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Ferrite Electromagnetic Wave Absorbers

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Abstract. The necessity of the electromagnetic wave absorbers is becoming larger and larger. After World War II, absorbers in microwave frequencies were necessary to develop microwave technology. Now it is a digital age. So from low frequency up to high frequency there are a lot of leakage electromagnetic waves. Let say from 30MHz up to 1000MHz. To absorb from 30MHz up to 1000MHz with thin and cheap absorber is strongly wanted.

Also, the absorbers which can absorb from 30 MHz to 60 GHz, for example, are asked to be designed with very thin thickness.

In this paper, firstly overview about absorbers will be given and secondary the present status of the art will follow.

1. Electromagnetic Wave Absorbers

The title of this paper is FERRITE ELECTROMAGNETIC WAVE ABSORBERS. But the author considers it is better to give first a short general explanation about absorbers.

1.1 Material

(i) Carbon (Conduction loss σ)

(ii) Ferrite (Magnetic loss μ'')

(iii) Ferroelectric Material (Dielectric loss ϵ'')

(iv) Combination of the above

1.2 Characteristics of Absorber

(i) Value of Reflection

In many cases a power reflexion less than 1% is permitted. That means that the absorption should be better than 99 %. According to the needs, the value will be adapted.

(ii) Frequency Characteristics

Frequency characteristics of reflection is very important for practical use. Two kinds of characteristics are defined. One is N type and the other is W type. There are shown in Fig. 1 (a) and (b), respectively. N type means in certain frequency band (from f_1 to f_2), the reflection is less than permissible value S_0 . The typical application of the N type is to prevent the TV signal reflection from the walls of buildings. In Japan they are sometimes being used. W type means the reflection is less than permissible value S_0 from f_1 up to infinity theoretically.

Fig. 1 Characteristics of Absorber's Type

(iii) Thickness

When we make an electromagnetic wave dark room, the size itself will be determined from the purpose of use of the room. Let's say 3m measurement or 10m measurement. So if we can design the absorber thickness as thin as possible, then, the needed absorber materials become as small as possible, which finally brings the cost down. In such a sense, the thickness needed is very important.

(iv) Weight**(v) Oblique incidence characteristics****(vi) Price****1.3 Application****(i) For dark room****(ii) Antireflection walls and sheet for buildings and bridge****(iii) Unwanted resonance elimination in electronics devices or dark rooms****2. Proposed Absorbers**

So far several proposals have been done. I will show them, in Fig. 2.

3. Characteristics of Proposed Absorbers**(1) Single layer (contains Carbon Powder) N type**

Thickness can be controlled by the kind of rubber and the amount of carbon, but generally speaking the bandwidth is narrow. This absorber is useful above X band. With the increase of the number of layers, characteristics are improved but the thickness becomes large.

(2) Pyramidal Absorber W type

This is the most widely used type in the world. W type can be made easily. The absorber the characteristics of which are less than 1% reflection from 30MHz up to infinity will be constructed with a thickness of about 4m.

(3) Single layer (Rubber containing Ferrite Powder) N type

Originally this type was tested at X band a long time ago. The matching frequency f_m is from 400MHz to 5000MHz. The thickness is about 6 ~ 8mm, regardless of the f_m . Bandwidth is wider than (1) but narrower than (4). [1]

Fig. 2 Many Proposed Absorbers

(4), (5) and (6)

These three types of absorber were proposed by Dr. H.W. Helberg et al in 1960, 1963 and 1965 respectively[2][3]. (4) and (5) are now widely being used. All are N type and when $f_l = 30\text{MHz}$ f_h are 400MHz, 700MHz, 2000MHz respectively. Ferrite thicknesses are about 6 ~ 8mm. In case of (6), the number of ferrite sheets is x2 and so it becomes expensive.

(7) Composite Absorber

This was proposed by the author in 1967. The characteristics are the same as (2) but the thickness is about 1m. This is now being used widely for EMC measurement room and is shorter than that of (2).

(8) Fin absorber

This is designed for one polarization. (4) can be used to absorb TV signal in VHF but (8) can absorb not only VHF but also UHF. It can work from 30MHz ~ 2000MHz.[4]

(9) Grid absorber

Vertical Fin and Horizontal Fin are put in one structure. This can work in the range 30MHz ~ 800MHz with less than 1% reflection. This is now becoming very popular for EMC chamber, because thickness needed is only 19mm. It is the thinnest structure in the world.[5]

(10) Improved version of (6)

As already mentioned, (6) are expensive because of double number of Ferrite sheet. With a good design, the front ferrite (Sintered) can be replaced by Rubber Ferrite. It brings the price less expensive and this can work from 30MHz to 1400MHz.

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