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ИННОВАЦИИ В МЕТАЛЛУРГИИ
И МАТЕРИАЛОВЕДЕНИИ

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INVESTIGATION OF THE PHYSICAL AND MECHANICAL PROPERTIES OF RADIO-ABSORBING MATERIALS

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Abstract. The paper studies the physical and mechanical properties of radio-absorbing materials. It is shown that to ensure an effective level of material absorption, it is necessary to introduce carbon fibers in the amount of at least 0.25% by weight.

Key words: electromagnetic radiation, radio-absorbing materials, physical and mechanical properties, carbon fibers, plasticizer.

Currently, there is a need to manufacture radio-absorbing materials for the manufacture of clothing and covers for technical purposes to protect against electromagnetic radiation. Such materials should be light and elastic and should not cause discomfort when in contact with a person. Previously, film radio-absorbing materials were actively developed to ensure the above conditions [5]. High-capacity polymers are of particular interest for the production of such materials. A significant number of different polymers are known, but plasticized polyvinyl chloride (PVC) has found wide industrial application [6; 8].

Plasticized polyvinyl chloride processing technologies make it possible to obtain films with different degrees of rigidity: hard, soft, and ultra-soft. The content of the plasticizer in it varies from

20 to 60 weight parts. It is obvious that the amount of plasticizer affects the properties of PVC films, and an increase in the content of plasticizer leads to an increase in the quality of mixing the components of plastisol.

In addition to PVC and plasticizers, plastisol also contains a filler, stabilizer and lubricant (stearic acid, calcium stearate, etc.). However, these components have little effect on the technological properties of the PVC paste, such as viscosity and fluidity. The study of the effect of the plasticizer content on the radiophysical properties of film materials based on polyvinyl chloride is of practical importance [1; 2; 3; 4; 7].

In order to obtain polyvinyl chloride films and evaluate the effect of the plasticizer on radio absorption, films with different plasticizer content were obtained. The basis was a standard recipe based on PVC (see Table), which is often used by the domestic industry to produce polymer films. The amount of DOP was from 60 to 90 wt. h. per 100 wt. h. PVC in increments of 10 wt. h. At the same time, the DOS content remained unchanged – 10 wt. h. per 100 weight parts of PVC.

All films had a smooth and flat surface without pronounced defects and irregularities.

In connection with the field of application of radio-absorbing polymer materials, it can be argued that in addition to their radiophysical properties, their physical and mechanical properties are of great importance. The materials can be used for the manufacture of products of complex shapes, while they have sufficiently high performance characteristics, especially strength and elasticity.

In this paper, we investigated the effect of an electrically conductive filler on the tensile strength and elongation at break of monolithic and porous films based on polyvinyl chloride modified with carbon fiber.

The analysis of the data showed that the filled monolithic and porous films are characterized by a general tendency to reduce the elongation and strength when introducing carbon fibers. It should be noted that the samples cut in the direction of the squeegee movement have higher physical and mechanical properties. This is because the carbon fibers are mostly aligned along the doctor's motion, and their atoms are combined into microscopic crystals that are aligned parallel to each other, giving the fiber a higher tensile strength.

From the diagrams (see fig. 1–4), it can be seen that, in comparison with unfilled monolithic films, a noticeable decrease in these properties of filled films is achieved with a low content of carbon fiber – 0.25 wt.h. per 100 weight parts of PVC. A further increase in the degree of filling of the films with carbon fiber to 0.75% by weight practically does not affect the decrease in strength properties. If the filling level exceeds 0.75 wt. h., there is a secondary decrease in the physical and mechanical properties.

The decrease in elongation at the break of the filled films is associated with the sorption of the plasticizer by carbon fiber and a decrease in its content in the polymer matrix. With an increase in the content of carbon fibers, the proportion of the adsorbed plasticizer increases, the stiffness of the polymer matrix increases, and the elongation at break decreases, which is confirmed by experimental results. However, the increase in stiffness should be accompanied by an increase in strength, which, according to experimental data, monotonically decreases. The explanation of this effect is associated with the forma.

Technologies of processing of PVC plastisols allow to receive films with various degrees of rigidity: rigid, soft, ultra-soft. The content of the plasticizer in it varies from 40 to 100 weight parts. At 100 wt.h. of PVC, it is obvious that the amount of plasticizer affects the properties of PVC films, and an increase in the content of plasticizer leads to an increase in the quality of mixing the components of plastisol.

Recipe for obtaining a film based on polyvinyl chloride

Component Name	Bulk parts per 100 wt. h. PVC
PVC-E	100
DOF	60-70-80-90
DOS	10
StCa	1,5
$CH_3(CH_2)_{16}COOH$	2

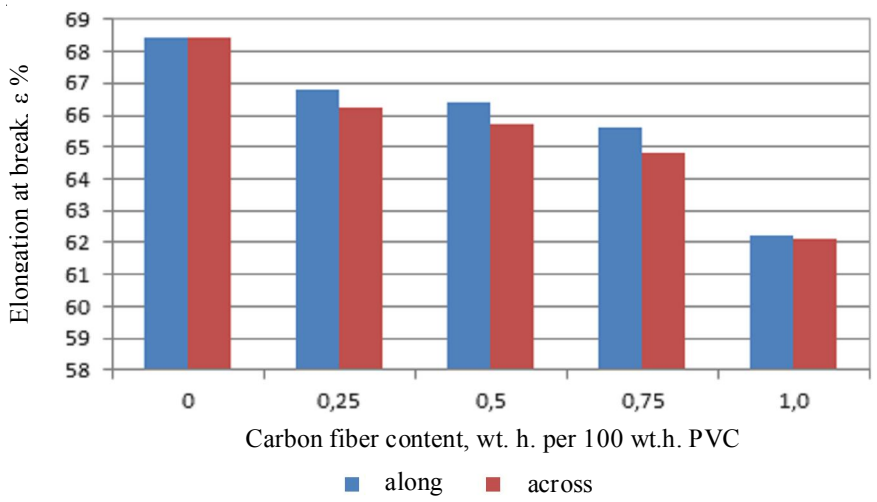

Fig. 1. Diagram of elongation at break of monolithic PVC-based films filled with carbon fiber

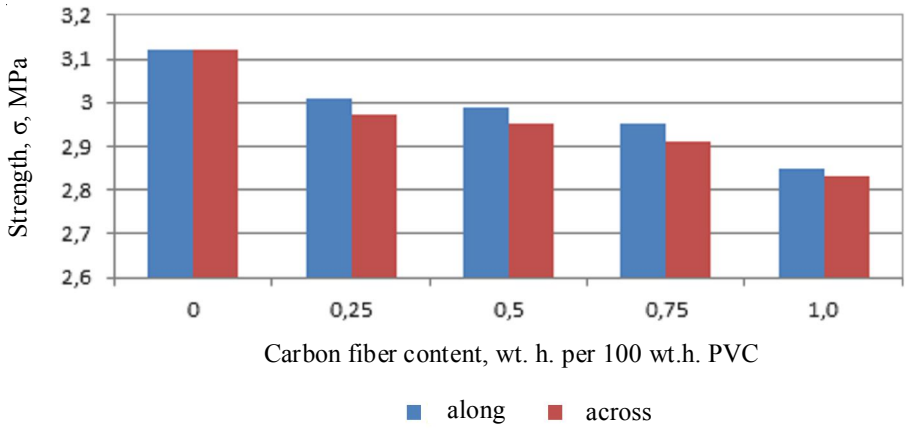

Fig. 2. Diagram of the tensile strength of monolithic PVC-based films filled with carbon fiber

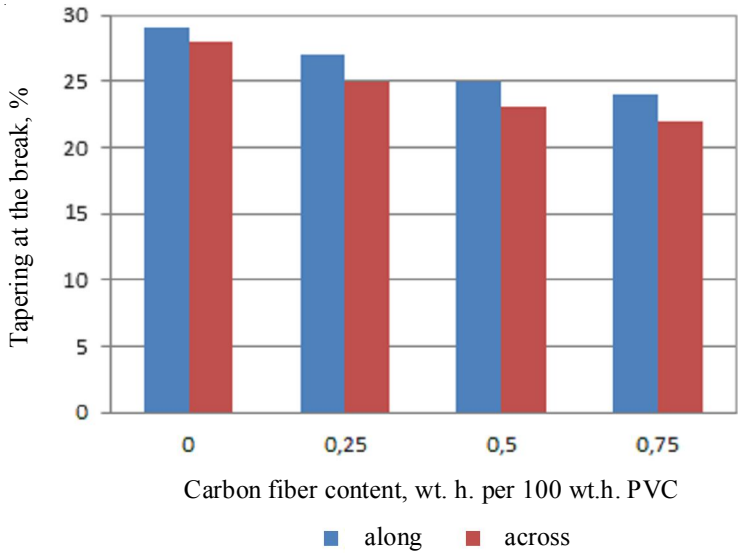

Fig. 3. Diagram of elongation at break of porous PVC-based films filled with carbon fiber

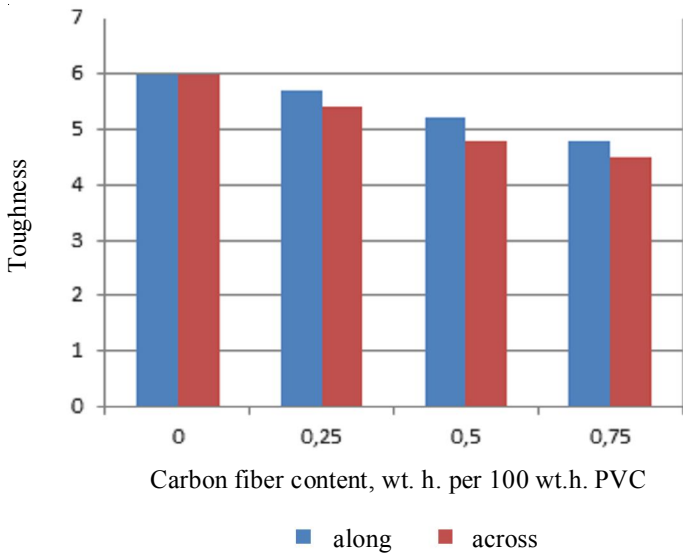

Fig. 4. Diagram of the tensile strength of porous PVC-based films filled with carbon fiber

In order to obtain polyvinyl chloride films and evaluate the effect of the plasticizer on radio absorption, films with different plasticizer content were obtained. The basis was a standard recipe based on PVC, which is often used in the domestic industry for the production of polymer films. The amount of DOP was from 60 to 90 wt. h. per 100 wt. h. PVC in increments of 10 wt. h. At the same time, the DOS content remained unchanged – 10 wt. h. per 100 weight parts of PVC.

When testing the technology for manufacturing plastisols and films, it was found that the introduction of carbon fibers in an amount of less than 0.25% by weight did not provide an effective level of absorption of the material. For the production of monolithic films with an increase in the filler content of more than 1.5% by weight. From the organoleptic point of view, the films became rigid and had obvious defects-alternating transparent areas and areas of crumpled filler. In the case of porous films, the increase in the carbon fiber content did not affect the technological parameters of plastisol, the film was formed evenly. The introduction of a filler with more than 1.25 wt.h. is not recommended, this leads to a significant decrease in the efficiency of the absorption of the material by electromagnetic radiation.

Thus, the amount of imported carbon fiber was in the range of 0.25 to 1.5 weight parts. per 100 weight parts of polyvinyl chloride for monolithic films and from 0.25 to 1.25 weight parts per 100 weight parts of PVC for porous films, the division is 0.25.

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ИССЛЕДОВАНИЕ ФИЗИКО-МЕХАНИЧЕСКИХ СВОЙСТВ РАДИОПОГЛОЩАЮЩИХ МАТЕРИАЛОВ

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Аннотация. В работе исследуются физико-механические свойства радиопоглощающих материалов. Показано, что для обеспечения эффективного уровня поглощения материала необходимо введение углеродных волокон в количестве не менее 0,25 % по массе.

Ключевые слова: электромагнитное излучение, радиопоглощающие материалы, физико-механические свойства, углеродные волокна, пластификатор.