

ABSTRACT

Chukwu Chinonso

Electromagnetic shields based on paints, filled with nanostructured components

THESIS

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Scientific supervisor,
Dr. Sc. Prof Lynkou Leonid,
Dr. prof. T.V. Borbotko

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INTRODUCTION

The use of passive methods and means to counter a possible leak of information on electromagnetic and optical channels is a very important aspect to improve the masking properties of the shielding element, which is located between the equipment to intercept and source of information.

To attenuate radiation controlled use various constructions and protective simulation hardware construction based on materials with different dielectric, conductive and magnetic properties.

These materials are usually created by the introduction of a variety of binding components of special additives (usually in powder form) and their subsequent transfer to solid state.

The main disadvantage of these materials are a significant indicator of mass care protective characteristics due to corrosion processes, increased cost of products due to the need for new equipment, etc.

Carbon powders are one of the basic materials used as structural components EMI shields. One of the most popular materials used as filler in such materials is shunt (30% carbon), which is widely used in various industries (water filtration, breeding, chemical engineering, medicine, steelmaking, and others.) Using a shunt as a composite material for the manufacture of screens EMR is under active applications (building materials), and conducting studies on the new first reflectance of EMR frequency range of 0.1 GHz or more.

GENERAL CHARACTERISTICS OF THE WORK

The purpose of technology is to create a high-performance screens electromagnetic radiation on the basis of shungite powders introduced into the different paints and adhesives, and recommendations on their use.

The main tasks:

1. Conduct a rationale for the choice of shungite powder and organic binders for coatings on various substrates and their possible use as shields electromagnetic radiation for technical information security systems;

2. To investigate the influence of the composition of shungite composite materials based on inks and adhesives applied to various materials, the characteristics of the absorption and reflection of electromagnetic waves;

3. Investigate Fire composite shungite paints applied to the fibrous materials and the impact of open flame in the radio shielding properties of materials and recommendations for possible use.

As objects of study selected shungite powder and fire-resistant paint and adhesives. The subject of the study are the characteristics of attenuation and reflection coefficients of electromagnetic radiation.

The provisions for the defense

1. Introduction to the fire-resistant paint and adhesives shunt in powder form allows you to create electromagnetic shields on various grounds with the efficiency of up to 10-30 dB attenuation and reflectance -8 ... -10 dB in the frequency range 2-18 GHz, which is very promising for hiding different TECHNICAL objects from detection means.

2. It was found that as a result of fire exposure screens electromagnetic radiation on the basis of a powdery shungite and fire retardant paint coke contains form a porous structure, which is characterized by stable performance and reducing the reflectance of electromagnetic radiation (± 2 dB).

In chanter 1 modern methods and means of information protection against leakage via technical channels based on shungite screens of electromagnetic radiation are presented.

Technical channels of information leakage can be formed due to imperfections of the element base, circuit design, operational wear or malicious acts. Source control, for example, due to radiation in the technical channels are a variety of technical means, which circulates information (power supply and ground line, automatic telephone network, voice amplifier, audio and video tools, computing appliances, electronic office equipment etc.).

Channels leak into the following groups: acoustic, material and material, visual and optical, electromagnetic.

Electric channel information leakage is due to interference of electromagnetic radiation technical means of transmitting information (TSPI) on trunks assistive technology and systems and foreign conductors, beyond the controlled area.

More economical passive method, which consists in shielding the radiation source location of the radiation source (computer) in a shielded enclosure or in the screening room entirely. Electromagnetic shielding - one of the most effective ways to protect information. Some regulatory and technical standards provided for screening rooms in which computer technology is, in particular, on which information is processed restricted distribution [1].

Shielding electromagnetic waves, which is understood as the protection devices against external electromagnetic fields (EMF) and localization of electromagnetic radiation of any funds. EMI shielding effectiveness - the ratio of the rms values of intensity EMF at a given point in the absence and presence of the screen [14,15].

Continuous improvement of special equipment stimulates the search for new, more efficient electromagnetic screens, including to protect against information leakage through technical channels of special protected areas, in particular, facilities for processing encrypted information, rooms for confidential talks cameras to configure and testing of special equipment, etc.

Modern EMR screens are distributed structure with losses matching characteristic impedance of free space to the characteristic impedance of the absorbent material or a conductive metal reflector behind it. Surge layers are generally composites of the dielectric and magnetic materials [16]. Absorption of electromagnetic wave depends on the availability of the material dipoles (electric and magnetic), changes its position under the influence of EMF.

Modern EMR screens are made of composite materials and include particulate filler (particle powders, fibers, beads and particles of various shapes), distributed and recorded in the binder (matrix).

Shungite is a carbonaceous mineral. Shungite screens are fire resistant, keeping his shield after the fire power and without emitting harmful substances in heating and fire.

Shungite rocks (Figure 1) – represent the structure of a natural composite – uniform distribution of fine crystalline silicate particles in an amorphous silica matrix. The average size of the silicate particles of about 1 micron. Shungite derived from shungite rock, has a complex mineral composition. Table 1.3 shows the mineral composition of rocks derived from Zaozhoginsk (Republic of Karelia, Russia).

A wide range of useful properties of shungite rock gives the so-called Shungite carbon and structure of the rock.

The structure of rock shungite is such that the particles have a small size silicates (on average about 1 micrometer) and distributed in a carbon matrix, then due to this carbon-silicates in the rock is created exclusively developed; close contact.

On the basis of analysis of the components that make up the shungite carbon has been proposed physical-chemical model. The model is multi-layered hollow globules (Figure 1.14) – less than 6 nm in diameter, which defines the role of components of shungite carbon added water, trace elements, fullerenes.



Figure 1 – Appearance shungite rock and electron micrograph of shungite carbon clearance

Shungite can be used for the manufacture of building materials both during the construction of buildings and structures in the form of powdered filler of concrete and plaster, and if necessary, the screening of the existing facilities in the form of paints, plasters, facing plates. In addition, it may be a component of protective clothing, covers and electronic equipment.

One of the promising areas of modern science is to create a new multi-functional composite materials, including at the micro- and nanoscale, using natural raw materials. Interest in composite materials based on natural compounds caused primarily by the fact that they have successfully replaced in many industries and resource-expensive is not always environmentally friendly in the manufacture and use of synthetic materials.

In chapter 2 research methodology were selected. The studies were conducted in panorama mode measuring VSWR and attenuation. Instrument calibration was performed over the entire operating frequency range according to standard procedure after setting the frequency span and level of incident power.

When measured in the frequency range 8 ... 12 GHz specimen is clamped between the flanges of the waveguide, this method at low thickness of the sample (no more than 3 mm) make equivalent use of the measuring cell.

For measuring VSWR and attenuation of samples in different frequency ranges following measuring instruments were used: frequency sweep Generator and waveguides section 23,0x10,0 mm.

Evaluating the effectiveness of the screening-level electromagnetic radiation of the samples was carried out in the laboratory using a measuring complex SNA 0,01-18

in the frequency range 0.7 ... 18 GHz selected with regard to the further application screens electromagnetic radiation.

Organic binders – substances of organic origin that can move from a solid state to a plastic or low ductility resulting from the polymerization or polycondensation. Compared with mineral binders, they are less fragile, have a greater tensile strength. These include the products formed during refining (asphalt, bitumen), the product of thermal decomposition of wood (pitch), as well as synthetic, thermosetting polyester, epoxy resins. Apply organic cementing materials in the construction of roads, bridges, floors of industrial premises, roofing materials, asphalt, polymer concretes et al.

The main representatives of such binders are different adhesives, compounds, foams, paints, silicones.

Seems very promising use of additives shungite powders in flame retardants (paints), with high adhesion properties to metal surfaces, such as paints "Agni term" on different bases, to give coatings based on these properties of electromagnetic shielding. It is possible to preserve the flame retardant characteristics.

The choice of titanium dioxide due to its dielectric characteristics, silica gel powders differ possibility of accumulation of water and solutions based on it, powders based on materials with magnetic properties are conventional excipients for solid screens electromagnetic radiation.

In chapter 3 the influence of the shungite composite materials based paints and glues on their characteristics escapes were studied.

The results of measuring the characteristics of the shielding screens EMI samples suggest that the coating of flexible polyurethane polymers for example dielectric powder having sportive properties, promotes the appearance of EMI absorbing properties even when absorbing coating thickness of about 1 mm. Installs a slight decrease of the reflection coefficient for samples with a coating of a mixture of powders of shungite and Ni-Zn ferrite in equal proportions. The test material samples show the relative stability characteristics throughout the measured frequency range.

Most are used to create composite shielding materials binders are combustible materials, which is why there is the problem of ensuring the protection of personnel and equipment at a potential fire. Fireproof action screens based on either their high resistance to thermal effects in a fire, maintaining for a predetermined time thermal characteristics at high temperatures, or their ability to undergo structural changes during thermal exposure like-coke to form porous structures, which are characterized by a high insulating ability. Location fireproof screens can be done either directly on the surface protects components, or on a slope with a special membrane-boxes, skeletons, embedded parts.

Fire-resistant paints, varnishes, enamels delayed ignition of materials, reduce the flame spread over the surface of materials. They perform the following functions: is the protective layer on the surface of materials absorb heat as a result of decomposition, emit gases inhibitor, release water, accelerate the formation of coke

layer on the surface of the material. Development of materials is achieved by low flammability superficial and deep impregnating materials with special structures, the introduction of the initial flame retardant compositions using various mineral fillers, as well as through the use of various technological methods.

After exposure to open flame temperature of 1700 ° C results were obtained samples of fire screens for EMI shielded rooms. The process of experiment is shown in Figure 3.5.

It has been established that burn-out of the screens of the samples coated with intumescent paint, occurs through a 7.24 when used as substrate and in knitwear 37.29 when used with a cellulose substrate, to form openings in both cases the diameter of 40 mm, the brim material substrates charring samples and the release of large amounts of smoke.

The introduction of fire-retardant paint powder shunt-silicate fillers has increased the time of burning of the screen based on the jersey to 9.72.

In the case of a cellulose substrate material having good adhesion of paint used, 15 seconds after the onset of exposure to the gas flame at the surface of the sample began to form coke, which is completely formed 30, burn-out material and the substrate did not occur for more than 12 minutes. The result, given the use of the same for covering two groups of samples, indicating an additional effect on the fire resistance characteristics of the substrate material. In this case, the use of cellulose and hygroscopic characterized inside fiber diffusion leads to thermal degradation of cellulose in the temperature range from 150 to 250 ° C and the formation of intermediate compounds which are different from the cellulose for further behavior at elevated temperatures and yield more coke.



a

b

a - knitwear coated fire retardant paint; d - cellulose, coated with powdered fire retardant paint particulate filler

Figure 2 – The study sample fire screens for EMI shielding of premises

CONCLUSION

The electromagnetic, optical and thermal channels of information leakage is the main technical channels of information leakage, which is associated with the ability to remove hidden information from these channels on protected objects at a distance. Therefore, an important area of science and technology is to create a means of preventing information leakage via electromagnetic, optical and thermal radiation. Such funds are passive screens electromagnetic radiation.

On the basis of literature and patent information shows that for a wide range of operating frequencies screens EMR apply complex multilayer structures and EMR screens with geometric irregularities of the surface. The main disadvantages of existing designs EMR screens are large mass and dimensions. As EMI shields pulverulent fillers widely used materials with magnetic properties, having a high electrical conductivity, high dielectric permittivity and semiconductors. It is shown that the use of powdered carbon-containing filler in the manufacture of screens EMR complex design can be achieved weight reduction of multilayer structures screens EMR while maintaining adaptability of their production and shielding effectiveness.

Incorporation of these materials in the form of powders in a binder allows the dielectric material to create a composite material with a desired value of attenuation of EMI in the operating range of frequencies and temperatures.

It is shown that promising fillers to create screens EMR carbonaceous materials are made on the basis of graphite and shungite allowing their concentration by controlling the on-screen EMR with predetermined characteristics attenuation and reflection. By forming a volume shunt micro- and Nano-sized particles of conductive materials, changes in the chemical composition and structure and surface structure shunt possible to create effective cheap EMR screens to create a screened room, protective clothing for staff and covers for electronic devices.

In view of mechanical strength, frost resistance and corrosion resistance of shungite materials to a relatively high electrical conductivity, they can be widely used as building materials (cement mixture, plaster, paint) to create a shielded space and equipment for the processing of the protected information.

It is shown that as binders for screens EMR is the prospect of the use of fire retardant paint with good adhesion to various substrates by introducing their constituent powders shugite, silica, and titanium dioxide, ferromagnetic.

THE LIST OF AUTHOR PUBLICATIONS

1. Chukwu Chinonso. Ognestojkie kompozicionnyh jekranirujushhie jelektromagnitnoe izluchenie materialy / Chukwu Chinonso, E.S. Belousova, L.M. Lyn'kov // Tehnicheskie sredstva zashhity informacii : materialy XIII Belorussko-rossijskoj nauchno-tehnicheskoy konferencii, Minsk, 4–5 ijunja 2015 g. / BGUIR – Minsk, 2015. – S. 68.

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