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PROPERTIES OF EPOXY MATERIALS WITH DIFFERENT NANO-MODIFIERS

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Summary. The work is the analysis of reseatch sources conducted on issue of manufacture and application of nanomodifiers.
The mechanism of co-operation of nanomodifiers is studied with a polymeric matrix at a molecular level, the technological modes of the process of forming of polymeric composite materials are considered along with nanodispersion structures and physical and mechanical properties of nanomodifiers epoxy materials.

Key words: nano-modifier, matrix, graphite, shungite.

INTRODUCTION

In the far-term, nanostructured materials, especially carbon, are attractive for many application.

Application of new nanomodifiers and nanotechnologies space system engineering, inorganic, biotechnology, nanoelectronics, building and medicine [1- 3].

Therefore visualization or device confirmation of structure and properties of new materials is a current task.

TASK AND RESEARCH METHODS

The purpose of our work is research of properties of epoxy materials with different nanomodifiers. A research object are modifiers of different nature - carbon materials with a different structure.

As a method of research an X-ray analysis was utilized.

Authentication of standards was conducted with the use of tables [4].

MODIFIER

Dispersion of powders is calculated by the formula:

$$\beta = \xi\lambda/D \times \cos\theta,$$

where
θ- are corners of reflection «at a sole»;
D- is a middle size of crystallites;
ξ- is a multiplier, taking into account the form of particles and indexes of reflecting plane, with the range of changes from 0,98 to 1,39, in practice accepted ξ=1.
β- is an integral width, $\Delta 2\theta = 2\theta_2 - 2\theta_1$.

Information of sizes of crystals, expected on widening of lines on X-ray photograph satisfactorily coincide with information of electronic microscopy.

Authentication of modifiers on X-ray showed the following:

a) diamond powder (fig. 1) contains two crystalline structures of carbon - diamond and graphite. The indexes of planes are distinctly determined and given in a table 1.

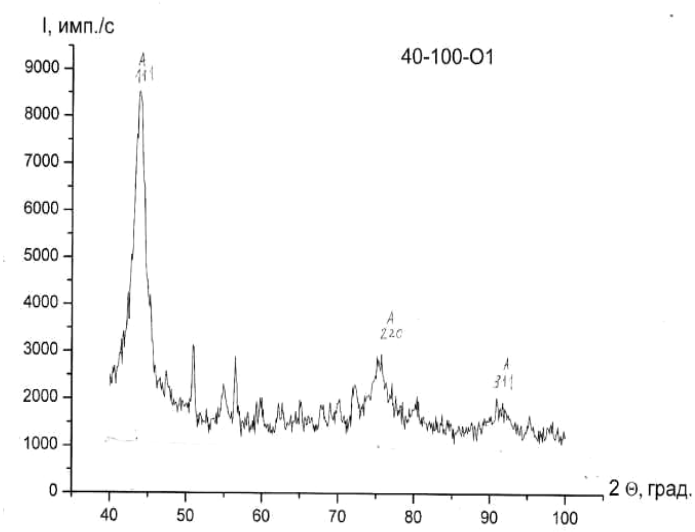

Fig. 1. X-ray of diamond powder

Table 1. **Decoding of X-ray**

Intensity	Indexes (h, k, l)	Type
100	111	Diamond
22	220	Diamond
11	311	Diamond

Correlation of diamond and graphite is approximately **4:1**. Dispersion is 5-50 nm.

в) shungit (fig.2), natural material of shungit contains from 30 to 70% carbon utillized in our experiment there is carbon in one of varieties. Material of texturired with expressl orientation of graphite on a plane **002; 004** and by maintenance of SiO_2 more than 50%.

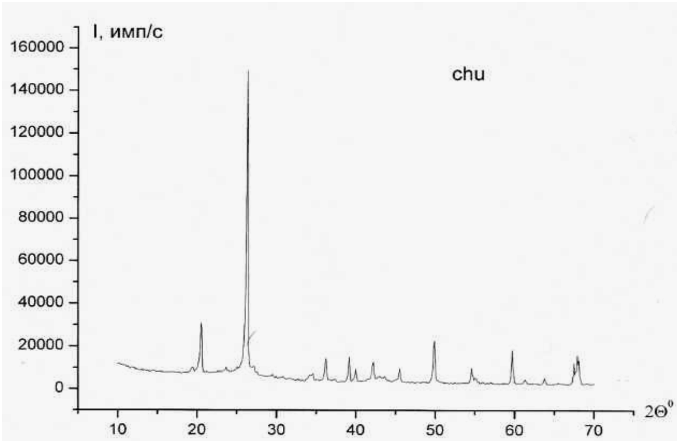

Fig. 2. X-ray of shungit

c) graphite produced in Ukraine has the same crystalline structure as shungit (fig. 3).

Unlike shungit it does not have any considerable admixtures (you will compare the fig. of 2 and fig. 3).

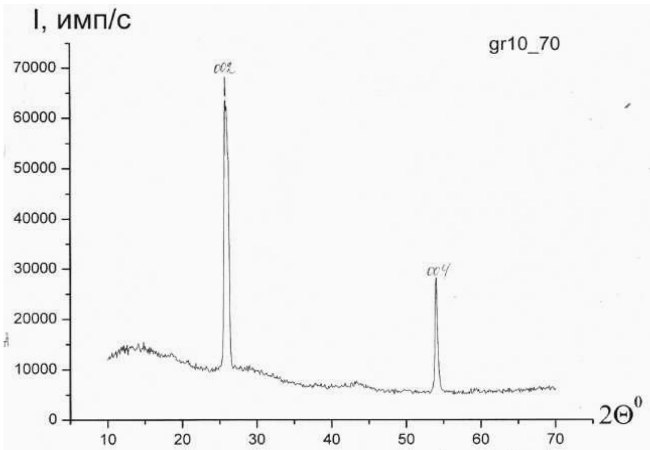

Fig. 3. X-ray of graphite

This choice is conditioned by comparative availability of these materials and possibility to vary physical and chemical properties of composits materials by the use of natural or produced on industrial scales nanomodifiers that will allow not to increase an expense as compared to expensive by carbon modifiers.

THECHNOLOGY

Epoxy resins has active groups, participating in the process of polymerization, in this case formations of the reticulated structure at introduction of hardener are active groups:

apoxy hydroxide

$- CH - CH_2$ (with O bridging) OH-

Hexametildyomin is a hardener - $NH_2\,(CH_2)_6\,NH_2$.

For finding out mechanism of co-operation of matrix with the hard phase of a modifier a series of samples with modifiers from 1 to 20 % .

A dried modifier was entered into hardener carefully mixed and dried out at the temperature of t=120^o C. With to stopping of selection of bubbles of air.

Hardening polymerization of samples was conducted on the modes:

- on air (20-40^{0}C) 6 hours;
- on air (20-40^{0}C) 2 hours + 5 hours at the temperature of 120 ^{0}C.

Therefore we entered carbon filler from 1 to 10 % periodically and a few standards with maintenance of modifier to 20%.

PROPERTIES OF EPOXY COMPOSITE

The structure and mechanical properties epoxy material was studied.

In table 2 show mechanical properties of epoxy with different levels of epoxy with different levels of modifier.

Table 2. **Mechanical properties of epoxy with carbon of modifier**

Epoxy: modifier Ratio	Tensile Strength (MPa)	Modulus (GPa)	Literature
100:0	64.71	2.43	1
100:2.5	67.82	2.61	6
100:5	63.46	1.0	5
100:7.5	62.23	0.9	5

Comparative descriptions (E, GPa) of composite materials initial and modified show the increase of tensile strength at compression to 10% for oncy 2-5% of modifiers.

The scientists of Ukraine receire electrically condactive composites on the basis of epoxy polymer and thermally widened graphite, able to change to five orders of electrical resistend [5].

Analysis of X-ray of the series of samples, modified shungit and graphite shows a considerable change in the structure of polymer, which change testifies intensity of maximums, characterizing structurired blocks and distances between them in a polymer, depending on the amount of the entered modifier.

CONCLUSIONS

1. Method of X-ray studied structure of different modifiers and epoxy without modifier, and with modifier.
2. Investigaishin mechanical properties epoxy with carbon modifier.
3. The obtained results show the increase of crystallinity, what confirms the offered mechanism of the effect of nano-modifiers on epoxy material.

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СВОЙСТВА ЭПОКСИДНЫХ МАТЕРИАЛОВ С РАЗЛИЧНЫМИ НАНОМОДИФИКАТОРАМИ

Малков И. В., Бондарь Л. П., Макухин А.Г., Сыровой Г.В.

Аннотация. В работе дан анализ научных основ предполагающий получение и применение наномодифицированных материалов.
Изучен механизм взаимодействия наномодификаторов с полимерной матрицей на молекулярном уровне, показана связь структуры наномодифицированного материала и его физические и механические свойства.

Ключевые слова: нано-модификатор, матрица, углерод, шунгит.