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Performance of The Heterogeneous Surfaces for Electromagnetic Absorbtion and Information Protection

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Abstract

Information protection data can be in difference types like data encryption, Protect the building from theft or her direct intervention, shielding equipment and the building of data leakage .Shielding properties of the absorbers with different form of surface such as a regular alternation of rectangular elements and a hemispherical shape have been investigated. Increasing values of electromagnetic radiation EMR attenuation from **-5.0 to -30.0** dB with increasing of frequency has been established. Reflection coefficient for the samples of developed constructions from **–4 to –15** dB has been obtained. It is shown that the formation of ordered heterogeneities of different shapes can enhance the effectiveness of the shielding parameters for the attenuation and reflection in the microwave.

الخلاصة:

في هذا البحث حماية البيانات تكون بعدة طرق مختلفة مثل تشفير البيانات وحماية البنايات من السرقة او التدخل المباشر لها ، تدريع الاجهزة والبناية من تسريب البيانات من اهم طرق الحماية الحديثة ، تم دراسة خصائص التدريع للمواد الماصة (absorbers) ذات السطوح المختلفة، كالاسطح المنتظمة للاشكال المستطيلة والنصف كروية. لقد تبين ان قيمة EMR تزداد من -5،0 إلى -30،0 ديسيبل مع ازدياد قيمة التردد. لقد تبين ان قيم معامل الانعكاس لعينات الهياكل المصممة تتراوح من -4 إلى -15 ديسيبل. وتبين أن تشكيل التغاير المنتظم للاشكال المختلفة يمكن أن يحسن من فعالية معاملات التدريع (shielding parameters) من ناحية معامل التخفيف (attenuation) والانعكاس في الميكروويف.

Key words: EMR absorber, reflection coefficient, information security, carbonaceous powders, geometric surface heterogeneity.

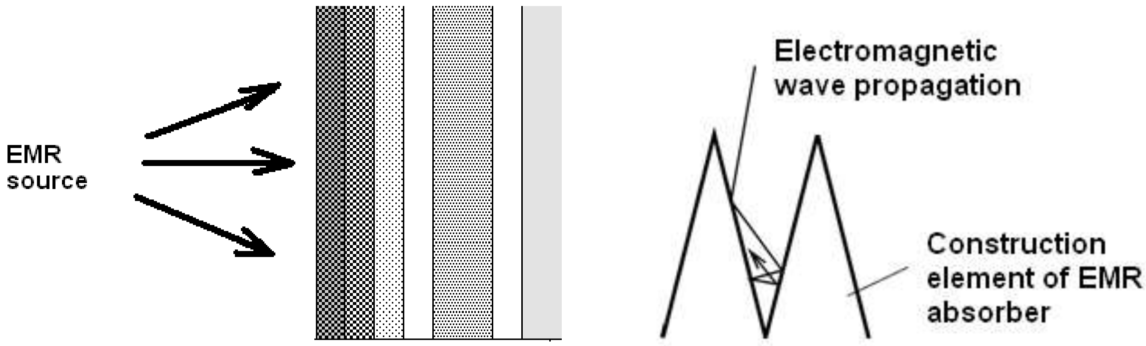
Introduction

An unwanted information leakage can be in various life sections (Hardware & Software), the electromagnetic energy can be used as giving and receiving information in communication systems, electromagnetic radiation (EMR) of modern technical devices can have a negative impact on computer technology. Enabling Electromagnetic Environment (WME) should be sure the requirements for electromagnetic safety of the facility [1]. Shielding of Electromagnetic Waves (EMW) is appropriate method of protection to reduce the level of unwanted EMR, electromagnetic filters and shields are used, made of different materials and in a variety of designs.

Widely known pyramidal absorbers of EMR, which can provide up to 50 dB EMR absorption in a specific frequency range [2]. However, these absorbers are narrow in a certain range of wavelengths, have considerable dimensions and weight parameters. In this researching work shielding characteristics of electromagnetic radiation absorbers with different geometrical heterogeneities on the surface from the carbonaceous powder with liquid inclusions are examined. The main goal of the work is determination of shielding parameters of the surface shape of composite EMR absorbers and effective use of such structures to protect against unwanted EMR effects. . The benefit of using this technology is to shield sites from outside, protect people inside houses from incoming waves (radiation) and manufacturing phones covers to reduce waves produced by mobile phones.

Theory

Effective action of most EMI absorbers based on the effect of interference of electromagnetic waves - the resonant absorbers (Fig. 1a); on the effect of multiple reflections EMW border surface irregularities construction screen, or by conversion of the incident electromagnetic waves (EMW) to the surface and scattering its energy (Fig. 1b). However, such absorbers in most cases are frequency narrowband and require precise dimensions for a particular frequency.



a) b)

Figure 1 - Examples of structures of EMR absorbers

Composite materials and chiral structures are promising directions in the creation of high-performance shields and EMR absorbers. Powder components set forth in a binding matrix, allow the creation of new materials and design shields and absorbers with required shielding effectiveness. In addition, it is possible to extend the frequency range and varying parameters such as absorption and reflection while maintaining the total amount of EMR attenuation.

Carbonaceous powder composites have high enough capacity to absorb electromagnetic radiation by creating conductive structures within the material at the molecular level (Fig. 2).

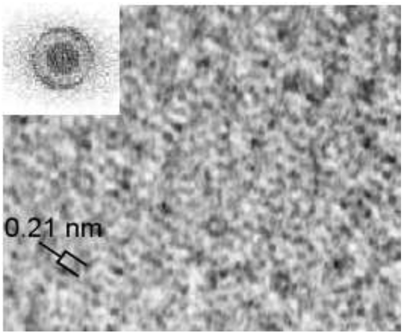


Figure 2 – Molecular structure of carbonaceous layers of using powder – optical diffraction

This carbon mineral has polycondensed carbon network, compared with a graphite monolayer structure, is distorted with increasing interatomic distances [3], which creates a loss of energy during the passage of electromagnetic wave through the sample.

Known from earlier publications, EMR absorbing materials and structures based on carbon composites can reduce the reflectivity of the surface on the order of -15 dB with the overall effectiveness of the shielding of more than 30 dB [4], [5].

Experiments

Significant weights of pyramid structures based on carbon powders with liquid inclusions causes additional steps for attaching the modules based on them on the walls and ceilings. For these reasons, we have offered other kinds of embodiment of data elements (Fig. 3). Shown structures have surface irregularities of various shapes, such as square and hemispherical roughness.

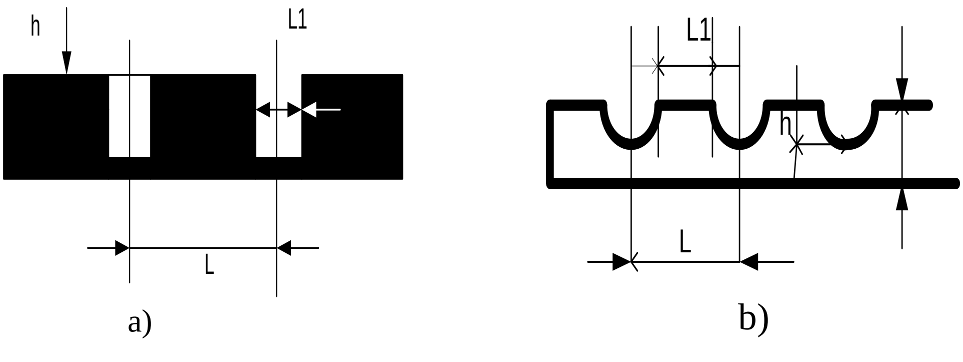


Figure 3 – Schematic representation and appearance absorbing module with ordered geometric heterogeneity

Results and Discussion

Mortar mixture of carbon powder with a small admixture of mineral substances (grain size ≈ 0,5 mm) and artificial inorganic binder in a weight ratio of 1:1 in 30% aqueous solution of earth metals alkaline were deposited on the wooden formwork size 0,4 x 0,3 m^2. The total thickness of these modules was ≈ 10 mm. Dimensions of structural elements samples were L ≈ 48 mm, L1 ≈ 10 mm, h ≈ 5 mm.

Shielding properties of the absorbers with different form of surface such as a regular alternation of rectangular elements and a hemispherical shape have been investigated. The comparative characteristics of existing conventional absorbers of electromagnetic radiation have been designed on the basis of the values of transmission and reflection coefficients in the frequency range 0.5...18 GHz (Fig. 4).

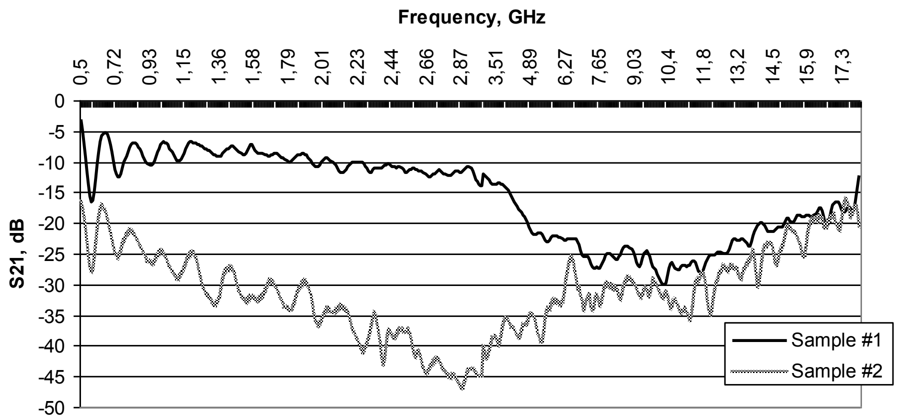


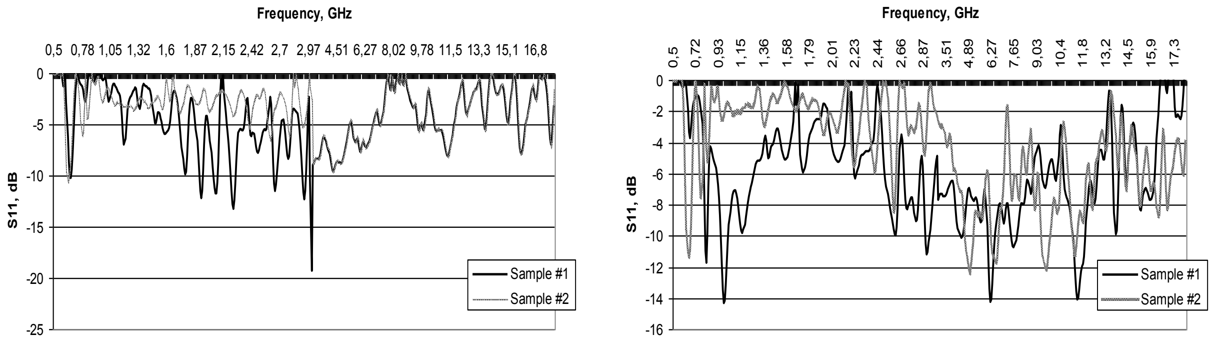
Figure 4 – Frequency dependence of transmission coefficient in the frequency range 0,5…18GHz:

Sample# 1 – a regular alternation of rectangular elements of module shape

Sample# 2 – a regular alternation of hemispherical elements of module shape

In the result of measurements, increasing values of EMR attenuation from -5.0 to -30.0 dB with increasing of frequency has been established. Sample with a regular alternation of hemispherical elements is more efficient in comparative with sample with a regular alternation of rectangular elements at frequencies of 0.5…7 GHz on average 15 dB. At frequencies of 7…17 GHz both of structures have equal transmission coefficient. Maximum attenuation for the sample with a regular alternation of hemispherical elements is 40 dB at 8 GHz and 30 dB at 10.4 GHz for the sample with a regular alternation of rectangular elements.

As we can see in figure 5a, for the sample with a regular alternation of rectangular elements reflection coefficient tends to local reduction from -4,0 to -10,0 dB and effective at frequency range 0.7…1.75 GHz, 1.6…5.0 GHz. Using a metal reflector behind the sample increases the reflection coefficient to -2.0 dB at the frequency range 1.5 ... 2.5 GHz. On average reflectance measurement with a metal reflector behind the sample is -8 dB over the entire frequency range with the local reduction up to –4 dB at frequency flange 1.3…2.5 GHz. For carbonaceous composites presence of metal reflectors behind the sample can redistribute the wave propagation in a material sample, thereby reducing the reflection coefficient.



a) b)

Sample#1 – a regular alternation of rectangular elements of module shape
Sample#2 – a regular alternation of hemispherical elements of module shape

Figure 5 – Frequency dependence of reflection coefficient in the frequency range 0.5…18GHz when measurements have been carried out:
a) Without metallic reflector behind sample;
b) With metallic reflector behind sample

It is established that the value of the reflection coefficient of samples with a regular alternation of hemispherical elements tended to decrease from -3.0 to -8.0 ... -12.0 dB in the frequency range of -3.0 ... -18.0 GHz. At the same time placing a metal reflector behind the sample, as we have seen earlier, can reduce reflection coefficient due to the above. This is especially evident at frequencies above 2.5 GHz.

Conclusion and Future Work

The hemispherical shape irregularities as a result of measurements increasing of values of EMR attenuation -20.0… -40.0 dB in the investigated frequency range have been found. The value of the reflection coefficient of these samples tends to decrease from -3.0 to -8.0 ... -12.0 dB in the frequency range of -3.0 ... -18.0 GHz. It is established that the investigated structures are more protective of broadband shielding efficiency and lower dimensions and weight parameters in comparison with known pyramidal absorbers in the microwave and lower reflectance compared to the flat EMR shields

References

1. “A Microwave Vision Company”. Internet-source, access mode: http://www.aemi-inc.com
2. “Emerson & Cuming Anaechoic Chamber” Internet-source, access mode: http://www.ecanechoicchambers.com/absorbers1.html
3. O.I. Evstafiev, S.P. Kopysov “Modeling of the structure and physical and mechanical properties of polyethylene filler schungit”, *Chemical physics and mesoscopic*, Vol. 10 No. 1, pp. 25-31, 2008.
4. EMR absorber with geometric irregularities on base of powder materials / Pukhir H.A., Krishtopova K.A., Mahmood M. Sh., Kazeka A.A. // *Pross. of VIIth international youth scientific-technical Conference “RT-2011”*, Sevastopol 11-15 April, 2011, SevNTU, 2011 – p. 391.
5. Investigation of the shielding properties of carbon composite EMR absorbing material at different disposition towards the source of radiation / Pukhir H., Mahmood M. Sh. // *Pross. of XXIth International Conference on Electromagnetic Disturbances*, 28 - 30 September, 2011, Białystok, Poland, Białystok University of Technology, 2011. – pp. 220-221.