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Aspects of Intellectualization of Polymer Composite Materials

The aspects of intellectualization of polymer composite materials are considered. It is noted that of particular importance is intellectualization for structural polymer composite materials intended for operation under extreme conditions of high mechanical impact, including alternating loads, and temperature differences.

Throughout the world, over the past decades, there has been a strong demand for intelligent materials (IM), primarily for innovative polymer composite materials (PCM) [1-8], in particular, intelligent PCM (IPCM) and products from them. This is due to the fact that the use of polymeric materials and plastic products from them, especially those that can react to changing operating conditions or warning of emergency situations, ie, intellectual polymer products (IPP).

IPCM and IPP are manufactured on the basis of various types of sensors and nanomodifiers, alloys with magnetic properties, fiber optic and piezoelectronic sensors, etc., which allow controlling the effect of external factors, in particular pressure, temperature, deformations and the like. At the present time, a large number of technical solutions have been developed, based on the principle of the effect of memory effect on the shape of thermomaterials, for example, thermistor couplings that are shrinkable.

The following classification of applications of nanomaterials in industry is widely used:

- nanoelectronics;
- nanoengineering;
- functional nanomaterials and high-purity substances;
- functional nanomaterials for space technology;
- nano biotechnology;
- structural nanomaterials;
- composite nanomaterials;
- nanotechnology for security systems;
- functional nanomaterials for power engineering.

One of the leading trends in the development of the world industry is an increase in the number of studies and publications in the field of nanotechnology, an increase in the number of patents on nanotechnology developments [1-8]. At the same time, the spectrum of possible applications of intelligent sensors in the composition of composite materials is increasing.

At the present time, intensive scientific research is being conducted in the direction of creating technologies and equipment for the production of IPCM, in particular, on the basis of experimental and numerical methods, and also modeling these processes.

These developments require continuation, addition, and improvement, especially when creating modern "self-controlled" compositions and responsible products from them. After all, now there are high requirements for obtaining the above IPCM while increasing productivity, reducing energy intensity and achieving resource-saving processes for their preparation, as well as optimizing the design and technological parameters of the process equipment.

According to the concept of the developers, the main types of IM are: IM, which are diagnosed (passive) and IM, which adapt (active). Further improvement of IM presupposes primarily the optimization of their composition and properties by means of a kind of "learning" (that is, by creating so-called intelligent designs - IC) based on the diversified use of the principles used in robotics, molecular electronics, as well as in nano- and biotechnology .

Intellectualization of PCM, for which the "intelligence" of their developers has been "transferred", is primarily aimed at ensuring the stability in time of their operational properties. This is achieved through the modification of PM components that translate such materials into materials that self-diagnose and adapt to external influences: intelligent IPM, IPCM, IFPCM.

As "modifying" components introduced in the IPCM, are widely used:

- conformal sensors, that is, sensors introduced into the material, micro- and nanosensors, materials and processes of micro- and nanosensors;
- executive mechanisms (actuators materials and processes of micromechanics), analysis, communication and control systems (fiber optic technology, micro-, nanoelectronics, micro-, nano optics, micro- and nanoprocessor technology).

For the "design" of constructs and technologists, IMs should actively react to changes in external conditions, that is, impacts applied to them. Of particular importance is intellectualization for structural PCMs intended for operation under extreme conditions of high mechanical impact, including alternating loads, and temperature differences.

These include, first of all, products and structures of automobile and shipbuilding, military-industrial complex, as well as aerospace engineering, and the like. One of the most promising areas of research in the field of IM relative to the latter is the creation of autonomous intelligent structural materials and systems based on the bioapproach to engineering design and biometric processes.

Currently, intensive scientific research is being carried out in the directions of creating technologies and equipment for the production of IPCM, in particular, on the basis of experimental and numerical methods and modeling of these processes.

Among the developments of the scientists, the research technology of the IPCM formation has been developed, in particular, by introducing into the structural material sensor elements based on optical fibers with Bregovskaya grating, which allows online monitoring of the stress-strain state of the structure during its operation.

Conclusions

Analysis of existing works also shows that despite, for example, the variety of existing components with shape memory, modern fiber optic and piezoelectronic

sensors and technologies, for example, the connection of heterogeneous cylindrical structural elements, currently there are no universal technologies and equipment for preparation of IPCM and their processing into responsible parts.

Therefore, the development of effective technical means for creating IPCM and predicting their SSS is extremely relevant for the domestic science and industry, can put these developments on a par with foreign counterparts.

This also implies the creation of new thermo- or reactive plastic IPCM with a predetermined set of properties, including the memory effect and the ability to respond to changes in force loads and the effects of other factors remains an urgent task.

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