Preconditions analysis of using of technological package concept for development strategy of space metallurgy

Omelyanenko Vitaliy

Prof. Assistant, Head of Technology Transfer Organization Group of Center of Scientific and Technical and Economic Information, Sumy State University, Ukraine
E-mail: sumyvit@yandex.ua

Article
The article deals with the main aspects of the development of space metallurgy technology package in the development of the space industry as an international Intersectoral high-tech industry. Scheme of industry development based on technology transfer within the concurrent engineering is proposed.
Key words: SPACE INDUSTRY, TECHNOLOGY PACKAGE, SPACE METALLURGY, TECHNOLOGY TRANSFER, DEVELOPMENT STRATEGY

Introduction

The relevance of the study is based on the understanding that space activity is one of the areas of possible economic breakthrough for economy of any country and is characterized by extremely high multiplier effect and contributes to the development of a large number of related industries (chemical, metallurgy, mechanical engineering, telecommunications etc).

Both in technical and fundamental terms this industry is a great source of new technological results that significantly increase the efficiency of other sectors of the economy. In all space exploration scenarios and development of space industry, enabling the transition from the current satellite constellation for large-scale space colonization, precisely materials science technology and space metallurgy are leading technologies.

Analysis of research and publications

Scientific and methodological approaches of priorities selection of scientific and technological development of metallurgy in modern scientific literature are limited due to a relatively conservative way of metallurgical production. However in the case of space industry selection of priorities is relevant and is complicated by depending on the goals and development trends of the technological system of high-tech space industry [5].

In this context the research «Challenges and opportunities for 3rd generation advanced high strength steel» [3] by representatives of Severstal North America (USA) stressed the importance of development innovative of metallurgical industry enterprises for remain competitive in the global market.

Several researchers noted that the innovative development must be considered in the intersectoral level because we observe the technology convergence, especially information technologies convergence [2]. Therefore we believe that the development of the space industry and its components should also be considered from the point of its analysis as an international intersectoral high-tech industry.

The basis of the main scenarios of space exploration is an industrial group for servicing and expansion of the satellite industry and other areas of space services. Within the scenarios space industrial constellation should be superstructure on existing satellite constellation. However unlike satellites, which function as repeaters or space observation station the industrial constellation will be capable of a variety of productive activities relating to transport, installation, servicing spacecraft, development of production and the development of extraterrestrial resources, ie, it will focus on self-development (expansion) [1].

The analysis of existing studies has shown that the areas of the innovation strategy of the development of space metallurgy is given insufficient attention.

The aim of research is to analyze the technological aspect of the strategy of development of space metallurgy. For solving this problem in research system approach for the investigation of technology package and retrospective analysis of industry technological dynamics are used.

Main material

Space metallurgy is an area of science and technology, which is based on scientifically substantiated by K.E. Tsiolkovsky necessity of development of space production. In this context space metallurgy as part of the space industry solves two main tasks:

1) development of methods of installation, assemblage and repair of products in outer space;

2) production of metals and alloys with improved properties for space industry.

Trends in of space metallurgy development can't be considered separately from the generally metallurgy industry trends. For example, labor productivity in metallurgy is one of the highest in the manufacturing sector but at the same time we can note the high energy consumption and high environmental risk of production. At the same metallurgy and related industries ranks more than 46% of revenue in the manufacturing sector of the EU and 11% (1.3 trillion euros per year) of the total Gross Domestic Product. So these differences between the countries are based on the level of added value in the industry and its technological level [4].

Realizing the importance of the industry the European Space Agency (ESA) has teamed up with leading research institutions to develop new materials and technologies for space missions. According to the website European Space Area as a result of this initiative in the next few years in the metallurgical industry of the EU, especially in Norway and Switzerland, can be created more than 100,000 workplaces. Now the industry employs about 10 million people.

In the context of the need for specialization and priorities selection EU experts identified 13 promising directions of development of the industry, which include the creation of new shock– and heat-resistant alloys, high-energy power lines (based on superconductors), thermoelectric materials, catalysts for pharmaceuticals and for plastics production as well as development of new magnetic materials and biocompatible implant. Also special attention is given to the ergonomics of the new materials, which should be light, their applying should reduce the weight of aerospace and automotive devices for more than 50%.

These circumstances form the necessity of interaction within the industry technology package as well as cross-sectoral cooperation. The possibility of using the proposed earlier package approach [6; 7] is based on the fact that the industry technology package includes a list of technologies that are interrelated and are developed together.

On the basis of metallurgical complex can be defined as a interdependent combination of following groups of processes:

– extraction and preparation of raw materials for processing (mining, aglomeration, obtaining the necessary concentrates, etc.);

– metallurgical repartition which is the basic process of production of pig iron, steel, ferrous and non-ferrous metals, pipes, etc.;

– various alloys production;

– recycling of main production wastes and reception from it various new products.

According to that the objectives of the space metallurgy are the following areas:

– reducing of high rate of convective melting;

– impact on the melt ultralow temperatures;

– development and obtaining materials with superconductivity;

– development and obtaining alloys with immiscibility region;

– development and production of composite materials;

– development of materials with high strength and heat resistance.

So the development strategy of space metallurgy

can be defined as the use of innovative strategy with the environmental outline. In this regard, as the priorities of scientific and technological development of the space metallurgy we offer to consider such directions:

– new development technologies for reduction of capital costs and emissions;

– efficient technologies and modules development for producing super pure metals, alloys and composite materials;

– mini-production creation to meet domestic demand for steel products, including production of colored coatings, aluminum products;

– new development technologies for processing of man-made recycled.

As the main mechanism of technological package formation of space metallurgy we propose to consider technology transfer and system management of technology system that includes the adaptation of technology within the technology packages of projects as the main form of space industry development management.

In the context of analysis of the potential transfer of technology transfer metallurgical processes into space opens up great prospects for alloys obtaining that requires the absence of any impurities and gravity during its smelting. For these purposes it is assumed for example to use the potential of International Space Station as the orbiting laboratory and the most promising area for research.

In this context the production of superconducting materials in space can open new perspectives as in weightlessness it is possible to implement new ways to manage the phase composition of materials, degree of homogeneity, the nature and density of defects in the crystal lattice.

The development of space metallurgy can be considered as the task of high technology selection, which is the best in each case to solve the problem which is a difficult one because of the actual crossing applications of technology and equipment developed by different manufacturers.

In order to make a choice properly for particular technological problem it is necessary to consider all existing restrictions, as well as the strengths and weaknesses (SWOT-analysis) of each technology compared with competing technological solutions in the context of the parallel engineering of spacecraft.

The development of the space metallurgy based of the concept of technological package is shown in Fig. 1.

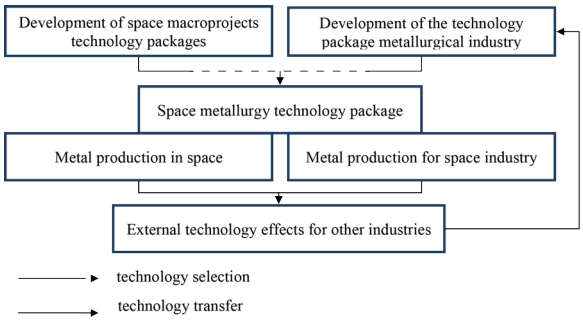

Figure 1. Scheme of space metallurgy development

The proposed scheme is based on the mechanism of selection of technologies and their further modification during concurrent engineering (e.g. the creation of the spacecraft) in creation of innovative materials and technologies for processing of materials and components for space industry.

Conclusion

The place of space metallurgy in the initial stage of space industry production chain makes it necessary to ensure the effectiveness and unity of technological standards based on cooperation. In organizational and economic terms its possible to identify two basic components of space metallurgy – direct development in the context of ensuring of competitiveness of space industry technological package and promoting the development of other industries through technology transfer. Implement of proposed mechanism is proposed through the metallurgy of technology package in context of concurrent engineering.

References

1. Grishin S.D., Leskov L.V., Savichev V.V. Space technology and manufacturing. Available at: http://www.k2x2.info/nauchnaja_literatura_prochee/kosmicheskaja_tehnologija_i_proizvodstvo/index.php
2. Skorodumov V.S., Vetyugov S.V., Bashutin A.O. System of transfer of high technologies in commercial production. Conference proceedings "Projection systems of engineering process preparation and control of life-cycle phase of industrial product CAD/CAM/PDM", 2011, Available at: http://lab18.ipu.ru/projects/conf2011/2/34.htm
3. Enloe Ch., Baker D. Challenges and Opportunities for 3rd Generation Advanced High Strength Steel at Severstal. Proceedings of the 1st International Scientific and Technological Progress in Ferrous Metallurgy, 2013.
4. Europe's new age of metals begins. European Space Agency. – 10 September 2014. – Avail-

able at: http://www.esa.int/Our_Activities/Space_Engineering_Technology/Europe_s_new_age_of_metals_begins
5. Jarvis D. J. , Minster O. (2006). Metallurgy in Space. *Materials Science Forum*. Vol. 508, p.p. 1–18.
6. Omelyanenko V. A. (2014). Analysis of Potential of International Inter-Cluster Cooperation in High-Tech Industries. *International Journal of Econometrics and Financial Management*. Vol. 2, No 4, p.p. 141–147.
7. Omelyanenko V.A. (2015). Space technologies transfer as an economic growth driver. *Economic Processes Management: International Scientific E-Journal*. No 2.