РЕАЛИЗАЦИЯ КОНКУРЕНТНЫХ ПРЕИМУЩЕСТВ ПРЕДПРИЯТИЯМИ РОССИЙСКОГО ВПК ЗА СЧЕТ ПРИМЕНЕНИЯ КОМПОЗИЦИОННЫХ МАТЕРИАЛОВ

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Аннотация: Актуальность данной статьи определяется необходимостью поиска эффективных направлений модернизации российской экономики в условиях негативного влияния санкционных ограничений. Одним из таких направлений может стать расширение масштабов и областей применения новых композиционных материалов. Оно должно стать одним из существенных конкурентных преимуществ, которые могут быть с успехом реализованы в стратегиях импортозамещения предприятиями российского ВПК. Тем более, что для производства современной военной техники и систем вооружений требуются материалы с новыми характеристиками, которые ранее были недоступны.

Основная цель данного исследования заключается в выявлении современных конкурентных преимуществ предприятий российского ВПК, в частности, за счет расширения масштабов и сфер применения новых композиционных материалов.

В статье обосновано, что на современном этапе модернизации экономики России применение новых композиционных материалов способствует интенсификации производства высокотехнологичной и наукоёмкой продукции. Благодаря наличию экстремальных свойств и качественно новых характеристик композиционные материалы уже сейчас используются многими предприятиями российского ВПК.

Имеющееся отставание России от развитых стран в части использования композиционных материалов может быть достаточно быстро компенсировано. Для этого следует интенсивно развивать их производство с последующим использованием для создания новых образцов военной техники и систем вооружений. При этом основные характеристики производимых уже сегодня образцов вооружений значительно опережают зарубежные аналоги.

Ключевые слова: Стратегии импортозамещения, санкционные ограничения, негативное влияние, конкурентные преимущества, композиционные материалы.

REALIZATION OF THE RUSSIAN MILITARY-INDUSTRIAL COMPLEX ENTERPRISES COMPETITIVE ADVANTAGES THROUGH THE APPLICATION OF COMPOSITE MATERIALS

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Abstract: The relevance of this article determined by the necessity to find effective ways to modernize the Russian economy in the face of the negative impact of sanctions restrictions. One of these areas may be the intensive growth and increasing scope of new composite materials. It will become one of the significant competitive advantages, which successfully implemented in the strategies of import substitution by enterprises of the Russian military-industrial complex (MIC). Moreover, the production of modern military equipment and weapons systems requires materials with new characteristics that were previously unavailable.

The main purpose of this study is to identify the modern competitive advantages of Russian military-industrial complex enterprises, in particular, by intensive growth and increasing scope of new composite materials.

The article substantiates that at the present stage of modernization of the Russian economy, the usage of new composite materials contributes to the intensification of the production of high-tech and science-intensive products. Due to the presence of extreme properties and qualitatively new characteristics, composite materials already used by many enterprises of the Russian MIC.

The existing gap between Russia and developed countries in terms of the usage of composite materials is possible to compensate. For this, their production should

intensively developed subsequent use to create new types of military equipment and weapons systems. The main characteristics of weapons produced today are already significantly ahead of their foreign counterparts.

Key words: Import substitution strategies, sanctions restrictions, detrimental effect, competitive advantages, composite materials.

Introduction

For the first time, composite materials began to use in ancient Egypt. It was there that primitive builders came up with the idea of adding straw to clay bricks so that they would not crack when fired in the sun and become more durable. More than one millennium has passed and it is already difficult to find such a branch of industrial production all over the world in which composite materials would not be used one way or another. Thus, at present, the leading branches of industrial production in the USA and Europe are actively using composite materials. If we compare the share of consumption of these materials in foreign production with the share of their consumption in the leading sectors of the Russian economy, then it will be 20 and 10 times higher, respectively. In the Russian economy, the leader in the usage of composite materials is the aircraft industry, where the share of their use reaches 15%, but in the shipbuilding industry, the share of use does not exceed 2%. Of course, in order to reduce the negative impact of sanctions restrictions, Russia should develop research and development (R&D) at a faster pace with a view to their subsequent implementation for the development of high-tech industries of its economy. As known, the military-industrial complex (MIC) always considered as one of the leading drivers for the modernization and development of the Russian economy and its industrial production, including the use of new composite materials. Due to fundamentally new characteristics, these materials used at most industry enterprises of the Russian military-industrial complex. The main areas of their use are ensuring the personal safety of military personnel through the production of protective ammunition (bulletproof vests), as well as in the areas of tank building, naval shipbuilding, rocket building, aircraft building and many others. Therefore, we can state with full confidence that the expansion of the scale and scope of new composite materials is one of the significant competitive advantages of Russian MIC. Modern features of these processes disclosed in this article.

Purpose of the study

The main purpose of this study is to identify the modern competitive advantages of Russian military-industrial complex enterprises by intensive growth and increasing scope of new composite materials. They can successfully implemented in import substitution strategies. The Russian MIC has always considered as one of the leading drivers for the modernization and development of the economy of our country. Therefore, it seems that the successful implementation of new competitive advantages in the import substitution strategies of military-industrial complex enterprises would significantly reduce the negative impact of sanctions restrictions on the economic development of Russia.

Materials and methods of research

The implementation of sectoral import substitution strategies at the present stage of Russia's economic development contributes to an intensive transition to the production of high-tech and science-intensive products. Its basis should be the active introduction of innovative technologies, improving the quality of products, modernizing all sectors of the economy. It is no coincidence that the Ministry of Industry and Trade of Russia approved 2,200 technological areas for the development of the domestic economy in the industry plans for import substitution, which determine measures to stimulate industries and leading enterprises participating in the implementation of these programs [1].

However, to date, there are still negative factors in Russia that impede the stable growth of production of industrial enterprises of the Russian economy. Among them, it is necessary to highlight the limited funding of R&D aimed at obtaining materials with fundamentally new characteristics. It entails the preservation of the technological backlog of Russian manufacturers of new generation composite materials. Therefore, a large number of domestic enterprises forced to purchase the necessary raw materials for the production of composite materials (resins and fibers) abroad. New characteristics of composite materials created by using several constituent components. The basis of these materials formed by a matrix of metal, polymer or ceramic, which additionally reinforced with fillers from different types of fibers, crystals and particles [2].

Developed system of tenders for such purchases remains a negative factor. On the one hand, it clearly spells out all the structural materials for the purchase. However, on the other hand, it completely lacks the necessary flexibility in choosing alternative solutions. In addition, the enterprises lack qualified specialists with the necessary professional competencies, knowledge and experience in the production of composite materials. Manufacturers of composite materials and large industry enterprises do not interact effectively enough that could identify those industry productions. Although they could receive an additional impetus for their development by replacing traditional materials with composite. Another difficult problem is the lack of effective technical regulation mechanisms, Russian standards for the production of composite materials, as well as methods for testing them. So, for example, only in 2015 in Russia was introduced GOST for fiberglass fabric.

At the same time, now there are all conditions for the development of the production of composite materials. Moreover, the situation in this area is gradually improving. In many ways, these conditions provided by the scientific groundwork that has been preserved at the enterprises of the military-industrial complex, the continued need to implement sectoral strategies for import substitution and increase the efficiency of interaction between enterprises producing composite materials with large consumer enterprises.

As you know, the practice of using composite materials today covers many industries. They used in the construction industry, in the production of armored glass, medical prostheses, bases for electronic circuit boards, etc. Qualitatively new characteristics of composite materials allow them to be successfully usable in the aviation, auto, ship and rocket industries for the production of military and civilian products. Elements of instruments and equipment made of composite materials using for operation in aggressive environments and at high temperatures, namely: in spacecraft, at nuclear power plants, in the production of military equipment and weapons systems.

The main types of composite materials include:

– metal-composite materials based on non-ferrous metals (copper, aluminum, nickel, etc.);

– ceramic composite materials that are produced by pressure sintering of ceramic mass with the addition of fibers with the required characteristics;

– organoplastics with organic fibers of both natural and artificial origin, which, in terms of weight characteristics, are significantly superior to products made of glass and carbon fiber;

– textolites, the basis for the production of which is a polymer matrix, and as a filler, fabrics of various nature are used.

However, polymer-composite materials (PCM) are the most widely represented. Various polymeric substances are used as a filler in PCM, which open up wide opportunities for their use in various industries, both for civilian purposes, for example, in dentistry, and for military purposes, for example, in the production of battle tanks, ships, aircraft, other equipment and systems weapons. Modern practice shows that PCMs are most effectively using in high-tech industries. Thus, engineers cannot create a modern aircraft without the use of PCM, while the share of PCM in advanced aircraft models is more than 60%. The main feature of PCM is the possibility of obtaining a certain set of characteristics by combining various matrices and their reinforcing elements. In other words, today it is possible to produce PCM with predetermined properties for their use in specific sectors of the economy [2].

For the production of PCM and products from them, there are two methods today. The first one is vacuum infusion technology. It allows you to produce products of a sufficiently large size. However, a significant disadvantage of this technology is the high cost of the used materials. Another method for the production of PCM - RTM, on the contrary, has limited application in the production of oversized products. For this reason, it is using for the production of medium-sized products, from which the entire structure is assembled. The usage of PCM for the production of large structures combines several technological processes. At the beginning of production, conventional and structural materials supplied in a certain sequence. In the course of production, they converted into PCM using one or another technology and used to assemble a specific product.

Results and discussion

Because of the studies, the features of the usage of PCM in various sectors of the Russian military-industrial complex revealed. In some of them, the share of foreign components and equipment manufactured using PCM exceeded 90% in 2016

Today, PCM is the basis for the development and creation of devices with enhanced stealth properties, which include unmanned aerial vehicles (UAVs). The use of PCM in UAV structural parts makes it much more difficult to detect them at medium and long distances.

A number of enterprises of the Rostec Corporation are currently mass-producing products from PCM for the Angara and Proton launch vehicles. Now, up to 40% of parts for such products made based on PCM, which contributed to a reduction in the weight of the launch vehicles themselves by 12%. Almost all elements of the sound-absorbing panels of aircraft engines of PAK DA, PAK FA and IL-112 aircraft produced at domestic enterprises using modern PCM. This made it possible to reduce the weight of aircraft without equipment by 20-30%, shorten the time and significantly reduce the total cost of manufacturing these aircraft as finished military-technical products within the framework of the state defense order and the implementation of industry-specific import substitution programs [3].

Today, the share of PCM application in the aircraft industry continues to grow steadily. If in the 80s of the last century the share of products from PCM was 10-15%

of the weight of the aircraft, then in modern long-haul aircraft it exceeds 60%. PCM used to manufacture the structures of the center section, fuselage, wing and tail unit. For the newest Russian aircraft MS-21 at the AeroComposite plant in Ulyanovsk, mass production of a wing structure made of PCM launched. In the aircraft industry, R&D carried out to develop the latest technologies for the production of light radar-absorbing PCMs based on nanocarbon compounds.

Thanks to the successful application of PCM in the aircraft industry, Russia is among the world's leading countries in the production of modern military aircraft. For example, on the T-50 multifunctional fighter of the fifth generation (PAK FA), the fuselage is completely made of modern radar-absorbing PCM, and the share of PCM is almost 25% of the total weight of the aircraft, excluding ammunition. In addition, due to the use of PCM, the total number of parts used to assemble the aircraft significantly reduced. Similar radar-absorbing PCMs used in the production of the fuselages of the MiG-29K/KUB and MiG-35 fighters. MIG Corporation launched a special production of high-strength carbon fiber parts, which uses materials of only Russian origin, including carbon fiber thread [4].

A number of enterprises produces various types of PCM for the needs of the branches of the Russian military-industrial complex. PCMs incorporate polymer fibers with fibrillar structures of different properties and functional purpose, the presence of which provides the most optimal combination of the duration of interaction with the damaging element and the rate of absorption of its damaging energy. The combination of these factors, in turn, makes it possible to obtain sufficiently high rates of anti-shock and anti-fragmentation protection for military personnel equipped with modern bulletproof vests. An important circumstance in this case is their relatively low weight compared to previously used samples.

Today, various types of armor protection made from PCM have appeared and successfully used. These include hybrid interlayer polymer-metal and polymer-ceramic materials, from which combined armor protection formed instead of the usual one, as well as modern nanopolymer and electroactive polymer materials. Having high shock-resistant and low weight characteristics, PCM widely used in the construction of outer skin and superstructures of warships. So, for example, in Russian corvettes of the "Guarding" type, the superstructure is completely made of lightweight PCM.

After the 80s of the last century, the use of armor protection from PCM for various purposes has become a generally recognized trend in the development of world tank building. Usage of armor protection from PCM not only made it possible to replace traditional armor made of durable steel, but also significantly increased the protection of the tank and its crew from shells of cumulative, kinetic and other purposes.

In the production of military helicopters, the protection of the cockpit in the firing sector of 360 degrees provided by ceramic-plastic armor. This effect achieved through the joint use of this type of armor protection in the “protector” shield of the cabin itself and the armoring of the crew seat backs. At present, in the production of modern helicopters, both individual hull elements and the entire hull structure made from PCM. As individual elements, we can note the production of all-composite carbon fiber blades for Mi-38, Mi-35M, Mi-28NM helicopters. The use of such propeller blades made combat helicopters more reliable by increasing the strength of the blades and increasing their engine life, which, in turn, led to an increase in their cruising and maximum speed by 10-15% [4].

The fifth generation of Russian submarines will have many elements from PCM. Such elements include a multilayer composite hull, control rudders (bow and stern), stabilizers, enclosing structures of the cabin, propeller blades, main engine shafts, etc. The launch of the production of these products began after 2020, when the production of all fourth generation submarines was completed.

Today, it is becoming commonplace for the Russian Navy to have an increasing number of warships, the hulls of which are completely made of PCM. The first unique minesweeper "Alexander Obukhov" with a total displacement of 890 tons accepted into the Russian Navy in 2016. Its body is 61 meters long and 10 meters wide. The main feature of the hull of this ship is that it is completely made of PCM in the form of monolithic fiberglass. The use of this material made it possible to increase the strength of the hull of this ship compared to the hulls of other ships made from conventional materials. In addition to increasing the strength of the hulls of naval ships, the use of PCM in the shipbuilding industry provides a significant reduction in their total mass. This circumstance contributes to an increase not only in the speed of movement by 10-20% without any modernization of the engines of the running units, but also in the mass of the payload in the form of additional units of military equipment and sets for weapons systems [4].

Among other developments of the shipbuilding industry as part of the implementation of import substitution programs, we should highlight the completion of the construction of a series of ships of project 12700 "Alexandrite". Also, export deliveries of a series of warships and ships that ensure their operation, the hulls of which are made of PCM, for the Navy of Kazakhstan and Turkmenistan were implemented. Shipbuilders planned for the coming years to set the task of expanding the geography of export deliveries. We should also notice the successful development of radar-absorbing PCMs, which used for the production of corvettes of projects 20380 and 20385. In addition to these developments, R&D is currently being carried out at industry enterprises of the defense industry, such as the Sredne-Nevsky Shipbuilding Plant, Steklonit, the Research Institute of Polymers, Dugalak, Elektroizolit and a number of others to develop fiberglass, metal foams, binder vinyl ester resins, which previously only purchased by import [4].

Other enterprises have successfully mastered the production of consoles from PCM for small and medium-sized ships, introduced technologies for the production of three-layer panels from PCM for the manufacture of sections of bulkheads, decks and superstructures of surface ships. The development of a technology for the production of ship hull elements from PCM is nearing completion. In 2017, producers created a catalog of products that are advisable to produce from PCM for the shipbuilding industry, and the production of pilot batches of such products introduced at the enterprises of the United Shipbuilding Corporation. Obtained results gave a new impetus to the use of modern PCM in Russian shipbuilding.

Conclusion

The results obtained in the course of the study allow us to formulate the following conclusions.

1. For the production of PCM, the implementation of industry-specific import substitution programs in the Russian military-industrial complex is more relevant than ever. First of all, because there is an active development and introduction into production of modern PCM and technologies for their manufacture and use. Thus, not only the competitive advantages of the Russian military-industrial complex in the production of the latest models of military equipment and weapons realized, but also the prerequisites created for the successful use of the latest PCM in civilian industries.

2. The Federal Program "Development of the military-industrial complex" establishes a requirement for a gradual increase in the volume of production of civilian products at industry enterprises of the military-industrial complex. Thus, the share of these products should increase by 1.5-2.0 times by 2025 [5]. Accordingly, we should expect an increase in the share of PCM used for its production. This circumstance allows us to be quite optimistic about the prospects for the development and implementation of import substitution programs in the Russian military-industrial complex.

3. Today, the leading enterprises of various sectors of the military-industrial complex have a significant number of projects, the implementation of which will lead to additional growth in the market and the business of suppliers. However, the successful implementation of these and other projects depends on the implementation of a consistent and balanced state industrial policy in the field of finance, planning of the state defense order and balanced protectionism of all interested participants, from government agencies to specific manufacturers of various types and types of military equipment and weapons.

References

1. Materials of the official website of the Ministry of Industry and Trade of the Russian Federation [Electronic resource]. URL - https://minpromtorg.gov.ru/ (date of the application 22.08. 2022).

2. Composite materials: what is it, properties, production and application [Electronic resource]. URL - https://fb.ru/article/264869/kompozitnyie-materialyi-chto-eto-takoe-svoystva-proizvodstvo-i-primenenie (date of the application 22.08. 2022).

3. Materials of the official website of the "Rostec" corporation [Electronic resource]. URL - https://rostec.ru (date of the application 22.08.2022).

4. Zazimko V. The use of composite materials as a driver of defense industries // New defense order: Strategies, 2017, №2(44).

5. Federal program "Development of the military-industrial complex". Approved by Decree of the Government of the Russian Federation № 425-8 May 16, 2016 [Electronic resource]. URL - https://minpromtorg.gov.ru/common/upload/files/docs/ 44[1].pdf (date of the application 22.08. 2022).