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THE ABSORPTION CHARACTER OF FERRITE-CERAMIC COMPLEX MATERIAL

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ABSTRACT

With specific technology and fabrication process, a new special uniform solid solution material may be obtained, that with variety of composition is made from high initial permeability soft magnet ferrite and high dielectric constant ceramic material. This new complex material, uniform solid solution, is a very good microwave absorption material.

I. INTRODUCTION

It was a success to make ferrite into microwave absorption material with magnetic loss character, but it is single component with two main disadvantages, one is with narrower frequency band and the other is with lower absorption character, particularly in high frequency band, for example, above 4 GHz, the absorption character may degrade sharply.

In order to overcome these disadvantage, it is recommended that ferrite powder be mixed with ceramic powder then added in proper quantity of other materials, as the result, the ferrite-ceramic complex has been compounded. Using its magnetic-loss and electric-loss we can reach two purpose of extending frequency band and increase the absorption. However, if we use the mechanical mixing method to get the mixture material, it may have poor mechanical strength and poor temperature stabilization. We adopted specific technology to compound high initial permeability MnZn & NiZn ferrite, high dielectric constant ceramic into uniform solid solution, that material still kept independent character both of ferrite and ceramic. The microwave absorption material may obtain very ideal results if it is made with the new compound.

This ferrite-ceramic complex solid solution has a very wide frequency spectrum and both its mechanical strength and temperature stabilization are superior as well. The new absorption material has got a wide application in radar antenna, microwave absorption load, antiradar camouflage and invisible technique etc. All of them function well.

II. COMPOSITION AND FABRICATION

The ferrites we adopted, are MnZn and NiZn soft magnetic ferrites, with initial permeability between 10 — 6000 and the ceramic material which we used, are composition series of $La(Mg0.5\ Ti0.5)O_3$ and $CaTiO_3$, with dielectric constant between 40 — 120. The complex may be obtained from ferrite and ceramic using a specific technology.

The complex's character of absorpting wave will not depend on its own structure property completely and may vary with many other factors. So, it should be designed precisely according to the usage, to determine the complex's μ', ε' and $\sqrt{\mu'/\varepsilon'}$ value as well as its shape required, then grind the ferrite and ceramic into adequate-grain-size powder, mixing them as a certain chemical composition in order to obtain the mixture powder. So as to let this mixture powder form solid solution at lower temperature, it is necessary to put in proper agent of fusion, but if unadapted property and quantity of agent of fusion is put in, it is impossible to form a good complex or the formed complex will not get both ferrite and ceramic character. At the same time, in order to increase the absorption character of complex, while mixing powder, we should add some metal ions that may increase magnetic and electric loss, such as Fe^{2+}, Co^{2+}, Na^{+}, K^{+}, Li^{+} etc, and press the uniform mixing powder that has already been put in the agent of fusion and metal loss ions, into required shape, fire at 1000°C, control the atmosphere inside the furnace precisely. So, a good absorption complex has been produced. It is possible to have the metal surface covered with complex layer by special methods.

Table I here below lists the electric and magnetic character of the complex as various composition ratio between MnZn ferrite, with μ' =6000 and ceramic, with ε'=80. From above we can see its μ' can change from 5 to 1000, while the ε' changes from 70 to 16. So it has got a very big changing range of its $\sqrt{\mu'/\varepsilon'}$. μ'' and ε'' of the complex listed above in the Table are very high, beyond the apparatus range and this character is just as the same as the good absorption property that we get during its application.

III. ABSORPTION CHARACTER AND APPLICATION

The absorption character of ferrite ceramic complex increases obviously than that of single ferrite and ceramic, its absorption frequency range extends obviously, too.

Table II we list different complex's with its maximum absorption frequency. It should be pointed out that the values in Table II is corresponding to measure methods, but not completely depend on complex itself and its change may be explained with well-known theory.

The temperature stability of this complex is very good, without any change of its absorption under very high temperature, such as over 100°C. The machnical strength and antifrictional ability are good too and can be used in a very bad circumstances. This material has been getting various applications, it functions good, for example:

A. Used in high power coaxial absorption load.

We make a ring shape of the complex which is 21mm outside, 9mm inside, 4.6mm thick into coaxial load, with V.S.W.R less than 1.25 at 3—6 GHz. It can stand a CW power of 50W continually and heat dissipation naturally. Its surface temperature goes up to 108°C and no change in properties.

B. Used to elimiate radar antenna secondary radar beam.

The diameter of the radar antenna reflection surface is $30\lambda_g$. Four pieces of complex material (size: 80cm^2) should be stuck to the proper position of the reflection surface (see Fig.1) and it can restrain the antenna first sidelobe effectively. So the anti-interference of the antenna has been increased. Hereafter list a value in Table 3.

Table I

The magnetic initial permeability and dielectric constant of complex material.

MnZn Ferrite, μ' =6000

MgLaTi Ceramic, ε' =80

Ratio Ferrite/ceramic	Character μ'	Character ε'
1.00 : 0.05	1,000	16
1.00 : 0.10	620	19
1.00 : 0.20	152	26
1.00 : 0.50	53	38
1.00 : 1.00	29	52
1.00 : 2.00	13	63
1.00 : 3.00	5	71

Table II

The maximum absorption frequency of ferrite-ceramic complex.

No	μ'	ε'	f_{max} (GHz)
1	53	46	7.1
2	39	43	8.2
3	21	39	9.0
4	12	61	11.0
5	6	69	12.4
6	60	16	5.2
7	62	21	6.5
8	57	32	7.3
9	66	39	8.6

IV. CONCLUSION

Adopting specific technology and com-

Table III

The retraining antenna first sidelobe function of the ferrite-ceramic complex material.

Frequency	Unstuck complex materiale		Stuck complex material	
	E-plane	H-plane	E-plane	H-plane
f_0	-17.1 dB	-18.3 dB	-27.0 dB	-22.3 dB
1.05 f_0	-18.6 dB	-20.5 dB	-24.3 dB	-29.1 dB

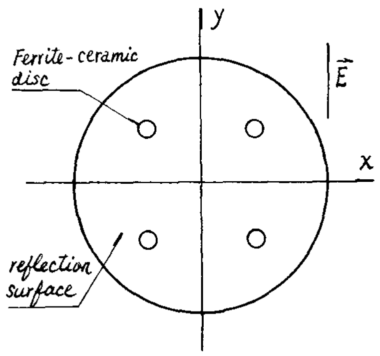

Fig.1 Arrangement of ferrite-ceramic complex disc on the reflection surface of radar antenna.

pounding the ferrite and ceramic into a uniform complex material,we may get the new material not only with the advantage electric-magnetic property both of ferrite and ceramic, but also get the good mechanical strength and stable temperature property. It is a good microwave absorption material in wide frequency band and it has got some applications in the fields of absorption load, radar antenna,antiradar camouflage and invisible technique.

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