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AN INNOVATIVE PRODUCT IN LINE WITH MODERN ENGINEERING MATERIALS AND DESIGN VALUES IS A TIME OF NEED

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ABSTRACT	KEYWORDS
In modern mechanical engineering, trends in the economy of energy and resources and ensuring optimal performance parameters of products for various functional purposes are obvious; a special place is occupied by the materials used, which must ensure the implementation of design solutions in compliance with technical requirements. documentation. Various operating conditions of technical equipment and increasing requirements for ergonomics, safety, repair and recycling require changes in traditional construction methods and new generation building materials. Modern structural materials must not only have operational characteristics parameters that correspond to the calculated values of the choice of design option, but also change these parameters during the operation of the product and ensure its adequate response to external conditions - temperature, temperature, speed, pressure. , composition of the environment, etc., the so-called concept of creating a product that meets the requirements at all stages of the life cycle of innovative products is one of the most pressing issues today. This article analyzes the methodological aspects of the selection of components of structural materials and the basis of polymer matrices used in the design of machines and technological equipment with increased performance indicators.	Machine construction, trend, economy, energy, resource, material, technical, ergonomic, safety, construction, operation, adequate, reaction, temperature, speed, pressure.

Introduction

The widespread use of structural materials based on polymer, oligomer and polymer-oligomer matrices in industry is due to high specific deformation-strength characteristics, manufacturability and processing into products using high-performance equipment and tooling, the possibility of recycling depreciated products and waste from production and processing processes. In terms of the totality of service and technological characteristics, polymer composites in some cases are superior to traditional engineering materials, and the areas of their practical application are continuously expanding in industrial sectors that determine the sustainable development of both individual business entities and state and supranational entities. Particular interest in polymer materials and compositions based on them is due to the possibility of recycling technological waste and depreciated products, which makes it possible to return a significant part of resources to the sphere of consumption without significant energy and material costs [1].

As part of the sustainable development strategy adopted by leading countries with high industrial potential, the problem of efficient use of regenerated raw materials is becoming one of the most pressing due to the increasing negative technogenic impact on the environment [2].

As is known, polymer materials in unmodified form are practically not used in industry [3]. This circumstance is due to the difference in consumer, technical, economic and technological characteristics used in each specific case of using products made of polymer materials. For example, when using polymers for the manufacture of structural and tribological products, the deformation-strength and thermophysical characteristics are insufficient to ensure the specified operational life of a friction unit, machine element or mechanism. Therefore, functional components are introduced into the matrix to reduce the intensity of adverse operational factors leading to various types of wear - antioxidants, structuring agents, reinforcing components, etc. [4].

In other cases, for example, when using multi-batch products with low strength characteristics (packaging, protective elements, etc.), the economic and technological indicators of the product - the cost of production and the manufacturability of processing and recycling of waste - are of paramount importance. Therefore, the selection of modifying components for such products is carried out according to the criteria of availability and low cost [5].

An analysis of literature sources devoted to various aspects of polymer engineering materials science [6] indicates the existence of various methodological approaches that ensure the production of products with given parameters of service characteristics, which can be formulated in a simplified form as follows:

-synthesis of polymer matrices with certain parameters of chemical composition, molecular and supramolecular structure;

-combination of industrially produced polymers and oligomers in order to form products with different levels of interaction (chemical, phase, intermolecular, etc.);

- modification of polymer, oligomeric or combined matrices by energetic influences, leading to a directed change in the molecular and supramolecular structure and intermolecular interaction [6];

- modification of industrially produced polymer, oligomeric and combined matrices with functional components in the form of particles of a certain composition, shape, and geometric dimensions [7].

Without delving into the specifics of the synthesis of high-molecular compounds of a given composition, structure and structure, which are quite widely discussed in a number of classical monographs, we note that, despite the significant difficulties of this important area of producing polymer materials on an industrial scale, due to large material, time and energy costs, and Also with a pronounced negative technogenic impact on the environment, in recent years work has been actively developing to create nanophase matrices with a set of new characteristics. This aspect is discussed in more detail in [7].

From the point of view of the effectiveness of practical application, the combination of matrices of polymers and oligomers, developed on an industrial scale, using various technological influences (mechanochemical, thermal, thermomechanical, etc.) is a more promising direction in functional polymer materials science [8]. Research carried out over a number of years by the school of academician Lipatov Yu.S. [9] and Belarusian scientists at the Institute of Medical Sciences of the Academy of Sciences of the BSSR (now the State Scientific Institution of the Institute of Medical Sciences named after V.A. Bely of the National Academy of Sciences of Belarus) prof. Pesetsky S.S., prof. Pinchuka L.S., prof. Goldade V.A. and others [1, 2, 3, 8, 9, 60-66], indicate wide possibilities for controlling the parameters of the structure of polymer matrices through the formation of copolymer macromolecules, low-dimensional aggregates and multiphase systems with high thermodynamic stability, due to the homogenizing effect on the melts of the initial components . Depending on the type of technological impact, the equipment used and the tasks formulated in the technical requirements for the composite material, it is possible to form both a predominantly copolymer matrix, due to mechanochemical synthesis in the reaction zone of the mixer, and, mainly, a multiphase system in which the modifier is distributed throughout the volume matrix polymer with a given homogeneity, providing a non-additive change in the parameters of the service characteristics of the composite. Based on thermodynamically combined mixtures, composite materials for structural and tribological purposes SAM, INGAM and their analogues have been developed.

An important aspect of this direction is the possibility of thermomechanical combination of polymer and oligomer components, both primary and after regeneration, using modern recycling technologies. This circumstance makes it possible to obtain high-grade engineering materials based on cheaper raw materials.

Within the framework of the third conceptual approach, it is possible to create functional composite materials by exposing industrially produced polymers to directed energy flows: laser, ionizing, thermal, etc. Common energy impacts include the processing of materials, semi-finished products or products with radiation of a given intensity and dose. This leads to the formation of intermolecular bonds with a given degree of structuring, which determine the parameters of deformation-strength, tribological, adhesion and other characteristics. A characteristic feature of the technology for radiation modification of polymer and composite materials is the ability to control the molecular weight of both individual segments of the cross-linked structure and sections of the matrix by changing the intensity of the energy impact. As a result, not only intermolecular structuring processes can occur, but also destruction, up to the formation of oligomeric and low-molecular products in the matrix volume and the formation of a multiphase composite based on a single-phase binder.

Using modern technologies of concentrated energy impact on components of polymer materials, semi-finished products in the form of threads, films, pipe blanks, sheets, plates, etc., as well as finished products, it is possible to form gradient structures along the cross-section and surface layers with optimized morphology.

For example, when laser irradiation is applied to a semi-finished product made of polytetrafluoroethylene (PTFE), the so-called “cotton wool” is a highly porous material with adjustable cell parameters. Ion etching of a semi-finished product made of PTFE or polyethylene terephthalate

(PET) makes it possible to obtain a developed adhesively active surface layer, which makes it possible to form products using liquid-phase adhesives.

Theoretical analysis of technological aspects of radiation materials science was carried out in the works of employees of the Institute of Mechanical Engineering of the Academy of Sciences of the BSSR.

Among the most promising directions for creating composite materials on polymer and combined matrices for the manufacture of a wide range of parts for structural, tribotechnical, decorative, protective and other purposes is the functional modification of base matrices with components of different composition, dispersion, habit and activity. This direction, traditionally developed in leading centers for the development of engineering composites, has become particularly relevant in the last decade in connection with the development of nanomaterials science and nanotechnologies.

An analysis of numerous literary sources devoted to various aspects of composite materials science [2, 10, 74-84] indicates that composites, referred to as nanomaterials in modern terminology, have been developed over the past 30 years. A characteristic confirmation of this fact is the study of composites based on thermoplastics and highly dispersed fillers (clays, mica), greases and liquids with controlled rheological and electrical characteristics, and dispersion-strengthened materials on inorganic matrices.

Among the first studies in the field of polymer nanomaterials science are the works carried out at the Institute of Mechanics and Mathematics of the Academy of Sciences of the BSSR (GNU IIMS named after V.A. Bely of the National Academy of Sciences of Belarus) by the school of prof. Struka V.A. .

Due to various circumstances determined by the regulatory framework in force in the period 1970-2000, which determines the procedure for publishing the results of scientific research, a number of works were published in a restricted access mode. For example, the studies examined the physicochemical aspects of the production and use of metal-polymers - composites based on thermoplastic polymer and oligomeric cross-linking matrices and nanodispersed (colloidal) metals (Cu, Pb, Zn, Sn, etc.). Work [86] is devoted to the use of highly dispersed metals and metal-polymers as anti-wear, electrically conductive and anti-friction additives in motor oils, hydraulic and technological media, and greases. Subsequently, these studies were developed in the works of prof. N.K. Myshkin and employees. Nanocomposite engineering materials based on combined polymer-silicate materials have been studied in the works.

The studies carried out in a number of cases stated the experimentally observed synergistic effect of a complex change in the structural parameters, deformation-strength, tribotechnical, adhesive and other service characteristics of composites containing nano-sized modifiers; mechanisms for implementing the effect were proposed, based on well-established ideas in the field of physical chemistry and technology polymer materials.

At the same time, as previously noted, given the variety of low-dimensional modifiers used, differing in composition, structure, habit, production technology, charge state and other parameters that determine their individuality, the problem of establishing patterns of manifestations is very relevant.

Conclusion:

It should be emphasized that at present not only there are well-established methodological approaches to the creation of functional polymer nanocomposites, but also the conceptual apparatus in this area is far from perfect.

One of the most important tasks of the science of modern polymer nanomaterials is to establish the characteristic properties that determine the transition of a dispersed particle to particles less than 100 nm in size with characteristic parameters corresponding to micro-sizes and macroparticles, for which no anomalies in service characteristics have been experimentally identified. established A number of studies have proposed the concept of a “nanostat”, which makes it possible to distribute semi-finished products, condense components in various states of aggregation, and isolate the structure and properties of low-dimensional objects obtained as a result of mechanochemical alloying. and other technologies.

It is clear that determining the properties of nano-sized objects and composites using nano-sized functional components is only possible using adequate analytical methods, including the use of new generation research equipment and improved experimental research methods.

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