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ELECTROMAGNETIC RADIATION SHIELDS BASED ON ANODIC ALUMINUM OXIDE

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Abstract. Decreasing of electromagnetic radiation reflection coefficient of aluminum foil after it anodizing was experimentally grounded. It's proposed to use shields based on this foil for manufacting of fabrics for human protection from electromagnetic radiation.

Keywords: anodic aluminum oxide, electromagnetic radiation, shielding characteristics.

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Electromagnetic radiation shields based on anodic aluminum oxide
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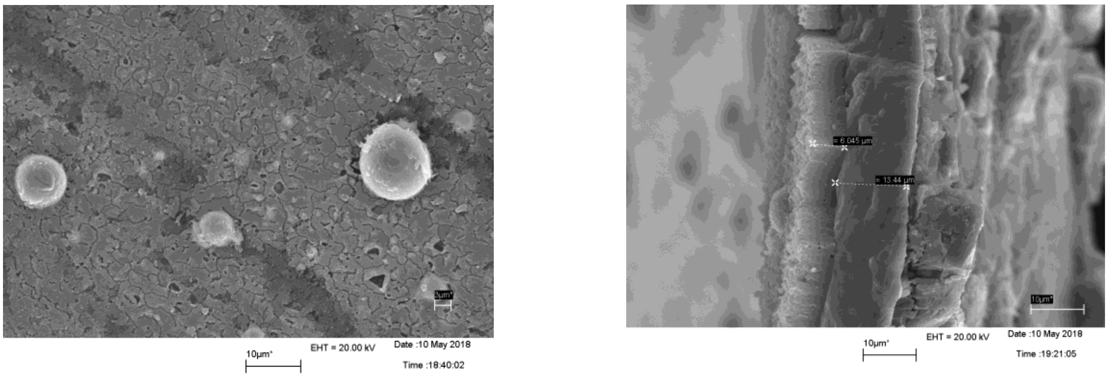
Foiled materials are main elements of high-performance electromagnetic shields, characterized by the property of elasticity and low mass. Such shields are widely utilized for production of special clothes for protection people working with electromagnetic radiation sources from influence of such radiation [1]. However, the average reflection coefficient of electromagnetic radiation (EMR) of such shields is no less than –2 dB. It make impossible of their utilization for production of special clothes in cases when it's necessary to protect people working with equipment characterized by high sensitivity to the electromagnetic noises. In this paper, authors propose an approach to reducing the value of the EMR reflection coefficient in the microwave range of shields based on aluminum foiled materials. The proposed approach consists in applying a porous anodizing layer of alumina to the surface of such materials. The decrease of EMR reflection coefficient of aluminum foil material as a result of using the proposed method is due to the formation on its surface of an oxide layer characterized by a lower wave resistance. The anodizing of aluminum foil is performed in galvanostatic mode with a constant current density in the presented work. The used electrolyte is a solution of oxalic acid. It has been established that the thickness of the layer of anodic alumina that can be formed on the surface of foil materials using this method is 5…25 μm. The layers of anodic aluminum oxide repeat the configuration of the surface of the aluminum foil completely with projections from 0.5 to 2.0 mm. The size of the periodic pore system varies from 50 to 70 nm.

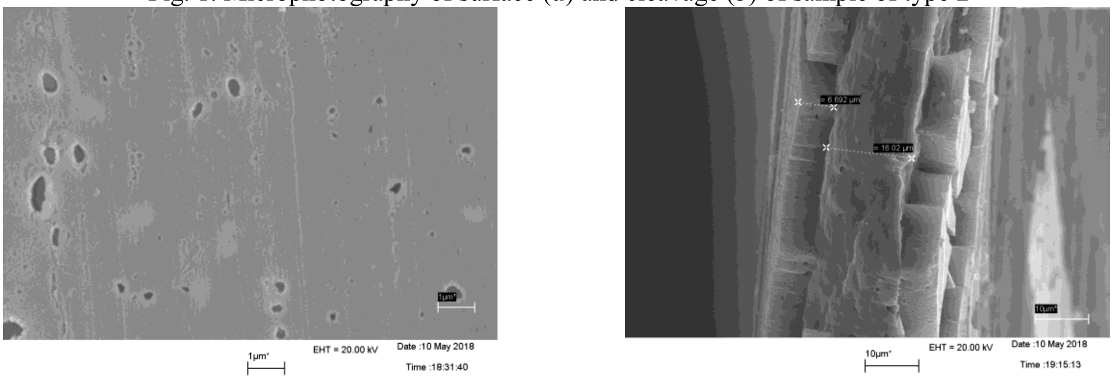
Three types of samples were obtained. The thickness of the alumina layer in samples of type 1 was no more than 7 μm, and in samples of types 2 and 3 is no more than 14 and 25 μm respectively. Appearance of surface and cleavage of produced samples are presented in Fig. 1–3.

Electromagnetic radiation reflection and transmission characteristics of the produced samples are analyzed depending on the thickness of the anodic aluminum oxide layer contained therein. It is established that the values of the EMR reflection coefficient in the frequency range 0.7…17 GHz of samples of type 1 vary in the range from –0.1 to –7 dB. The range of variation of the parameters for samples of types 2 and 3 is from –0.1 to –12 dB and from –0.1 to –17 dB. The values of EMR transmission coefficient in the frequency range 0,7…3 GHz of the studied samples are from –30 to –45 dB regardless of the thickness of the anodic aluminum oxide layer contained in them. In the frequency range 3...17 GHz, the value of this parameter for samples varies from –15 to –40 dB (Fig. 4).



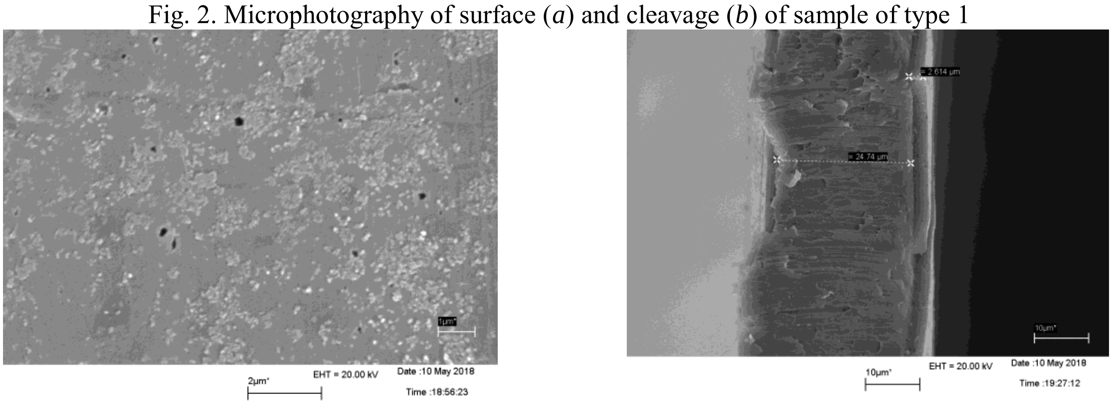
a *b*

Fig. 1. Microphotography of surface (*a*) and cleavage (*b*) of sample of type 2



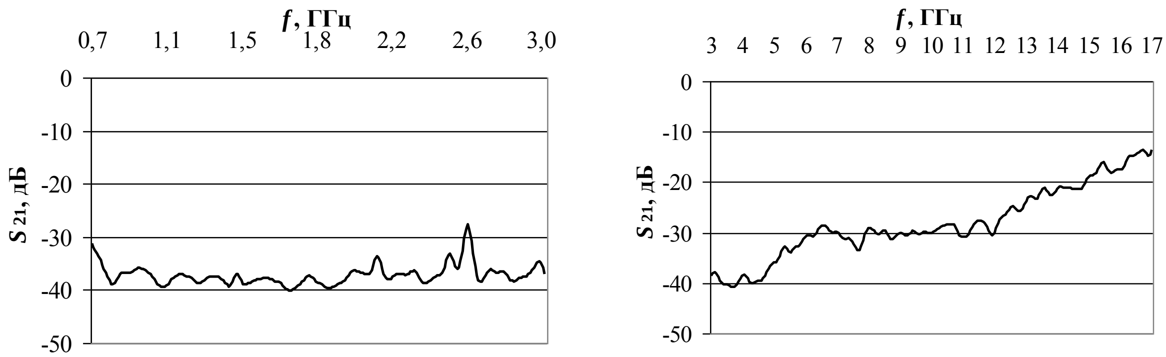
a *b*

Fig. 2. Microphotography of surface (*a*) and cleavage (*b*) of sample of type 1



a *b*

Fig. 3. Microphotography of surface (*a*) and cleavage (*b*) of sample of type 3



a *b*

Fig. 4. Electromagnetic radiation transmission characteristics in frequency range 0.7…3 GHz (*a*) and 3…17 GHz (*b*) of samples of the shields № 1 (lines 1), № 2 (lines 2) and № 3 (lines 3)

It was established that decrease in 2–5 times of the thickness of the layer of anodic aluminum oxide deposited on the surface of foil materials causes an increase by 5–20 dB of EMR reflection coefficient in the frequency range 3–11 GHz of shields based on such materials (Fig. 5). This is due to the change in the difference in the path of the electromagnetic waves reflected from the surfaces of the layers of these screens.

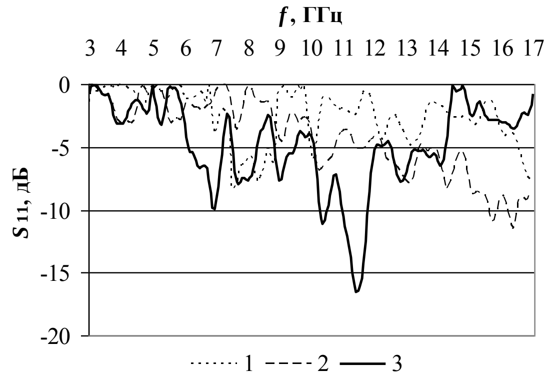


Fig. 5. Electromagnetic radiation reflection characteristics in frequency range 3…17 GHz of samples of type 1 (line 1), 2 (line 2) and 3 (line 3)

The principle of the electromagnetic shield based on anodic aluminum oxide is based on the following phenomena. The electromagnetic wave interacting with the layer of anodic aluminum oxide is partially reflected from it, partly beyond its limits and reflected from the surface of the aluminum foil. Electromagnetic waves reflected from the anodic aluminum oxide layer and the aluminum foil surface at resonant frequencies are characterized by the largest phase difference, which causes a decrease in the reflection coefficient of the electromagnetic EMF of an electromagnetic screen based on anodic aluminum oxide. Electromagnetic waves reflected from the layer of anodic aluminum oxide and the surface of aluminum foil are characterized by the largest phase difference at resonant frequencies, which causes a reduction in these frequencies of the reflection coefficient of the EMP of an electromagnetic screen based on anodic aluminum oxide.

Thus, the investigated electromagnetic shields are characterized by the property of elasticity and, as a result, they can be proposed for utilization for manufacturing of fabrics with complex configuration for human protection from influence of electromagnetic radiation.

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