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CURRENT STATUS AND TENDENCIES OF USE OF NEW MATERIALS AND TECHNOLOGIES IN THE DESIGN OF UNMANNED AIRCRAFT VEHICLE (UAV)

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СОВРЕМЕННОЕ ПОЛОЖЕНИЕ И ТЕНДЕНЦИИ ИСПОЛЬЗОВАНИЯ НОВЫХ МАТЕРИАЛОВ И ТЕХНОЛОГИЙ ПРИ ПРОЕКТИРОВАНИИ БЕСПИЛОТНЫХ ЛЕТАТЕЛЬНЫХ АППАРАТОВ (БПЛА)

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ABSTRACT

This article shows the current trend of materials and technologies are used to design and manufacture UAVs and also presents future tendencies.

АННОТАЦИЯ

В данной статье показана современная тенденция использования материалов и технологий при проектировании и производстве БПЛА, а также представлены тенденции будущего.

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Keywords: unmanned aerial vehicles, composite materials, alloys, flight time.
Ключевые слова: беспилотные летательные аппараты, композитные материалы, сплавы, продолжительность полета.

INTRODUCTION. It is possible to create a new generation of local complexes with unmanned aerial vehicles, using new high-quality materials and their technologies.

With the advent of unmanned aerial vehicles (UAVs), there is a growing interest and need for new materials and technologies for their production in UAVs models.

Today, the main part of the design elements of unmanned aerial vehicles are made of polymer composite materials (PCM). However, in developing UAVs to solve the problems that arise, foreign manufacturers consider, offer and use the most modern materials and technologies to create UAVs:

- transgenic biopolymers are used in the development of ultra-light, ultra-strong, 7 elastic materials for UUA construction;
- carbon nanotubes used in electronic systems of UAVs. In addition, carbon nanotubes are used to attenuate electromagnetic radiation in composites;
- microelectromechanical systems combining microelectronic and micromechanical elements;
- hydrogen engines to reduce noise;
- intellectual materials that change their shape (or perform a certain function) under external influences;
- intelligent composites, specially designed systems, consisting of subsystems for signal reading (exposure), its processing, functional response, feedback mechanisms, self-diagnostics and self-recovery (in reverse mode);
- self-healing materials: polymers, ceramics, metals and graphite-based materials;

DISCUSSION. Composite materials - metallic and non-metallic matrices (bases) with a given distribution of hardeners (fibers, dispersed particles, etc.);

- at the same time, composite materials allow effective use of the individual properties of the components of the composition. By combining the volumetric composition of the components, depending on the purpose, it is possible to obtain composite materials with the required strength, heat resistance, elastic modulus resistance values. Composites have a set of structural and special properties that are practically unattainable in traditional materials based on metals, polymers, ceramics, carbon and other matrices. The comparative properties of different structural materials are given in Table 1.

Table 1.

Comparative properties of different structural materials

Material	Density ρ, kg/m³	Hardness σv, МПа	Elastic module E, GPa
Carbon fiber	1500	1200	170
Boroplastic	2000	1200	270
Organoplastic	1300	2000	95
Fiberglass	2000	2000	70
Aluminum alloys	2700	600	70
Titanium alloys	4500	1100	110
Steels	7800	2100	200

In the near future, new types of specially coated fiber can be created and used in UAVs designs. The solar cells are combined, the fibers to which a thin film coating is applied are then used to produce a structural fabric capable of generating electricity for UAVs and its load. Upon successful completion of the work, a new design material will be obtained that will allow UAVs developers to create a lightweight, small-sized UAVs with a long flight life.

Significant fundamental and applied research work aimed at the formation of advanced scientific and practical knowledge should be carried out before the development of local complexes with a new generation UAVs, which is ahead of the models of major foreign competitors in terms of technical level. However, the creation of new samples of UAVs is not possible without the use of new high-quality materials and their technologies.

Therefore, one of the most important tasks of creating a scientific and technical basis for the development of local complexes with UAVs should include the creation and development of a new generation of materials with unique technical and operational characteristics superior to foreign analogues.

In this regard, the strategic directions of the development of materials and technologies for their processing, which are a key component in the creation of promising products and the formation of the necessary scientific and technical framework until 2030, should play a decisive role.

Thus, for example, in the design of the exterior of the UAVs is often used aerodynamic scheme "flying wing", which excludes the combination of vertical and horizontal tails, the air intake of the engine is covered with a material that protects against radar radiation. The engine itself is equipped with a flat nozzle that makes

it easy to use radio-absorbing materials and designs. In turn, radio-absorbing and flexible materials and coatings are widely used in the design of UAVs construction, the complex application of which can significantly reduce the visibility of UAVs in radar, thermal and optical wavelength ranges.

The following measures should be taken to improve the quality and design perfection of components in the production of new generation UAVs:

- development of modern structural materials, primarily using composite materials, including nanoparticles, as well as welded, corrosion-resistant low-density aluminum-lithium alloys, solid-phase welding technologies;
- physical integration and integration of air equipment and various systems into the UAVs body;
- improvement of modern computer technologies, including multi-processor systems for data collection, processing and storage;
- creation of automatic control systems combined with information transmission, encryption, compression systems;
- development of space technologies, as well as ensuring stable and highly stable and noise protection of communications;
- improvement of remote sensing technology (radar, optoelectronic systems, multispectral sensors);
- development and application of energy technologies, use of alternative energy sources: ultra-high-capacity batteries, solar energy, high-capacity fuel cells;
- Introduction of GPS, GLONASS satellite navigation aids and systems, as well as geographic information systems to ensure the accurate location of UAVs;
- Improving the technology of image processing, line (dot) detection;
- improving human and machine interface technology and artificial intelligence systems;
- development of high-speed control systems technology to ensure the directional stability and control of the UAVs to prevent the negative effects of aerodynamic forces and stochastic loads during flight;
- creation of a high-efficiency propulsion system that meets the requirements for energy capacity and power density, ensuring maximum flight duration and confidentiality, requiring the use of new materials and technologies;
- development of visibility reduction technology - Implementation of a special form of UAVs design and widespread use of radio-absorbing, radio-scattering and flexible materials and coatings in the design of UAVs.

Under the influence of the above factors, trends in the technical development of modern complexes with UAVs are formed. Based on the analysis of the experience of advanced countries in the creation of UAVs, we can talk about the formation of two opposite directions:

- Improving the functionality of complexes with UAVs. Including: increase of flight distance, payload and flight time in the air;
- Optimizing the shape of the UAVs and reducing its weight and measurement properties, reducing its visibility of electromagnetic radiation at wide wavelengths.

Experimental studies show that the use of composite materials can reduce the weight of a UAVs structure by 30-40% compared to the weight of a structure made of traditional metal materials. All of this provides a weight reserve that can be used to increase flight distance or payload. The use of composite materials in the aerospace industry significantly reduces the material consumption of structures, increases the material utilization rate to 90%, reduces the amount of equipment and drastically reduces the labor cost of production structures by reducing the number of parts inserted.

Fabrics, hard woven coatings, tapes, ropes, multi-phase and polycrystalline continuous fibers and yarns based on glass, carbon, barium, beryllium filament single crystals, high strength and elastic modulus organic fibers can be used as reinforcement for composites.

CONCLUSION. Therefore, it is impossible to create complexes with unmanned aerial vehicles without the implementation of the following important scientific directions of development of materials and materials science technologies:

- polymer composite materials;
- "smart" design;
- smart, flexible materials and coatings;
- layered metal-polymer, bimetallic and hybrid materials;
- metal-matrix and polymatrix composite materials;
- intermetallic materials;
- nanostructured, amorphous materials and coatings;
- monocrystalline, high heat-resistant super alloys, natural compositions;
- In the process of creating and working with materials it is necessary to use computer methods of modeling their structure and properties.

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