Absorbers Analysis For Anechoic Chamber

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Abstract- The most important element in an anechoic chamber is absorbers. Absorbers will absorb an electromagnetic wave to provide non-reflecting environments sir to outer space. Absorbers have been develc at Radio Science Laboratory, Faculty of E. cal Engineering, UTM, consisting of absorbing material in pyramid shape, carbon powder and coating liquid (paint). Absorbers are coated with carbon using oil and water-based paint. This paper highlights the design and construction of the absorbers, as well as the measurement system configuration for absorption measurements. The result is compared with those of commercially available absorbers.

I INTRODUCTION

Anechoic chambers are commonly used to perform a variety of indoor RF measurements involving spacecraft, antennas and electronic systems. These measurements include antenna gain, radiation pattern, beamwidth, directivity, polarization, impedance, radar cross section, electromagnetic interference (EMI) and electromagnetic compatibility (EMC). Rectangular-shape chamber has been used since World War II [1]. Rectangular chambers are preferred because of simplicity in design and construction. However, due to limitation of rectangular chambers at frequency below 1 GHz, pyramidal horn and dome-shaped chambers were introduced[3].

In order to prevent or minimize the electromagnetic reflections in the anechoic chamber, an absorbing material has been used. Absorbers are made by dispersing a lossy material, such as ferrite. Metal-backed impedance matched absorbers made from spinel type ferrites are widely used. It has good absorption properties in the MHz range but does not work well in the GHz range, which has become popular recently. A composite material with ferrite powder shows better absorption in this frequency range, but its permeability values are low and have only a little flexibility in adjusting to the absorption condition[2].

The purpose of this study is to investigate the application of carbon powder as an absorbing material. Carbon is chosen due to its properties that are quite similar to ferrite and easily found in the local market. Besides, the price is also cheaper.

II DESIGN AND EXPERIMENTAL

The design specification was minimum 20 dB absorption over 8 GHz to 12 GHz (X-band). Absorbers were made from polystyrene, which were cut into pyramidal-shaped and then coated with carbon. There were two types of coating, water-based and oil-based paint. The goal of the coating was to achieve surface resistance of 210-270Ω/square[4]. A free space bistatic measurement setup operating in the frequency range of 8 GHz to 12 GHz as shown in Fig.1 was employed to measure absorption.

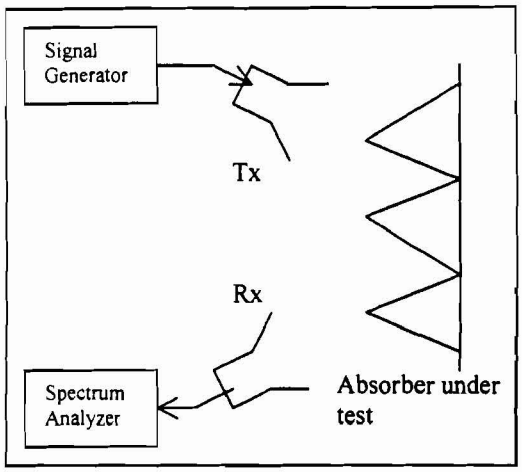

Fig.1 Measurement setup

III MEASUREMENT RESULTS

Fig. 2 shows that the higher percentage of carbon gives better absorption. However the water-based coating results are below commercial absorber absorption. Oil-based coating gives better absorption compared to oil-based coating, as shown in Fig 3. Oil-based coating gives absorption above 20 dB throughout the frequency range. Fig. 4 shows that with oil-based coating, less amount of carbon is needed to give better result compared to water-based coating with more carbon. At different room temperatures, it was discovered that the water-based coating was more stable compared to oil-based coating, as shown in Fig. 5 and Fig. 6.

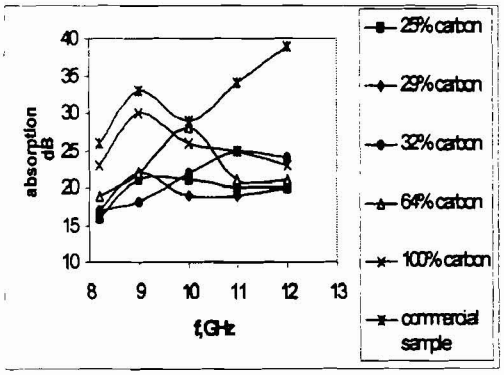

Fig. 2 Water-based coating at various carbon content

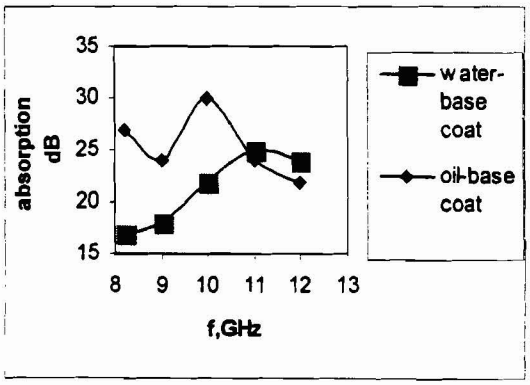

Fig. 3 Water-based coating vs Oil-based coating

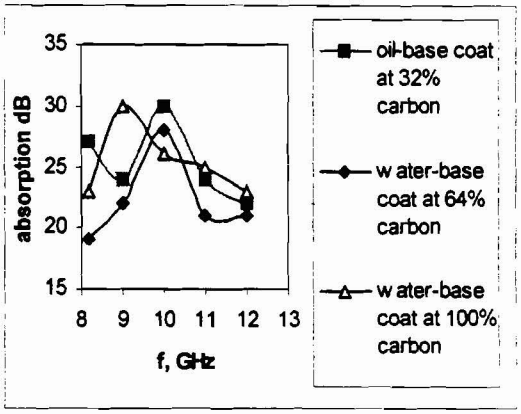

Fig. 4 Water-based and Oil-based coating at various Carbon content

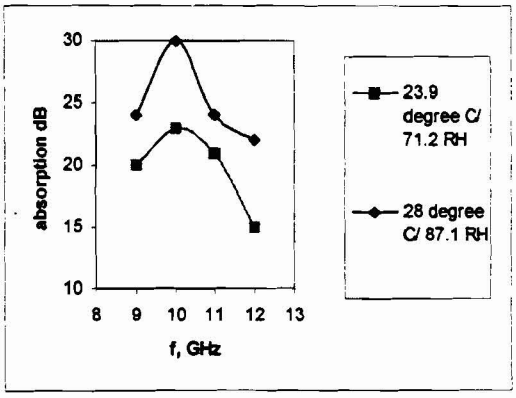

Fig. 5 Oil-based coating at different temperature

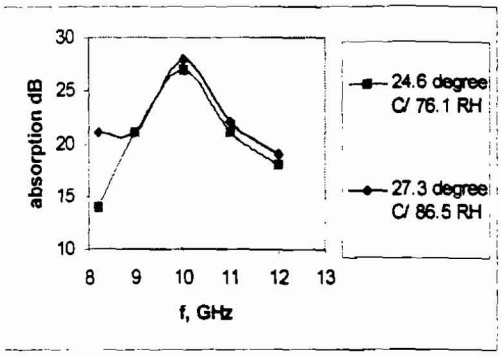

Fig. 6 Water-based coating at different temperature

IV CONCLUSION

Preliminary results show that carbon-coating can be used as absorbing material. However, further studies should be carried out to determine other contributing factors that may improve the absorption performance. The results also should be verified by using commercial software such as HFSS (High Frequency Structure Simulator).

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