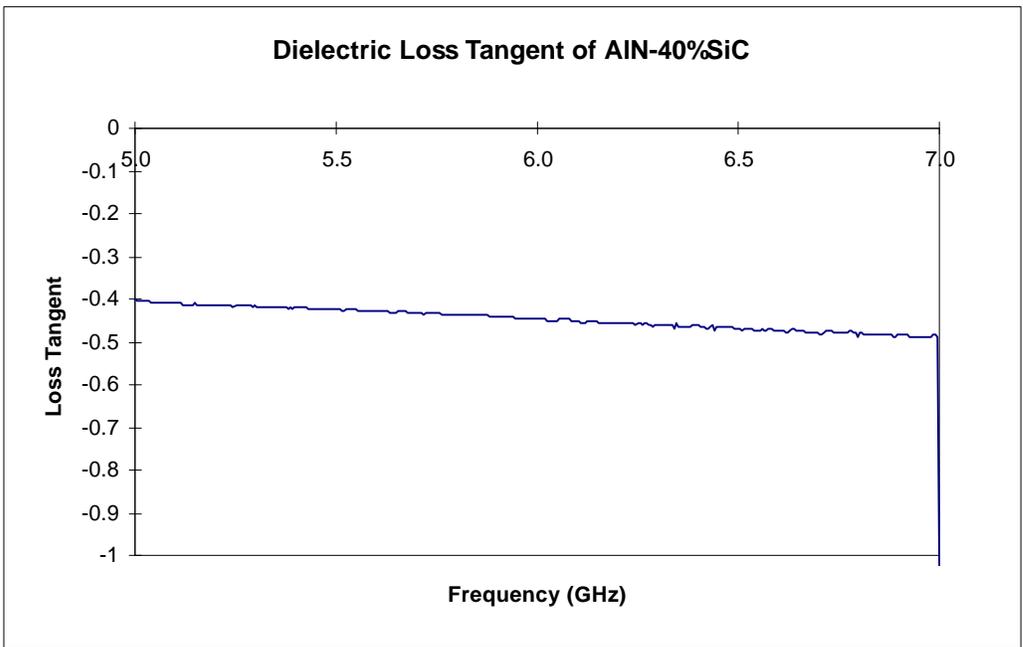


Figure 10. Dielectric Loss Tangent of AlN-40%SiC

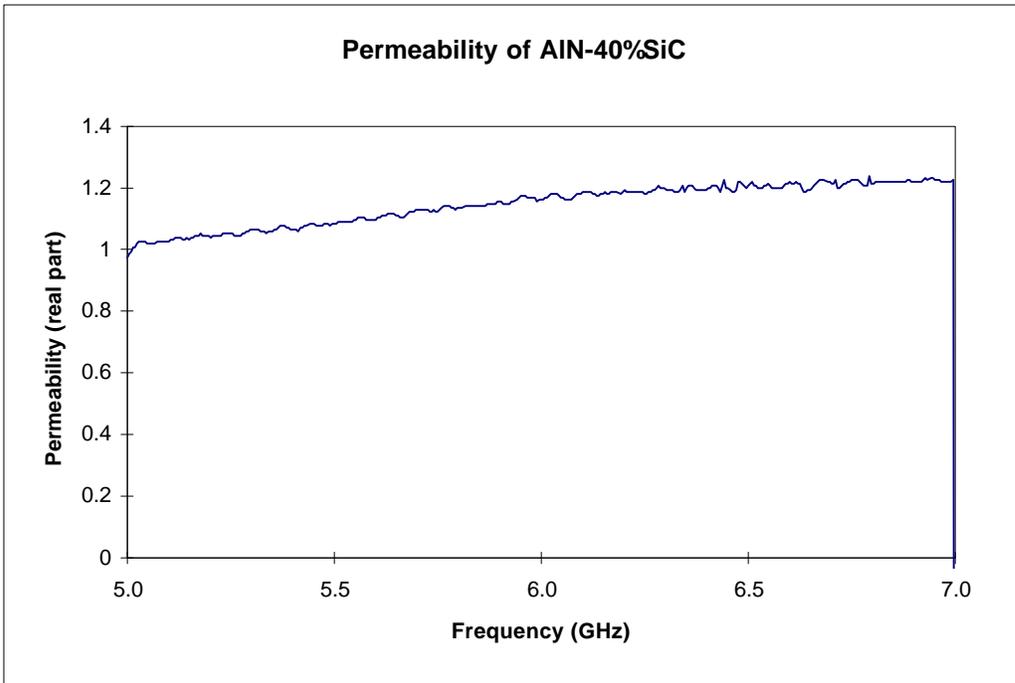


Figure 11. Permeability of AlN-40%SiC

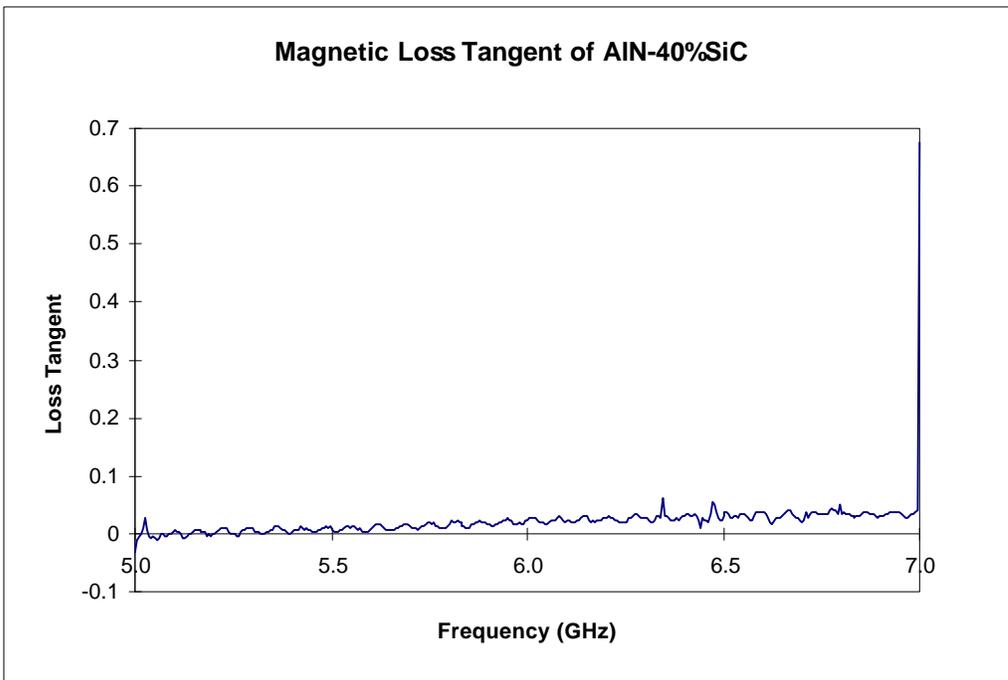


Figure 12. Magnetic Loss Tangent of AlN-40%SiC

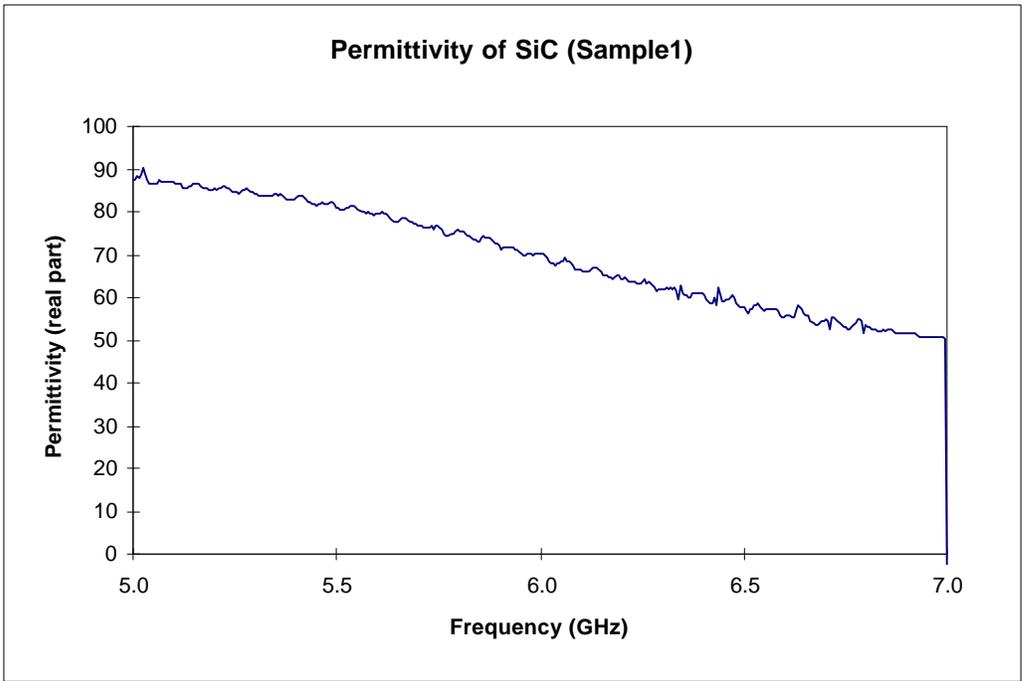


Figure 13. Permittivity of SiC (Sample 1)

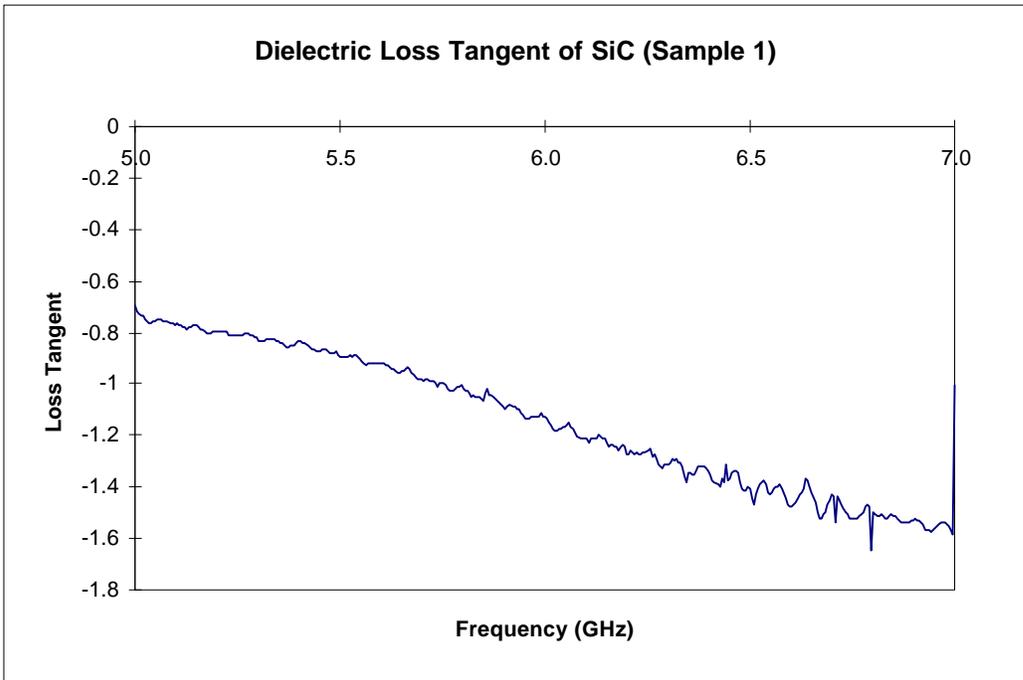


Figure 14. Dielectric Loss of SiC (Sample 1)

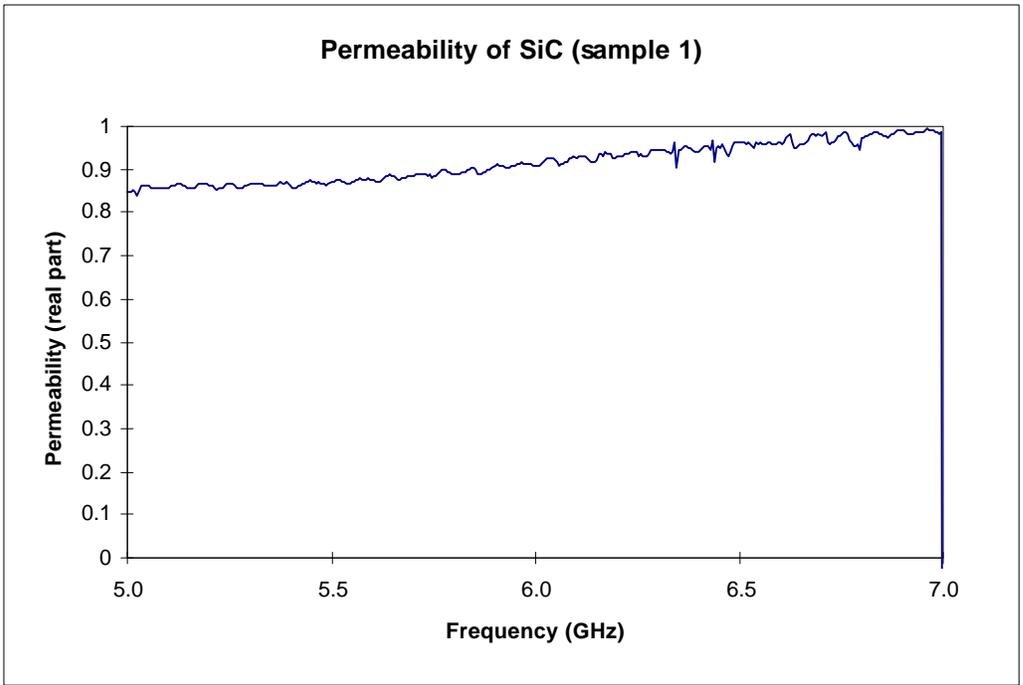


Figure 15. Permeability of SiC (Sample 1)

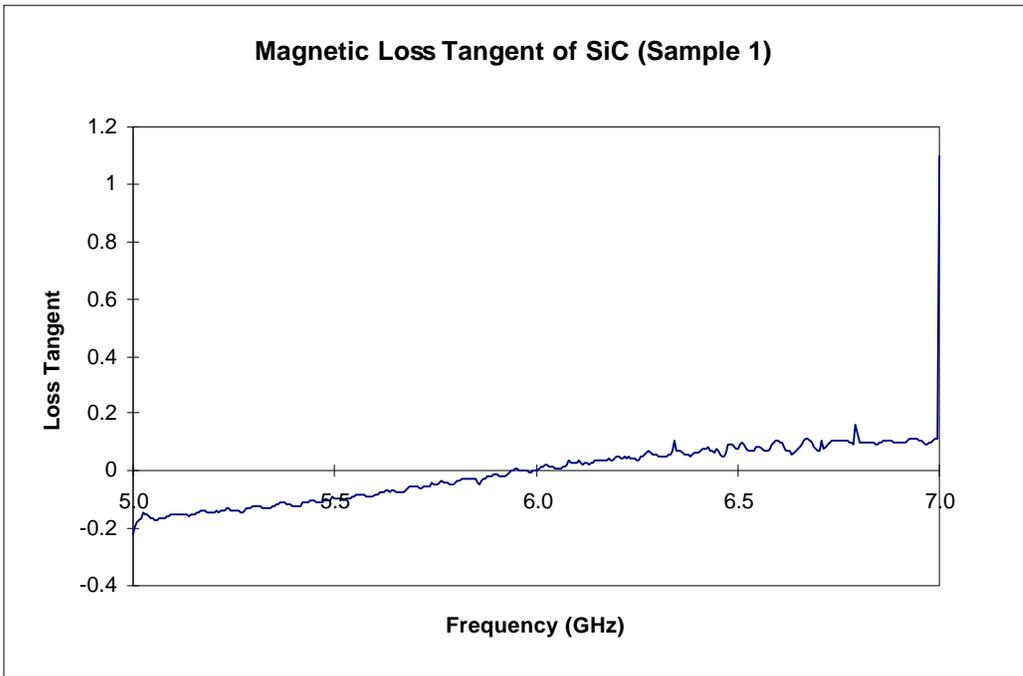


Figure 16. Magnetic Loss Tangent of SiC (Sample 1)

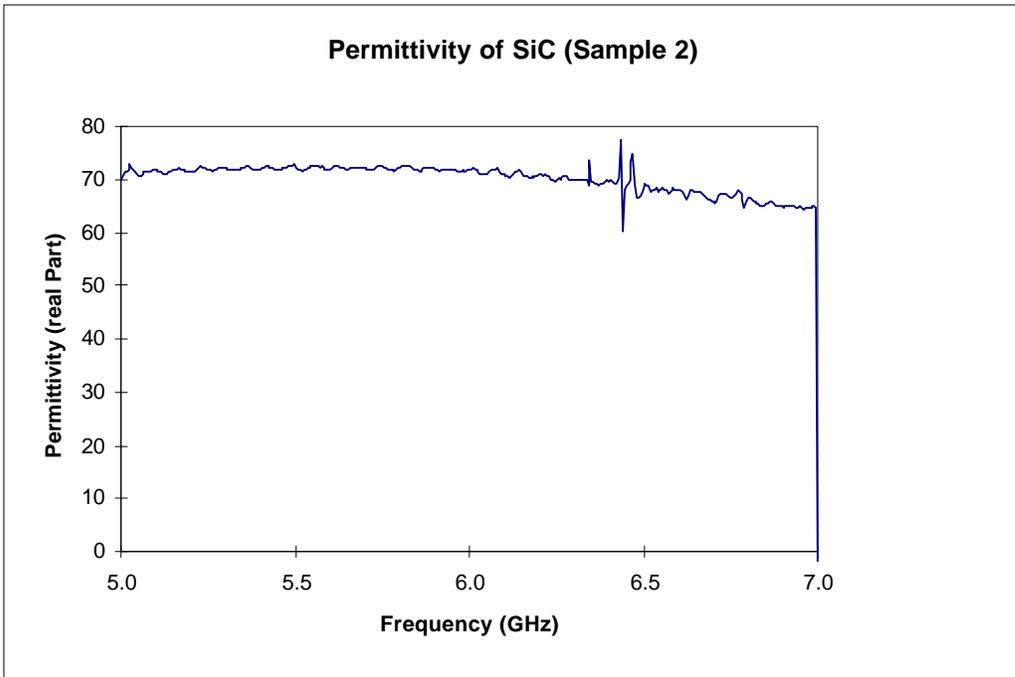


Figure 17. Permittivity of SiC (Sample 2)

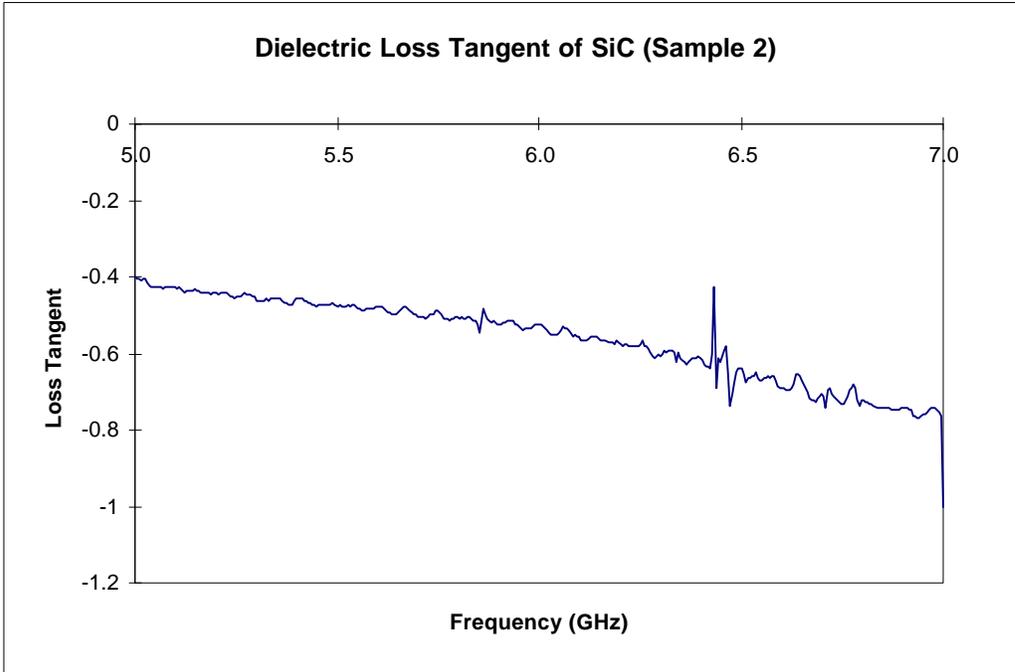


Figure 18. Dielectric Loss Tangent of SiC (Sample 2)

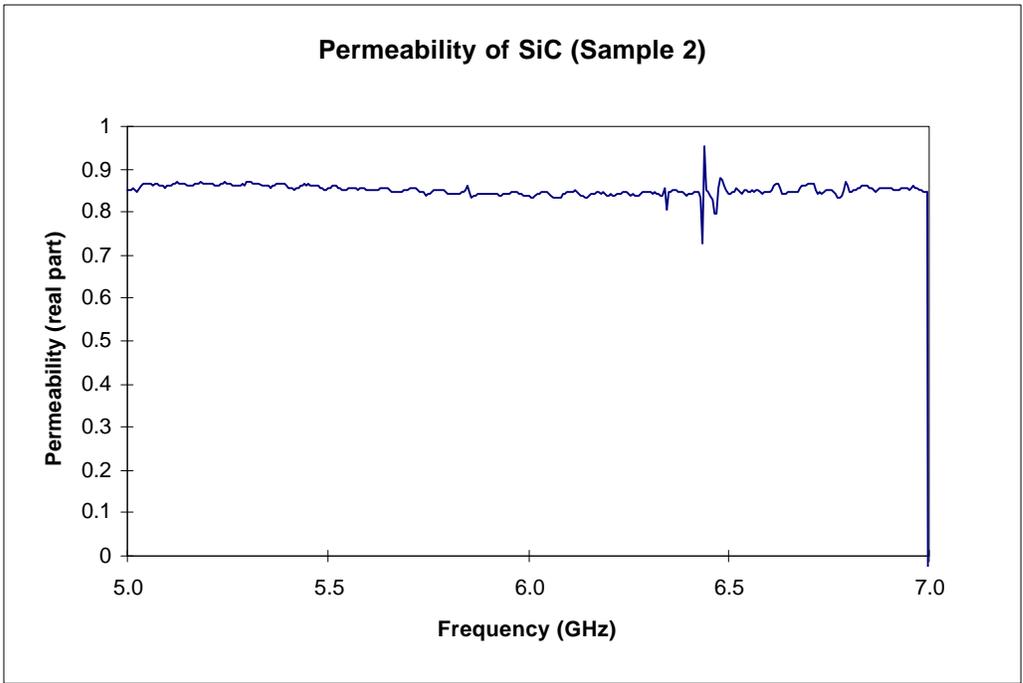


Figure 19. Permeability of SiC (Sample 2)

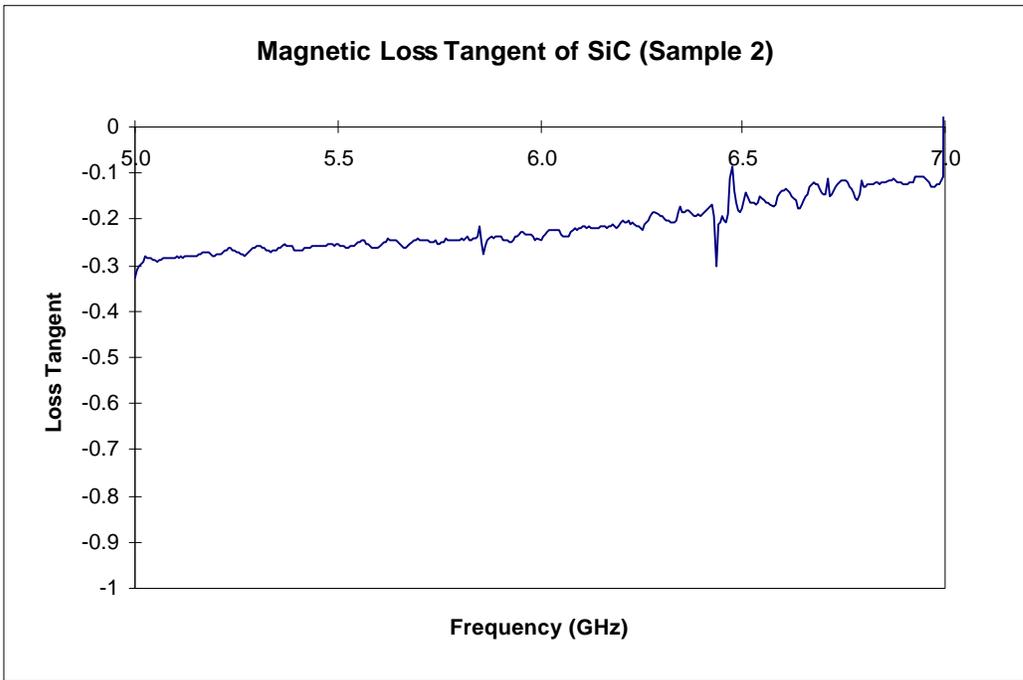


Figure 20. Magnetic Loss Tangent of SiC (Sample 2)

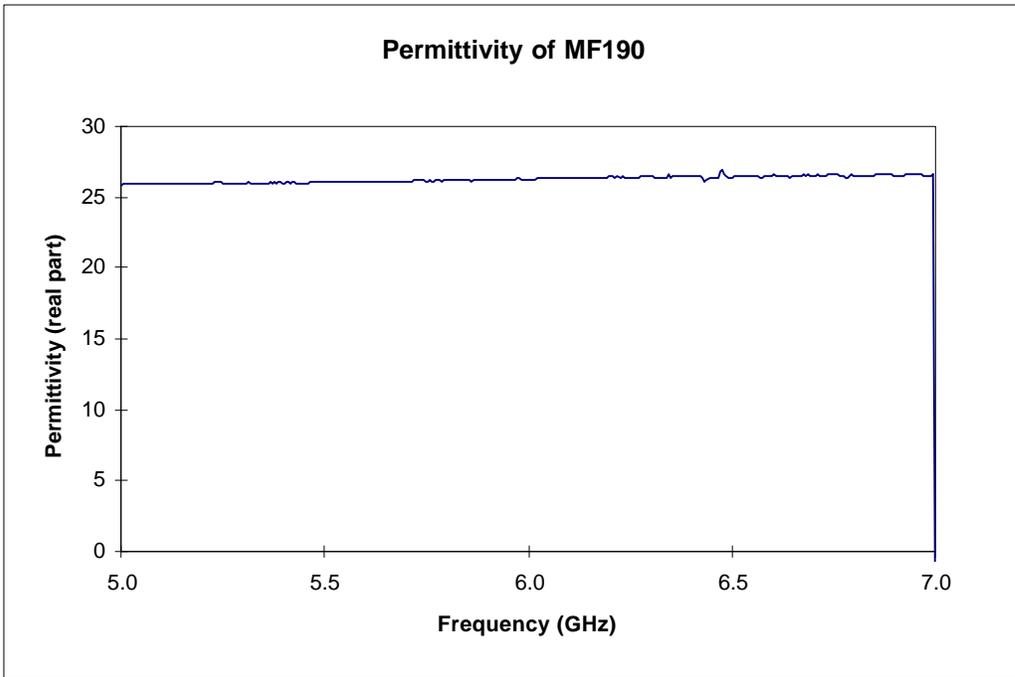


Figure 21. Permittivity of MF190

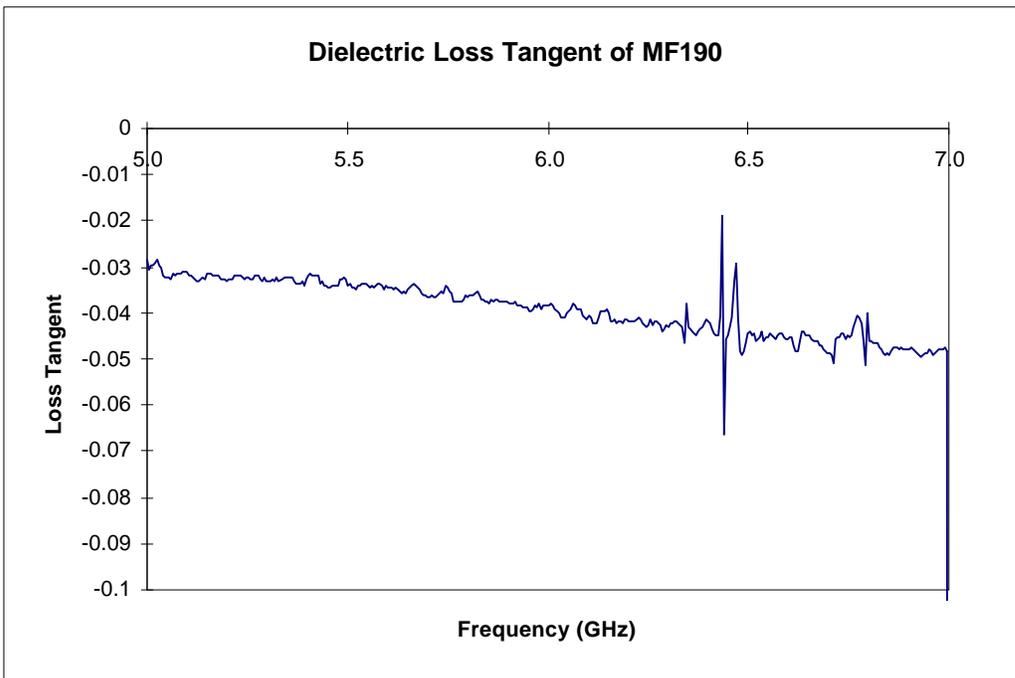


Figure 22. Dielectric Loss Tangent of MF190

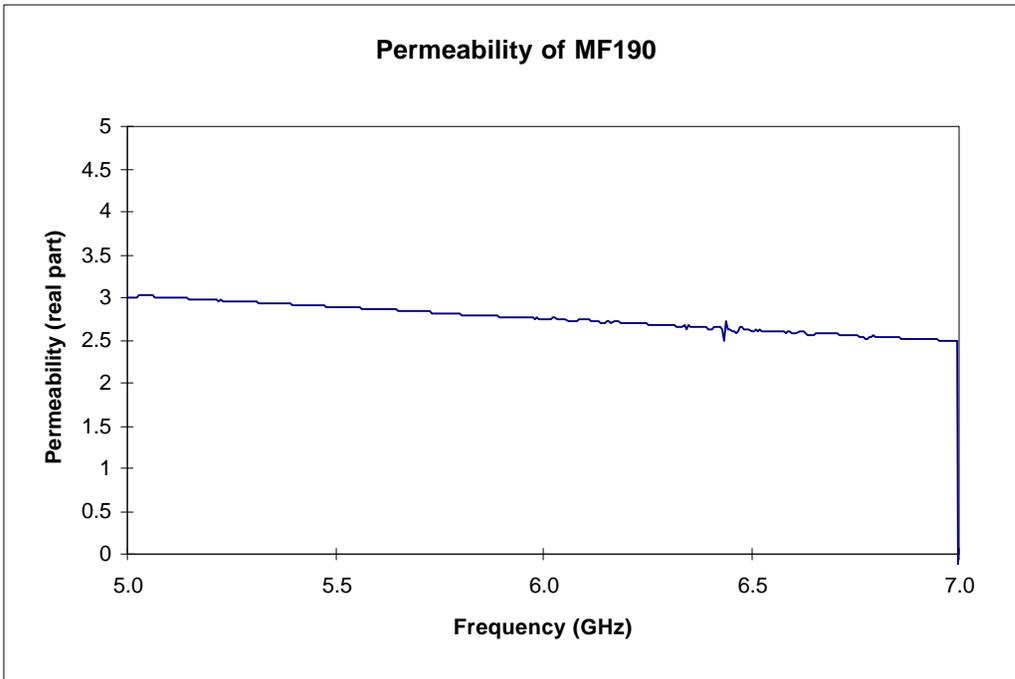


Figure 23. Permeability of MF190

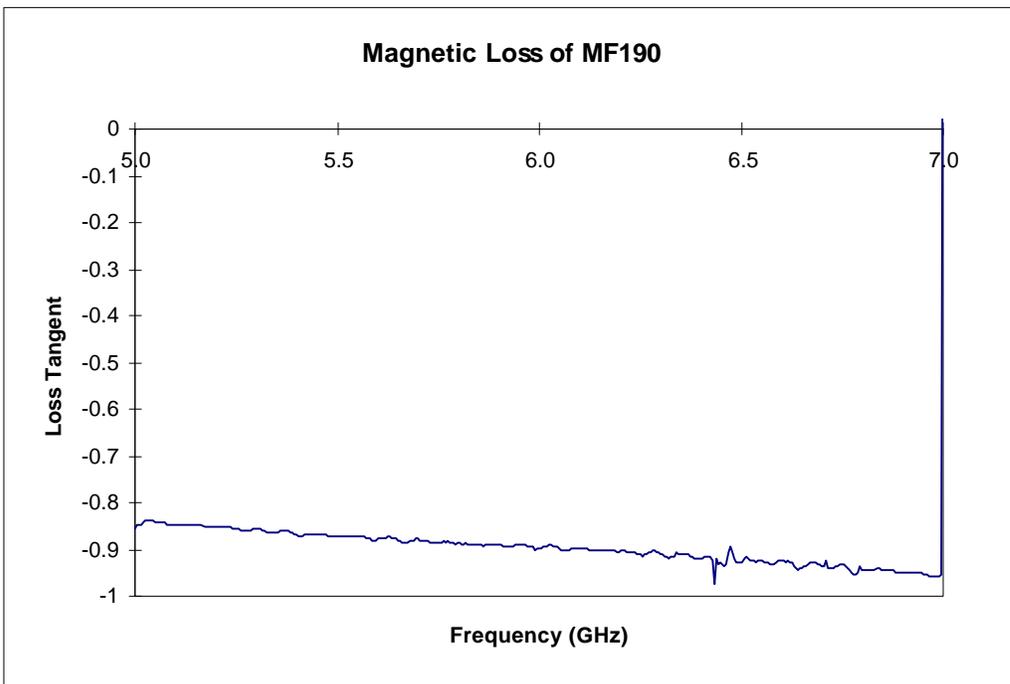


Figure 24. Magnetic Loss Tangent of MF190

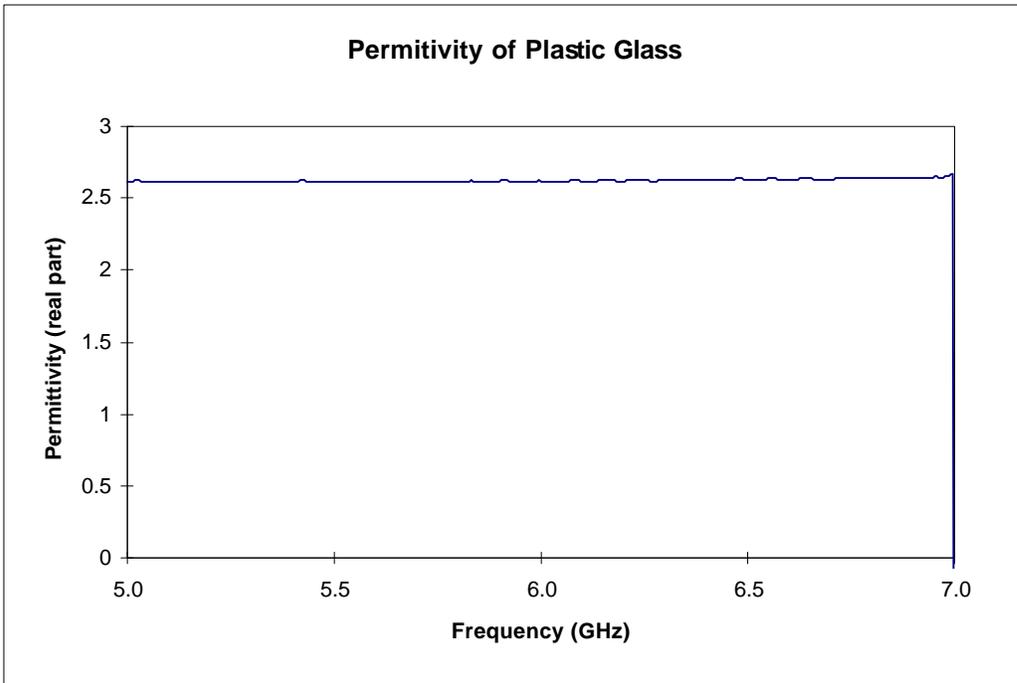


Figure 25. Permittivity of Plastic Glass

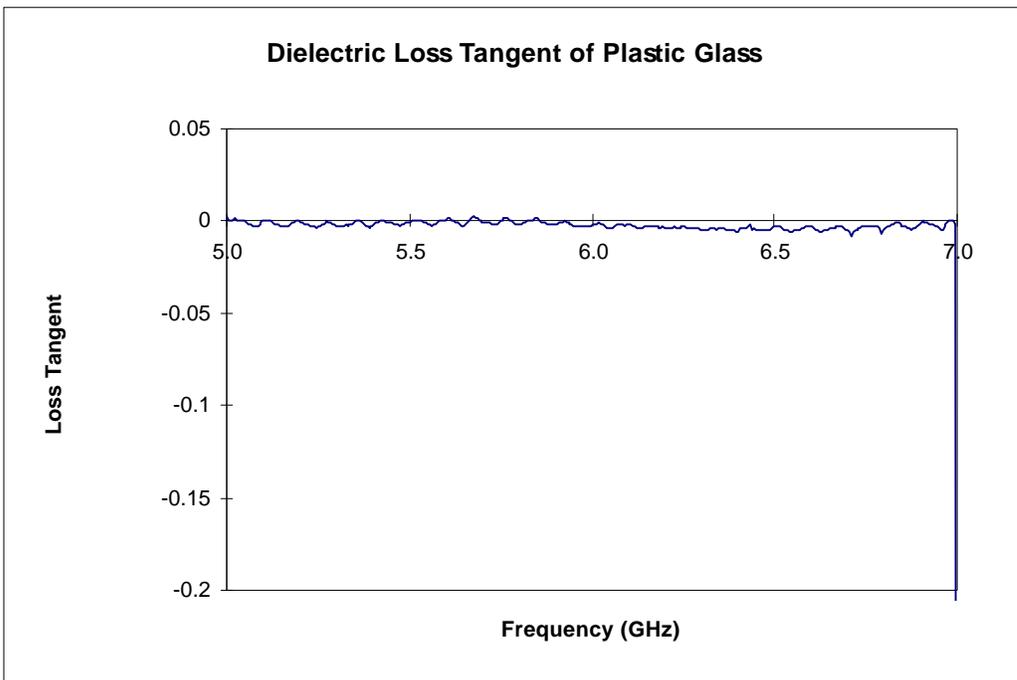


Figure 26. Dielectric Loss Tangent of Plastic Glass

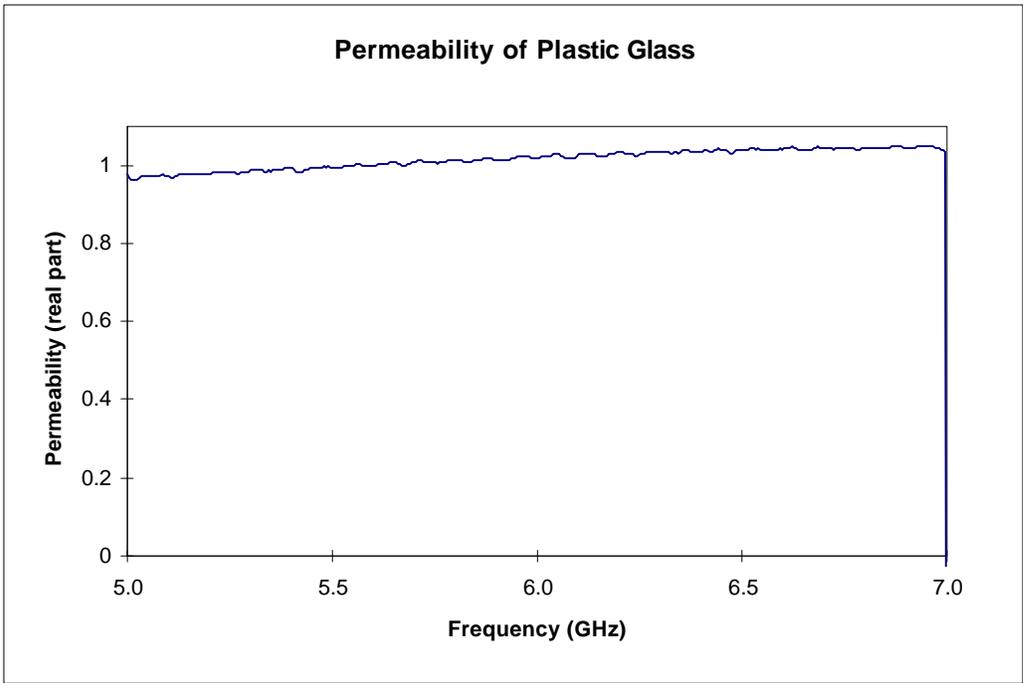


Figure 27. Permeability of Plastic Glass

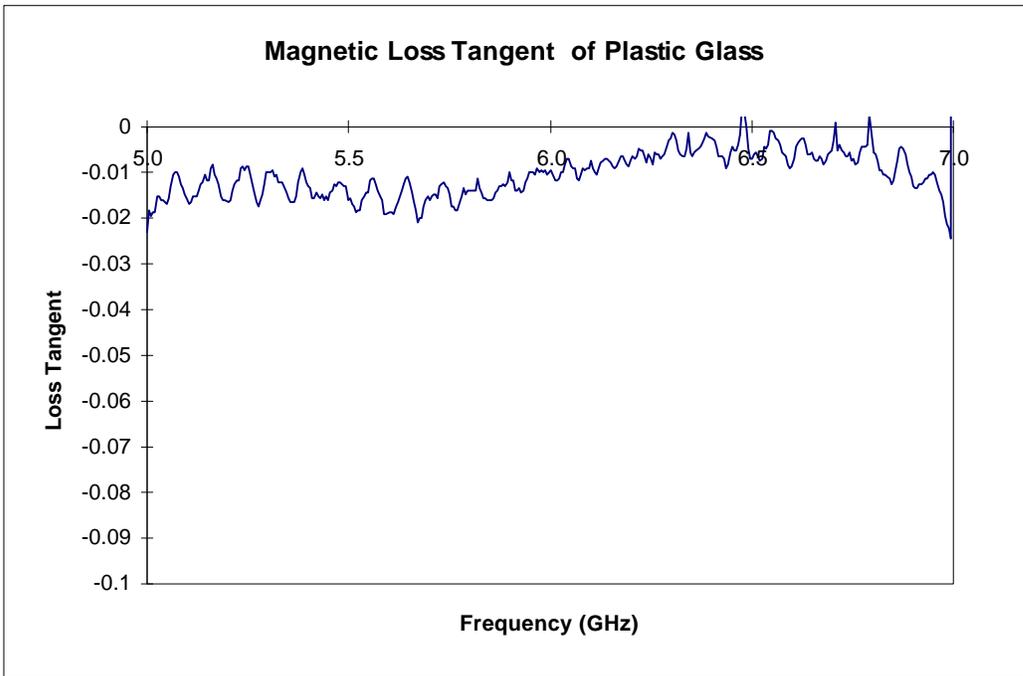


Figure 28. Magnetic Loss of Plastic Glass

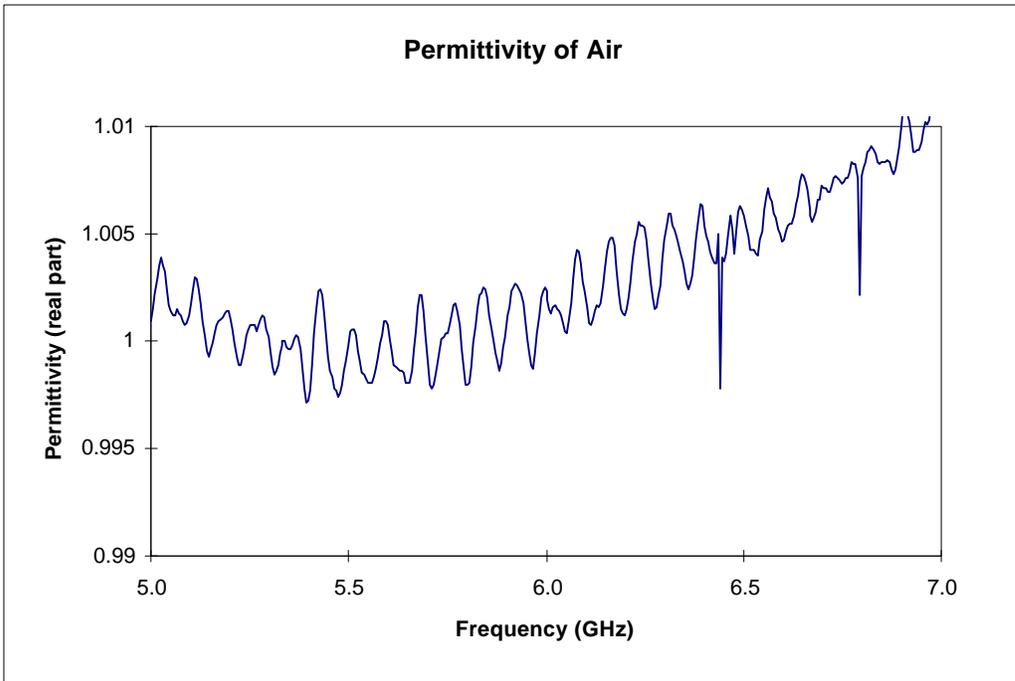


Figure 29. Permittivity of Air

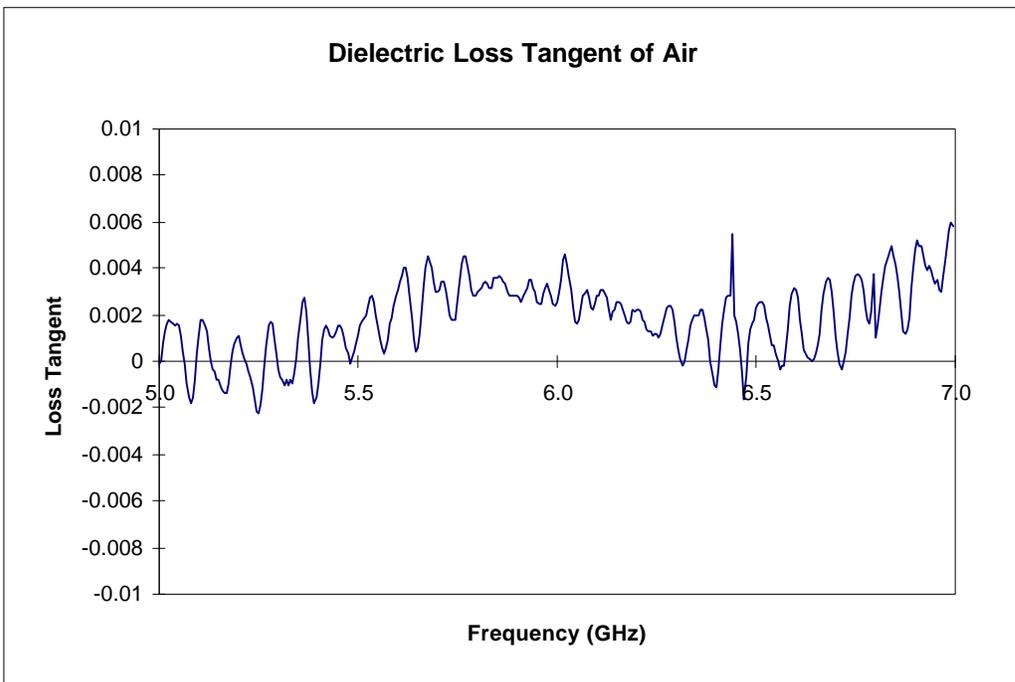


Figure 30 Dielectric Loss Tangent of Air

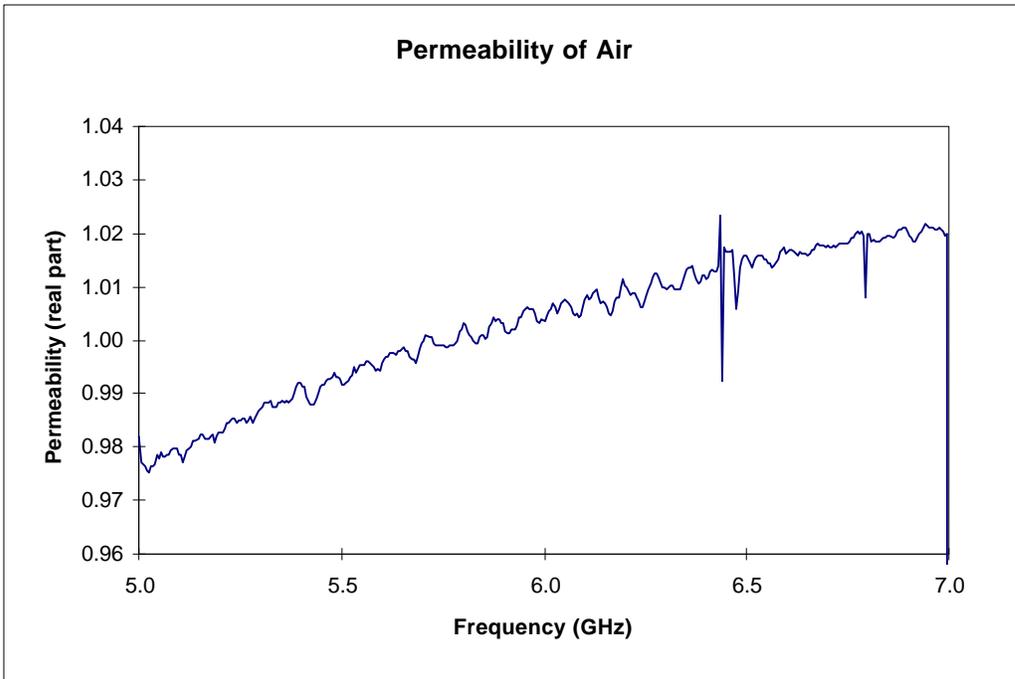


Figure 31 Permeability of Air

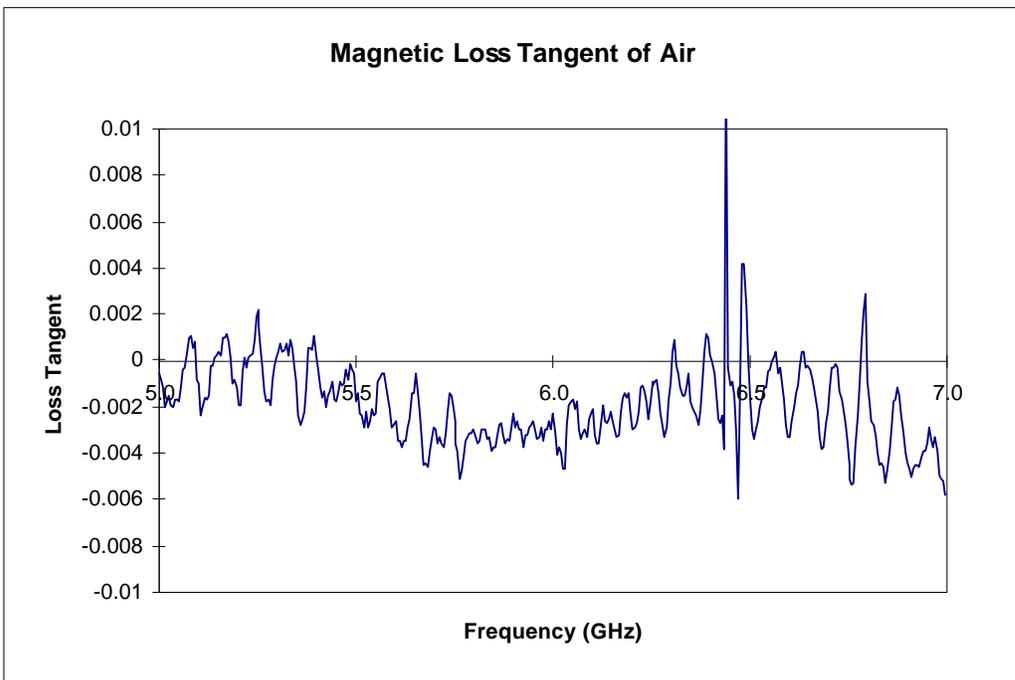


Figure 32 Magnetic Loss Tangent of Air

