EVALUATION OF THE RADIO ABSORBING PAINT EFFECTIVENESS

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Radioabsorbing materials (RAM) have specific dielectric characteristics that ensure effective absorption of electromagnetic radiation, the main of which are the complex dielectric and magnetic permeability ($\varepsilon = \varepsilon' - j\varepsilon''$, $\mu = \mu' - j\mu''$), the tangent of the dielectric and magnetic loss angle ($tg\delta_e = \varepsilon''/\varepsilon'$, $tg\delta_m = \mu''/\mu'$), as well as the reflection coefficients (R) and absorption (A) of electromagnetic radiation (EMR).

Unlike typical radio-absorbing composites containing carbon nanostructures, ferrites, or metals as fillers in the polymer matrix, using technogenic microspheres extracted from ash waste of thermal power plants in this role is promising. Previous studies have established that because of the heat treatment of cenospheres, maghemite (γ-Fe_2O_3), hercynite ($FeAl_2O_4$), hematite (α-Fe_2O_3), and spinel $MgAl_2O_4$ phases are synthesized in their shell. Hybrid paints with such cenospheres can absorb EMFs through key mechanisms:

- The content of hematite and spinel will contribute to absorption due to interfacial and ionic polarization;
- Maghemite and hercynite, which have pronounced magnetic properties, enhance absorption due to magnetic losses and resonance;
- Multiple reflections of waves from the microsphere's surface increase losses due to an increased wave path length inside the composite and their diffuse scattering.

In addition, the presence of spinel with magnetic and dielectric losses will expand the frequency range at which the cenosphere-containing paint will be an effective EMF absorber. Therefore, it can be assumed that the structural and phase features of composites containing heat-treated cenospheres should provide effective shielding of radio waves and a wider range of absorption frequencies due to the combined absorption of EMF's electric and magnetic components.

To test these assumptions, a predictive assessment of the effectiveness of a hybrid paint based on polyethylene terephthalate (PET), which contains 50 % of heat-treated spheres at a layer thickness of 2 mm, which promotes resonant absorption by the quarter-wave mechanism and is typical for single-layer coatings, was carried out. For this purpose, calculations of the wave impedance (Z), reflection coefficients (R), and absorption (A) were carried out at a radio frequency of 10 GHz, as is typical for modern radar systems. At this coefficient of wave transmission through the polymer matrix, T=0. According to the results of calculations, it was determined that the hybrid paint of the actual composition R=12 % (i.e., absorbs 88 % min).

To improve the protective effect of the radio-absorbing paint, it is advisable to introduce 8 – 10 % of a modified additive of a mixture of graphene, graphite oxide, and nanometric nickel. At the same time, changing the ratio of the components of the complex additive allows you to change the absorption frequency range from low-frequency (300 MHz – 2 GHz) to high-frequency (18 – 40 GHz), as well as obtain paints that absorb waves in a wide range (300 MHz – 40 GHz), which are effective for radar masking of equipment, as well as a solution for protection against electromagnetic interference.