Report on the work of the dissertation Council

Dissertation Council on metallurgy and materials science the Kazakh national research technical University named after K.I.Satpayev on specialties (direction of training):
- 6D070900–«Metallurgy»;/8D07204 – «Metallurgical engineering»
- 6D070900–«Metallurgy»;/8D07201 – «Ore Beneficiation»
- 6D071000–«Materials science and technology of new materials»./ 8D07103 – «Materials Science and Engineering»

1. Data on the number of meetings held– 5 meetings.
2. Full name of members of the dissertation Council who attended less than half of the sessions: none.
3. List of doctoral student indicating the organization of training:

Paltusheva Zhaniya Urazgalievna - KazNITU named after K. I. Satpaev
Yessirkegenov Meirbek Ibragimovich- KazNITU named after K. I. Satpaev
Utegenova Meruyert Erkinovna - NJSC «D. Serikbayev East Kazakhstan technical university
Abdikerim Bekzat Erubayuly- KazNITU named after K. I. Satpaev
Makhanbetova Baktygul Alimzhanovna - Comprehensive processing of the Shalkiya deposit oxide natural and sulfide technogenic zinc-containing raw materials»
Tastanova Aisha Yerbulatovna- KazNITU named after K. I. Satpaev
Yeshmanova Gaukhar Bauyrzhankyzy- KazNITU named after K. I. Satpaev
Kuspanov Zhengisbek Boranbayuly- KazNITU named after K. I. Satpaev
Turar Kusmanovich Sarsembekov- KazNITU named after K. I. Satpaev
Ablakatov Ilyas Kabylashimuly- KazNITU named after K. I. Satpaev
Baiserikov Berdiyar Meiirzhanuly- KazNITU named after K. I. Satpaev

4. Brief analysis of dissertations considered by the Council during their porting year

№	Full name of the Doctoral student	Topics of work	Code and title of specialty
1	Paltusheva Zhaniya Urazgalievna	«Synthesis and study of the properties of nanostructured semiconductor materials for application in sensor devices»	educational program 8D07103 – «Materials Science and Engineering»
2	Yessirkegenov Meirbek Ibragimovich	Processing of heap leach solutions of copper with reduced crud formation during solvent extraction under the conditions of the Aktogay Mining and Processing Plant	8D07204 - "Metallurgical Engineering"
3	Utegenova Meruyert Erkinovna	"Recycling of metallurgical slags from lead and copper production in the context of transition to sustainable development of the metallurgical industry"	8D07202 – "Metallurgy"
4	Abdikerim Bekzat Erubayuly	«Obtaining modified sorbents on the basis of natural raw materials for uranium extraction»	educational program 8D07204 - "Metallurgical Engineering"

5	Makhanbetova Baktygul Alimzhanovna	Comprehensive processing of the Shalkiya deposit oxide natural and sulfide technogenic zinc-containing raw materials	8D07220 – «Metallurgy»
6	Tastanova Aisha Yerbulatovna	Development of a technology for processing tailings from chromite and manganese ore beneficiation to obtain pellets for ferroalloy production	8D07204 - "Metallurgical Engineering"
7	Yeshmanova Gaukhar Bauyrzhankyzy	Development of a technology for applying protective coatings of plasma electrolytic oxidation on the surface of aluminum alloys	8D07103 - "Materials Science and Engineering"
8	Kuspanov Zhengisbek Boranbayuly	«Development and study of Al-doped photocatalyst based on $SrTiO_3$ with dual co-catalysts for efficient water purification and hydrogen production»	8D07103 – «Materials Science and Engineering».
9	Turar Kusmanovich Sarsembekov	Development of a Technology for Recovering Niobium Compounds in the Production of Titanium Tetrachloride	6D070900 – «Metallurgy»
10	Ablakatov Ilyas Kabylashimuly	Research on the Development of Domestic Aluminium-Lithium Alloy *(DOU)	8D07103 "Materials Science and Engineering"
11	Baiserikov Berdiyar Meiirzhanuly	Research of ways to create domestic prepreg *(DOU)	8D07103 – «Materials Science and Engineering »

4.1 Analysis of the topic of the dissertation by Z.H. Paltusheva "Synthesis and study of the properties of nanostructured semiconductor materials for sensor devices", presented for the award of the Doctor of Philosophy (PhD) degree in the specialty 8D07103 – "Materials Science and Engineering".

The topic of this research work lies at the intersection of such relevant scientific areas as nanotechnology, materials science, sensorics, and biomedicine. The main focus of the work is on the development of highly sensitive sensor devices using nanostructured semiconductor materials—zinc oxide (ZnO) and its composite with graphene oxide (ZnO/GO). The relevance of the chosen topic is determined by the rapid development of sensor technology and the need to create next-generation sensors with enhanced selectivity, sensitivity, and response time.

Contemporary challenges in the fields of medicine, ecology, and industrial safety require the development of innovative sensor solutions for early disease diagnosis, biomarker monitoring, environmental composition control, and detection of hazardous substances. A particularly important direction is the creation of sensors for biomarkers, such as CD44 – a transmembrane glycoprotein associated with various oncological diseases. The determination of CD44 with high precision and sensitivity is a key element of early diagnosis and personalized medicine. The work is focused on the development of a fiber-optic sensor for the detection of CD44, reflecting the interdisciplinary nature of the research and its medical significance.

The application of nanostructured ZnO, which possesses unique physicochemical properties (wide bandgap, high carrier mobility, and large specific surface area), makes it especially promising for sensor applications. ZnO/GO composites enhance material functionality through a synergistic effect, improving the sensitivity and selectivity of sensors due to modified morphology and defect structures.

The conducted patent analysis and the presence of a patent in Kazakhstan confirm the originality and practical significance of the obtained results, as well as the high potential for commercialization of the developed sensors.

Thus, the topic of the dissertation is relevant, interdisciplinary, and practically oriented. The obtained results contribute to solving an important scientific and technical task—the creation of new highly sensitive sensor platforms based on nanostructured semiconductors. This opens up prospects for their implementation in medicine, analytical chemistry, environmental monitoring, and related industries.

Connection of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law on "Science" and/or state programs.

The topic of the dissertation "Synthesis and study of the properties of nanostructured semiconductor materials for creating highly sensitive sensor devices" directly aligns with the priority areas of scientific and technological development approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan, in accordance with paragraph 3 of Article 18 of the Law of the Republic of Kazakhstan on "Science".

The work is related to the following priorities:

Rational use of natural resources, including water resources, geology, raw material processing, and energy production

The development of sensor devices based on nanostructured materials can be used for environmental monitoring—determining pollutants in air, water, and soil, which contributes to ensuring environmental safety and sustainable use of natural resources.

Public health, including fundamental and applied research in medicine and pharmaceuticals

The dissertation focuses on creating biosensors for early disease diagnosis, particularly for detecting the CD44 cancer marker. This direction contributes to the development of personalized medicine, accelerated diagnostics, and improving treatment efficiency, which corresponds to the tasks of improving public health and developing medical technologies.

Information and telecommunications technologies

The use of fiber-optic sensors and their integration with digital platforms for remote monitoring opens up opportunities for the development of intelligent sensor systems and digital medicine, aligning with the direction of digitalizing the economy and society.

Fundamental scientific research

The work includes the study of the fundamental properties of nanostructured materials and the investigation of mechanisms of interaction between biomolecules and semiconductor surfaces, contributing to the development of fundamental knowledge in nanotechnology, materials science, physical chemistry, and electronics.

Connection with state programs:

State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020–2025 -- the dissertation aligns with goals to stimulate scientific research aimed at practical application and commercialization, including in biomedicine and nanotechnology.

National Digitalization Strategy ("Digital Kazakhstan") – the results of the work, especially in fiber-optic sensors and remote monitoring, correspond to tasks for implementing intelligent devices in healthcare and ecology.

Analysis of the level of implementation of the dissertation results in practical activities.

Based on the dissertation research, 19 works have been published, including:

1 article in journals indexed in Scopus and Web of Science (CiteScore percentile over 35%); 4 articles in publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan; 15 works in the proceedings of international and national scientific-practical conferences.

A patent for an invention has been obtained: Abdulllin K.A., Gritsenko L.V., Kedruk E.Y., Paltusheva Z.H. "Method for obtaining photocatalytically active zinc oxide powders" No. 35707, issued on 06.10.2022, application No. 2021/0249.

4.2 Analysis of the dissertation topic by Meirbek Yessirkegenov titled "Processing of heap leach solutions of copper with reduced crud formation during solvent extraction under the conditions of the Aktogay Mining and Processing Plant", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07204 – "Metallurgical Engineering."

In the context of increasing global production of cathode copper, one of the pressing challenges in Kazakhstan remains the processing of dilute heap leach solutions formed from the treatment of oxidized and mixed copper ores. A major technological issue during the solvent extraction stage is the formation of an interfacial emulsion layer (crud), which significantly hampers phase separation, reduces copper recovery, and leads to extractant losses. These effects contribute to considerable annual technological and economic inefficiencies.

This dissertation presents a comprehensive set of scientifically grounded approaches aimed at minimizing crud formation and optimizing copper solvent extraction. A thermodynamic analysis was conducted to investigate the behavior of impurities such as silicon, manganese, and vanadium in aqueous systems and their effect on phase interactions. The study revealed that silicon promotes colloid and gel formation, vanadium alters the acidity of the system, and manganese reduces extractant selectivity. The research also established how these impurities compete with Cu^{2+} ions and contribute to the formation of difficult-to-separate phases at the organic–aqueous interface.

The proposed technology incorporates modified extractants from the Acorga series (M5640, M5774), the crud-suppressing additive CR60, and the coagulant POLYPACS-30. These allow a 3.2-fold reduction in crud volume and increase copper extraction efficiency up to 98.84%. A method for crud processing by centrifugation was developed, enabling separation into three distinct phases: organic, aqueous, and solid. The experiments further explored the effect of varying concentrations of extractants and additives on crud volume, copper recovery, and phase stability.

As a result of laboratory and scaled-up testing with pregnant leach solutions from the Aktogay Mining and Processing Plant, a solvent extraction–electrowinning (SX-EW) flowsheet was developed and adapted to local production conditions. Practical recommendations were made for industrial implementation, taking into account the composition of the solutions and the plant's infrastructure.

The findings of the dissertation have high practical value for improving the techno-economic performance of hydrometallurgical operations, reducing extractant and copper losses, and enhancing environmental outcomes. The technology is also applicable to other mining operations with similar leaching conditions.

Connection of the dissertation topics with the directions of science development, which are formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and (or) state programs. The dissertation aligns with the national research priority "Ecology, Environment, and Rational Use of Natural Resources," and falls under the specialized scientific direction "Advanced Processing of Mineral and Organic Resources" as defined by the National Scientific Council under the Government of the Republic of Kazakhstan.

The field of research corresponds to the classifier: "Engineering and Technology; Materials Engineering; Metallurgy."

The research was conducted within the framework of the following grant and program-targeted projects:

AP14871587 "Development of a comprehensive technology to reduce crud formation during copper solvent extraction" (2022–2024)

AR19175411 "Development of a technology for intensifying the copper electrowinning process" (2023–2025)

BR21881939 "Development of resource-saving energy-generating technologies for the mining and metallurgical sector and establishment of an innovation engineering center" (2023–2025)

Analysis of the level of implementation of the results of the dissertation in practice. A total of 7 scientific articles were published, including 2 in journals indexed in the Web of Science database (Q1, Q2), 1 in Scopus (41st percentile), 4 in journals recommended by the Committee for Quality Assurance in Science and Higher Education (MES RK), and 1 conference paper. A positive decision was received for the patent application No. 20524/0449.1 dated 03.06.2024. A monograph was also published:

Chepushtanova T.A., Yessirkegenov M.I., Mamyrbayeva K.K., Merkibayev Y.S. Sustainable Development of Copper Hydrometallurgy – Principles and Technologies for Crud Reduction during Solvent Extraction of Copper. – 2024. – 136 pages. ISBN 978-601-08-4140-6.

Thus, the technological solutions proposed in the dissertation demonstrate a high degree of scientific and practical significance. They offer a relevant contribution to improving copper solvent extraction with minimal environmental and operational losses.

4.3 Analysis of the topic of the dissertation by Utegenova M.E. "Recycling of metallurgical slags from lead and copper production in the context of transition to sustainable development of the metallurgical industry ", presented for the award of the Doctor of Philosophy (PhD) degree in the specialty 8D07202 – " Metallurgy ".

The subject of this research work is at the intersection of such relevant scientific areas as metallurgy, materials science and new materials. The main focus of the work is on the processing of metallurgical slags from lead and copper production as a contribution to the achievements of a circular economy in the metallurgical industry. The relevance of the chosen topic is due to the need to introduce effective technologies for processing metallurgical slags, which corresponds to the strategic national priorities of Kazakhstan to ensure environmental safety, increase resource efficiency and implement the concept of a "green economy". In addition, this area is consistent with the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan until 2060. The use of man-made waste from metallurgical enterprises of the country, such as lead and copper slags, to obtain new materials with specified properties is an important step in solving urgent technological problems facing the industry of Kazakhstan.

The problem of metallurgical slag disposal is relevant all over the world. Processing of metallurgical slags allows to reduce the volume of burial and reduce the need for primary resources, which is an important step towards a circular economy and sustainable development. The proposed technological scheme of complex processing of metallurgical slags of lead and copper production provides for the initial leaching of residual concentrations of valuable components, followed by processing and synthesis of new multi-purpose ceramic materials from a mixture of metallurgical slags and natural raw materials in the form of granules, tablets, blocks, Lego bricks, tiles. As a result of the scheme implementation, land plots are freed from accumulated industrial waste, which allows them to be used for agricultural purposes, construction or recreational areas.

The interdisciplinary nature of the work is confirmed by the use of a wide range of physicochemical methods: X-ray diffraction analysis (XRD), methods of simultaneous thermal analysis (thermogravimetry / differential thermal analysis) (TGA / DTA), optical microscopy (OM) and scanning electron microscopy (SEM), the HSC 9 software package for calculating thermodynamic reactions and constructing diagrams of metallurgical processes, the SolidWorks Flow Simulation software package for modeling the extrusion process. The study is aimed not only at a fundamental understanding of slag recycling processes, but also at creating a technology applicable on an industry scale.

Thus, the topic of the dissertation is relevant, innovative and practically oriented. The results obtained contribute to solving an important environmental and technological problem -

the processing of metallurgical slags from lead and copper production, including additional extraction of residual concentrations of valuable components (Pb, Cu, Zn) and the subsequent use of slag residue in the synthesis of new ceramic materials.

The conducted patent analysis and the presence of a patent of the Republic of Kazakhstan confirm the originality and practical significance of the obtained results, as well as the high potential for commercialization.

Connection of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law on "Science" and/or state programs.

The topic of the dissertation corresponds to the priority direction of scientific development "rational use of natural resources, including water resources, geology, processing, new materials and technologies, safe products and structures". The area of research in accordance with the Classifier of scientific areas "Engineering and technology; Materials engineering; Metallurgy".

The dissertation was carried out within the framework of research projects financed by the Ministry of Science and Higher Education of the Republic of Kazakhstan:

- GF scientific research "Development of technology for obtaining new ceramic materials based on domestic natural raw materials and man-made waste of metallurgical enterprises of Kazakhstan" for 2018 - 2020;
- GF of young scientists "Zhas Galym" "Development of digital production of advanced ceramic materials synthesized from natural raw materials and semi-finished products of non-ferrous metallurgy" for 2024 - 2026.

Analysis of the level of implementation of the dissertation results in practical activities. Based on the results of dissertation research, 15 works were published, including: 3 articles in publications indexed in Scopus and Web of Science databases (CiteScore percentile indicator is more than 35%); 3 articles in publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan and 7 works in collections of International and Republican scientific and practical conferences.

A patent for utility model RK No. 5394 RK dated 09/25/2020 "Method for producing a granulated carrier for a catalyst" was received and a patent for invention reg. application number 2024/0968.1 dated 11/11/2024 "Method for increasing the mechanical strength of ceramics" was filed (at the stage of examination on the merits).

4.4 Analysis of the topic of the dissertation by Abdikerim B.E. "Obtaining modified sorbents on the basis of natural raw materials for uranium extraction", presented for the award of the Doctor of Philosophy (PhD) degree in the specialty 8D07204 – "Metallurgical Engineering".

The subject of this research lies at the intersection of several current scientific fields, including technologies for the treatment of liquid radioactive waste, sorbent chemistry, and the processing of industrial waste materials. The primary focus of the study is the development of a cost-effective and efficient technology for modifying natural minerals — zeolite and shungite — to create high-performance sorbents for the extraction of uranium from low-concentration solutions.

The relevance of this research direction is driven by the increasing scale of uranium mining, especially in Kazakhstan, where in-situ leaching (ISL) is the main method used. This process results in the formation of significant volumes of liquid waste, with uranium concentrations ranging from 0.01 to 10 mg/dm³. The treatment of such waste requires accessible, low-cost, and efficient sorbent materials.

The scientific novelty of this work lies in the use of phosphorus slags — industrial waste from yellow phosphorus production — as modifiers for natural sorbents. These slags are primarily composed of wollastonite and phosphorus-containing compounds that show high reactivity toward uranyl ions. Activation of the slags in carbonate and chloride media enables the formation of a porous structure, lattice defects, and the stabilization of functional groups, thereby enhancing the sorption performance of zeolite and shungite. This led to the development of new solid-phase extractants with a sorption capacity reaching 38 mg/g for uranium.

The study also addresses the issue of sorbent regeneration. For the first time, the mechanism of uranium desorption using sodium carbonate was investigated, achieving an efficiency of up to 70%, thereby demonstrating the feasibility of reusing modified shungite, which improves the economic viability of the technology.

The interdisciplinary nature of the work is supported by the use of a wide range of physicochemical analysis methods, including X-ray diffraction (XRD), infrared spectroscopy (IR), scanning electron microscopy (SEM), and various chemical analysis techniques. The research is aimed not only at gaining a fundamental understanding of the modification processes but also at developing an applicable industrial-scale technology.

In conclusion, the theme of this dissertation is highly relevant, innovative, and practically oriented. The results contribute to solving an important ecological and technological problem — the extraction of uranium from liquid waste using inexpensive and locally available materials, with significant potential for application in the nuclear industry and radiation safety systems..

Connection of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law on "Science" and/or state programs.

The topic of the dissertation corresponds to the priority area of scientific development: "Ecology, environment, and rational use of natural resources". It is also aligned with the specialized scientific direction "Deep processing of mineral and organic resources" of the National Scientific Council under the Government of the Republic of Kazakhstan.

The research area, according to the Classifier of Scientific Fields, falls under: "Engineering and Technology; Materials Engineering; Metallurgy."

The dissertation was carried out within the framework of program-targeted funding projects:

"Development of a technology for selective extraction of uranium from productive solutions of uranium production using modified natural minerals" (2018–2020);

"Development of methods for modifying natural sorbents for uranium extraction using industrial waste" (2020–2022).

Analysis of the level of implementation of the dissertation results in practical activities.

Based on the results of the dissertation research, 14 scientific works have been published, including: 6 articles in journals indexed in Scopus and Web of Science databases (with a CiteScore percentile exceeding 35%); 2 articles in journals recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan; 6 conference papers published in the proceedings of international and national scientific-practical conferences.

The following patents for inventions have been obtained:

- Kenzhaliev B.K., Surkova T.Yu., Berkinbayeva A.N., Dosymbayeva Z.D., Chukmanova M.T., Abdykerim B.E. Patent for invention "Method for Uranium Extraction by Sorption" Registration No. 2019/0116.1, Patent No. 34401;
- Kenzhaliev B.K., Surkova T.Yu., Berkinbayeva A.N., Abdykerim B.E., Yesimova D.M., Abikak E.B., Bektaev M.E. Patent for invention "Method for Uranium Extraction from Aqueous Solutions" Registration No. 2021/0255.1, Patent No. 35747.

4.5. Analysis of the topic of the work of B.A. Makhanbetova "Comprehensive processing of the Shalkiya deposit oxide natural and sulfide technogenic zinc-containing raw materials ", submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D07220 - Metallurgy.

- The subject of this research paper is devoted to solving an urgent problem - improving the efficiency and environmental sustainability of complex processing of hard–to-enrich zinc-containing raw materials, including both natural oxide ores and man-made sulfide ore waste from the Shalkiya deposit.
- In conditions of depletion of readily available resources and the growth of man-made accumulations, the development of integrated processing technologies is becoming a priority task for the mining and metallurgical complex of Kazakhstan. A distinctive feature of the deposit is the presence of significant up to 50% silica content in the ores. Indigenous sulfide ore belongs to hard-to-enrich and flotation processing extracts 77% of zinc from the ore into zinc concentrate, and 56% into lead. In the tailings of enrichment, the mass of which is at least 0.9 tons per 1 ton of ore, 23% Zn and 44% Pb are transferred. With the tailings of sulfide ore enrichment, all silica and iron are also lost. In addition, there is a problem of complex processing of the oxidized ore of this deposit, containing ∑ Zn and Pb 3-3.8%, 40-50%SiO2. These ores are practically not processed and are exported to landfills or processed together with sulfide ore, thereby worsening the enrichment rates. Based on this, it is currently important to create a new technology with a significant increase in the extraction of not only base metals, but also a non-metallic component, silica, into the target product for the complex processing of oxidized ore and tailings of Shalkium ore.
- For the first time, the features of processing two different types of zinc-containing raw materials for the Shalkiya deposit have been comparatively analyzed: natural oxide and man-made sulfide origin.
- A technological scheme has been developed for the complex electrothermal processing of oxidized zinc-containing ores from the Shalkiya deposit and tailings of sulfide ore processing with the simultaneous production of siliceous ferroalloys and zinc sublimates with the replacement of scarce steel shavings with magnetite concentrate
- Based on the experimentally obtained mathematical models, the optimal process parameters (amount of coke, amount of steel shavings, degree of replacement of iron contained in scarce steel shavings with iron contained in the magnetite concentrate) were determined for producing ferrosilicon of FeSi25 and FeSi45 grades and sublimates containing 35.5-39.5% of ∑Zn and Pb from the Shalkiya oxidized ore, its concentration tailings and their mixtures, with extraction of 75-85% of silicon into the alloy and 98-99% of zinc and lead into the sublimates.
- The conducted large-scale laboratory tests on the electrothermal processing of the concentration tailings and sulfide ore mixture allowed us to establish that during the formation of FeSi45 ferrosilicon, the maximum degree of silicon extraction into the alloy (83-86%) takes place during the smelting of the tailings and the ore in the presence of magnetite concentrate. At least 98-99% of zinc and lead are extracted in the sublimates containing up to 31% of Zn and 10.1 of Pb.
- **The relationship of the topic of the dissertation with the directions of science development, which were formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and (or) state programs.**
- Compliance with the priorities of scientific and technological development of the Republic of Kazakhstan
- The topics of the work fully correspond to the priority areas of science and technology approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (in accordance with paragraph 3 of Article 18 of the Law "On Science"):
- 1. Rational use of natural resources, geology, raw materials and products
- 2. The research is aimed at increasing the completeness of zinc extraction, minimizing losses and involving man-made accumulations in economic turnover, using the non-metallic body of the Shalkiya deposit.
- 3. The work covers both applied aspects of technology and fundamental studies of phase transformations and the behavior of components at high temperatures.

- Connectionwithgovernmentprograms
- The dissertation work was carried out on targeted program financing on the topic "Development of an integrated technology for processing hard-to-enrich polymetallic ores from the Shalkiya and Zhairem deposits" within the framework of the BR19777171 program "Development of fundamentally new technologies for integrated processing of polymetallic raw materials" for 2023-2025 under contract No. 35 dated June 16, 2023 between the RSE na PHB "National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan" and the Committee of Industry of the Ministry of Industry and Construction of the Republic of Kazakhstan
- **Analysis of the level of implementation of the results of the dissertation in practical activities. The results of the dissertation work have been comprehensively scientifically tested and demonstrate a high level of publication activity.:**
- 16 scientific papers have been published, including:
- - 6 articles in international publications indexed in Scopus and Web of Science databases (CiteScore percentile from 21 to 77%), which confirms the international recognition of research;
- - 9 publications in collections of International and National scientific and practical conferences;
- Patent for invention No. 36683 KZ dated 04/05/2024 was obtained. "Method of processing high–silicon sulfide lead - zinc ores "
- The proposed technology for processing zinc-containing ores from the Shalkiya deposit and enrichment tailings can also be used for similar facilities in Kazakhstan and the CIS countries.
- Thus, the subject matter and content of the dissertation fully comply with the requirements for papers submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D07220 - Metallurgy.

4.6 Analysis of the dissertation topic by Aisha Tastanova " Development of a technology for processing tailings from chromite and manganese ore beneficiation to obtain pellets for ferroalloy production ", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07204 – "Metallurgical Engineering."

Ferroalloy production is one of the leading sectors of Kazakhstan's mining and metallurgical complex, as it is primarily based on unique reserves of chromite and manganese ores. Although Kazakhstan ranks second and fourth globally in terms of proven reserves of chromite and manganese ores, respectively, their extraction at former levels has been constrained due to declining ore quality and increasingly complex mining and technical conditions. At the current rate of extraction, chromite and manganese ore resources will last only for the next 30–35 years. Due to the depletion of rich chromite and manganese ore reserves, technogenic mineral formations generated during beneficiation processes are receiving increasing attention. During the operation of large known deposits such as Donskoy Mining and Processing Plant's Dubersai and Akzhar deposits, and the Ushkatyn-3 deposit of the Zhairem GOK, tens of millions of tons of chromite beneficiation tailings and several million tons of manganese tailings have accumulated. Although the corresponding slurry tailings contain up to 32% chromium oxide and up to 16% manganese, their beneficiation remains a rather complex technological task. In all studied cases, high recovery rates of chromium oxide and manganese were achieved through the efficient application of gravity concentration methods, including preliminary separation of slurry tailings into narrow particle-size classes to produce fine-grained conditioned concentrates. Optimal adjustment of operating parameters for jigging machines and shaking tables when processing fine-grained chromite and manganese tailings contributed significantly to these results. For the processing of fine-grained conditioned chromite and manganese concentrates, a technology for the synthesis of composite fired pellets was developed. This process uses a new universal fluxing component — ferruginous diatomite, a natural silicate raw material obtained from the Zhalpak deposit located near the Emba station in the Aktobe region. During the firing of composite chromite and manganese pellets with fluxing components, including ferruginous diatomite, their porous and fusible structure promotes, at temperatures up to 1000 °C, the formation of magnesian hedenbergite ($Ca(Fe,Mg)Si_2O_6$) in chromite pellets or hedenbergite ($CaFeSi_2O_6$) in manganese pellets. Further increasing the firing temperature to 1200 °C results in the formation of a ferrosilico-calcium binding phase within the structure of the fired chromite and manganese pellets, significantly improving their mechanical strength and enhancing their technological properties for subsequent ferroalloy smelting.

To address the issue of processing fine-grained chromite and manganese tailings, this dissertation developed a scientifically substantiated complex of solutions for the gravity concentration of technogenic chromite and manganese waste, with preliminary particle-size classification followed by the synthesis of composite fired chromite and manganese pellets and their subsequent smelting into standard-grade ferroalloys. Thermodynamic calculations of the carbothermic reduction of the main components of the composite chromite and manganese pellets demonstrated the feasibility of producing corresponding high-carbon ferroalloys.

Pilot-scale laboratory studies on the smelting of composite fired chromite and manganese pellets confirmed the possibility of obtaining ferroalloys that meet national standards as well as those of China and Germany, the main export markets for ferroalloys produced by JSC TNK Kazchrome. Based on the experimental studies, process flow diagrams for the production of composite fired chromite and manganese pellets under different slurry beneficiation schemes were developed, and their comparative technical and economic assessments were performed.

The results of this dissertation have significant practical importance for improving the technical and economic performance of mining and metallurgical enterprises, increasing the overall extraction of chromium oxide and manganese from processed ore raw materials, and enhancing the environmental performance of production processes. The developed technologies can also be applied at other similar mining and metallurgical enterprises.

The connection of the dissertation topic with the directions of scientific development, which were formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and (or) state programs. The dissertation topic is closely related to the scientific development priorities established by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan, in accordance with paragraph 3 of Article 18 of the Law "On Science" and corresponding state programs. The topic corresponds to the priority scientific direction: "Ecology, Environment, and Rational Use of Natural Resources", as well as the specialized direction: "Advanced Processing of Mineral and Organic Resources."

The research field is classified as "Engineering and Technology: Materials Engineering; Metallurgy."

The dissertation was carried out within the framework of the following scientific projects:

- "Development and testing of an improved technology for producing strong chromite pellets from fine-grained chromite concentrate and their smelting into ferrochrome" (No. AR08856229, 2019–2022);

- "Development of a technology for producing manganese pellets for the production of ferrosilicomanganese and high-carbon ferromanganese from fine-grained sludges" (No. AR09258880, 2020–2023);

- "Improvement of technology for producing chromite pellets from fine-grained sludges for the production of high-carbon ferrochrome" (No. AR09259594, 2020–2023).

An analysis of the implementation level of the dissertation results in practical activities showed that 14 scientific papers were published, including 8 in journals indexed in the Scopus/Web of Science databases, 2 in other scientific journals, and 4 presented at international scientific and practical conferences.

Thus, the proposed solutions in this dissertation possess a high degree of scientific and practical significance and represent a timely contribution to the development of technologies for processing technogenic chromite and manganese wastes.

4.7 Analysis of the dissertation topic by Yesmmanova Gaukhar titled "Development of a technology for applying protective coatings of plasma electrolytic oxidation on the surface of aluminum alloys", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07103 - "Materials Science and Engineering".

Modern advanced technologies of surface treatment of materials allow solving urgent problems in the direction of increasing the reliability and durability of machine parts and mechanisms operating in conditions of friction and aggressive environments. Since these methods make it possible to influence the phase composition and microstructure of the sample surface without affecting the entire volume of the material. The plasma electrolyte oxidation (PEO) method is the environmentally friendly and most effective method of surface hardening of treated materials. However, PEO technology is characterized by a number of problems that hinder the competitiveness of the obtained protective coatings on the surface of aluminum alloys in the global economic arena. Today, the most urgent tasks are to reduce energy consumption during processing, increase process productivity and reduce the porosity of the coatings obtained.

To solve the above problems, the dissertation developed a set of scientifically based solutions for optimizing processing conditions using environmentally friendly electrolyte formulations using special pulsed electrolysis modes. A detailed analysis of the effect of processing parameters on the transition to the soft sparking mode during bipolar PEO treatment has been carried out, and the conditions ensuring high energy efficiency of the process have been optimized. An increase in the density, wear and corrosion resistance of coatings has been established due to the introduction of silicon-containing particles into the electrolyte and their subsequent incorporation into the oxide layer. The pattern of changes in the coatings phase composition depending on the electrolyte composition and final voltage during oxidation is determined. The influence of the chemical stability of silicate electrolytes on the PEO process has been established.

The developed optimal processing modes ensure the formation of coatings with a controlled structure and phase composition, which makes it possible to achieve the required set of operational characteristics of the surface of the aluminum alloys. The development of an alternative cost-effective method based on optimizing the electrolyte composition in the unipolar PEO treatment mode, which saves energy with rapid coating growth, as an alternative to bipolar treatment in the soft sparking mode is considered the most promising approach. The use of an optimal electrolyte composition contributes to energy savings of up to 31 % when using a low current density of 50 mA/cm^2 in unipolar PEO treatment. The proposed approach is innovative, aimed at comprehensively solving the problems of high growth rate of coatings, improving their structural characteristics and increasing the energy efficiency of the process.

The proposed solutions using low-cost materials and the use of special electrolysis modes have an economic advantage over previously developed PEO modes. The results of the study make it possible to substantiate the feasibility of using the PEO method for aluminum alloys as an effective alternative to traditional technologies, expanding the possibilities of its practical application in various industries.

Connection of the dissertation topics with the directions of science development, which are formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and (or) state programs. The dissertation topic aligns with the national research priority: "Energy, advanced materials and transport" as defined by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan.

The field of research corresponds to the classifier "Technical Sciences; Materials Engineering; Coatings and Films".

The research was conducted within the framework of the following grant and program-targeted projects:

- International project FUNCOAT (functional coatings) Horizon H2020-MSCA-RISE-

2018 ("Development and design of new multifunctional PEO coatings", 823942);

- The Zhas Galim project AP25795409 "Study of surface modification of aluminum alloys by plasma electrolytic oxidation" (2025-2027).

Analysis of the level of implementation of the results of the dissertation in practice. A total of 4 scientific articles were published, including 2 in journals indexed in the Web of Science database (Q1), 1 in journals recommended by the Committee for Quality Assurance in Science and Higher Education (MES RK), and 1 publication in the conference proceedings.

Thus, the technological solutions proposed in the dissertation demonstrate a high degree of scientific and practical significance. They offer an important contribution to the development of energy-efficient technologies for obtaining protective coatings on the surface of aluminum alloys.

4.8. Analysis of the topic of the dissertation by Kuspanov Zh. B. «Development and study of Al-doped photocatalyst based on $SrTiO_3$ with dual co-catalysts for efficient water purification and hydrogen production», completed in the form of a series of scientific articles and submitted for the degree of Doctor of Philosophy (PhD) in specialty 8D07103 – "Materials Science and Engineering".

The topic of this research lies at the intersection of several relevant scientific fields: materials science, photocatalysis, and technologies for water purification and hydrogen production. The main focus of the study is the development and optimization of an Al-doped $SrTiO_3$-based photocatalyst modified with dual cocatalysts to enhance the efficiency of photocatalytic degradation of organic pollutants and water splitting under solar irradiation.

The relevance of this direction is determined by the global need for sustainable and environmentally safe technologies for hydrogen generation and water purification from organic contaminants. In the context of the growing energy crisis and the increasing pollution of water resources, the development of efficient photocatalysts capable of utilizing solar energy for the decomposition of harmful compounds and the generation of clean fuel is of particular importance. The creation of Al-doped $SrTiO_3$ with dual cocatalysts represents a promising solution, ensuring high activity, stability, and cost-effectiveness in photocatalytic water splitting and wastewater treatment processes.

The scientific novelty of the work lies in the development of an Al-doped $SrTiO_3$ photocatalyst modified with dual cocatalysts Rh/Cr_2O_3 and CoOOH for efficient photocatalytic degradation and water purification. It was established that the molten-flux method provides uniform incorporation of Al into the $SrTiO_3$ lattice without disturbing its structure, reducing the concentration of Ti^{3+} species and forming oxygen vacancies that promote improved charge transport. The deposition of dual cocatalysts by photodeposition accelerates charge separation and reduces recombination. The resulting composite exhibited high activity in the degradation of organic pollutants and stable hydrogen evolution under solar irradiation in a panel reactor with a surface area of 1 m^2.

The interdisciplinary nature of the research is confirmed by the use of a wide range of physicochemical analysis methods, including X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM, TEM), X-ray photoelectron spectroscopy (XPS), and UV–Vis diffuse reflectance spectroscopy (UV–Vis DRS). The study is aimed not only at the fundamental understanding of doping and charge generation processes in $SrTiO_3$:Al but also at the development of practical technologies for producing efficient photocatalysts applicable in scalable water purification and solar-driven hydrogen generation systems.

Thus, the topic of the dissertation is relevant, innovative, and practically oriented. The obtained results contribute to solving important environmental and energy challenges — the development of efficient and economical photocatalysts based on affordable materials for water purification and renewable hydrogen production under solar light. The proposed approaches possess high potential for implementation in systems of environmental safety and sustainable energy.

Relevance of the dissertation topic to the national science development priorities established by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with Article 18(3) of the Law "On Science" and/or state programs.

The topic of the dissertation corresponds to the priority area of scientific development "Energy, Advanced Materials, and Transport" and to the specialized research direction "New Materials and Nanotechnologies" defined by the National Scientific Council under the Government of the Republic of Kazakhstan.

According to the National Classification of Scientific Fields, the area of research falls under "Technical Sciences; Materials Engineering; Multidisciplinary Materials Science".

The work was carried out within the framework of scientific projects:

- Grant funding competition of the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan for 2022–2024, project No. AP14869381, titled "Development of a composite photocatalyst $SrTiO_3$@Al/Graphene Oxide for efficient hydrogen production via water splitting."
- Program-targeted funding project BR18574073 (2022–2024), "Development and advancement of innovative devices, materials, and hydrogen technologies for the implementation and use of hydrogen energy in Kazakhstan."

Analysis of the implementation level of the dissertation results in practical activities. Based on the results of the dissertation research, 10 scientific papers have been published, including 9 articles in journals indexed in the Scopus and Web of Science databases (with CiteScore percentile above 35%) and 1 article in a journal recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

4.9 Analysis of the topic of the dissertation by T.K. Sarsembekov "Development of a Technology for Recovering Niobium Compounds in the Production of Titanium Tetrachloride", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D070900 – "Metallurgy".

The production of titanium tetrachloride is one of the strategically important sectors of the mining and metallurgical complex of the Republic of Kazakhstan, as it provides the basis for manufacturing titanium sponge, titanium alloys and high-quality ferroalloys. This area is particularly relevant under the current conditions, which require more complete and rational use of the mineral resource base, the involvement of complex and technogenic sources of raw materials in processing, and an increase in the depth of recovery of rare and rare earth elements, including niobium. At the same time, existing technological schemes for titanium tetrachloride production are focused mainly on the target metal, titanium, whereas the behavior of niobium and other associated components at the stages of ore-thermal smelting and chlorination remains insufficiently studied, and a significant share of niobium is irreversibly lost with technogenic waste and by-products.

In the course of ore-thermal smelting and chlorination of ilmenite feedstock, a wide range of technogenic products is formed: titanium slags, off-gases and dust, condensates, tailing slurries and the slurry of spray scrubbers of chlorination units. These streams are traditionally regarded as wastes subject to neutralization or disposal, although a substantial part of niobium transferred from the initial ilmenite raw material is concentrated precisely in them. At the same time, regulatory documents and existing technological regulations mainly specify requirements for the target product, titanium tetrachloride, without addressing the issues of comprehensive utilization of niobium and reduction of losses of this valuable component.

To solve this scientific and technical problem, the dissertation of T.K. Sarsembekov develops a set of scientifically grounded solutions aimed at studying the behavior of niobium at all key stages of the technological chain "ilmenite concentrate – titanium slag – chlorination – industrial by-products" and at creating an efficient technology for recovering niobium compounds from spray scrubber slurry. Based on thermodynamic modelling of ore-thermal smelting and chlorination processes in multicomponent systems Nb–Ti–Fe–Si–Al–Cl–C–O, as well as detailed mineralogical and phase investigations by X-ray diffraction (XRD) and scanning electron microscopy with microanalysis (SEM-EDS/WDS), it is shown in which phases and mineral carriers niobium is localized in titanium slag, off-gases and dust, $TiCl_4$ condensate and scrubber slurry. It is established that the highest concentration of niobium under conditions suitable for its subsequent technological recovery is formed in the solid phase of the spray scrubber slurry, whereas in titanium tetrachloride condensate and part of the dust products the niobium content is at trace levels and does not represent practical interest.

On the basis of the obtained thermodynamic and mineralogical data, the author has developed and experimentally tested a technology for recovering niobium compounds from the solid phase of spray scrubber slurry. The technological scheme includes two-stage evaporation of the slurry with separation of the liquid titanium tetrachloride phase and its return to the main production cycle, calcination of the solid residue with conversion of niobium into stable oxide forms, and subsequent selective hydrometallurgical processing to obtain a niobium-bearing concentrate. Laboratory and pilot-scale tests have demonstrated the possibility of producing a concentrate containing approximately 12–20 % niobium, with an overall recovery of up to 23.8–23.84 % of niobium relative to its content in the original titanium slag. It has been shown that the proposed scheme simultaneously reduces losses of technical titanium tetrachloride, decreases the volume of technogenic wastes, and yields an additional product – a niobium-bearing concentrate suitable for further processing within existing or prospective rare-metal production facilities.

Based on a set of experimental studies, a conceptual process flow diagram for a spray scrubber slurry processing unit has been developed, material balances have been compiled, and techno-economic assessments of various options for technology implementation have been performed. It has been demonstrated that the organization of a dedicated slurry processing unit at operating chlorination plants requires relatively modest capital expenditures, provides a significant increase in niobium recovery into a marketable product, and reduces specific losses of technical $TiCl_4$, which together leads to improved techno-economic performance and better environmental characteristics of the plant.

The results of the dissertation have important practical significance for enterprises engaged in ore-thermal smelting and chlorination of ilmenite feedstock, primarily for titanium-magnesium production in the Republic of Kazakhstan. The developed scientific approaches and technological solutions make it possible to increase overall niobium recovery from complex titanium-containing raw materials, to involve previously unused industrial streams in processing, and to reduce the volume and toxicity of technogenic wastes.

Relationship of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and/or state programs. The dissertation topic corresponds to the priority areas of science defined by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science", namely: "Ecology, environment and rational nature management". The work also relates to the specialized scientific area "Deep processing of mineral and organic resources".

The field of research is classified as "Engineering and technology; Materials engineering; Metallurgy".

The dissertation was carried out within the framework of the following research project:
– "Титан бар шикізатты хлормен өңдеу кезінде ниобий алу" ("Recovery of niobium during chlorination of titanium-bearing raw materials") (No. [illegible] for 2024–2026).

Analysis of the level of implementation of the dissertation results in practical activities. Based on the research, 8 scientific papers have been published, including 2 articles in journals indexed in the Scopus/Web of Science databases, 3 articles published in other scientific journals and editions, and 3 papers presented at international scientific and practical conferences.

Thus, the solutions proposed in the dissertation have a high degree of scientific and practical significance and represent a timely contribution to the development of technologies for processing by-products and wastes of titanium production.

4.10 Analysis of the Dissertation Topic of I.K. Ablakatov, "Research into the Development of a Domestic Aluminum–Lithium Alloy," Submitted for the Degree of Doctor of Philosophy (PhD) in the 8D07103 "Materials Science and Engineering."

Deformable aluminum alloys are the main structural materials for advanced products in military and aerospace equipment. This is due to their low density, good technological properties, weldability, and other operational characteristics. Their composition, structure, and heat treatment regimes are constantly studied and improved due to the increasing requirements for structures. Special structural materials are required for the manufacture of military vehicle hulls and certain aerospace components. Such materials must meet the following requirements: light weight, high strength and hardness, high modulus of elasticity, good weldability, and bullet resistance.

Various aluminum alloys are used in aerospace and military equipment. Among aluminum alloys, aluminum-lithium alloys have the most promising prospects. They are distinguished by the lowest density, increased hardness, strength, and good weldability. The first aluminum-lithium alloy developed was the Russian 1420 alloy. It has a strength of up to 450 MPa, hardness of 140 HB, impact toughness up to 80 kJ/m², and 11% elongation. The 1420 alloy is characterized by low density, high corrosion resistance, good weldability, high modulus of elasticity, and sufficient strength and hardness. Compared to the D16 alloy, the 1420 alloy is 12% lighter and has an 8% higher modulus of elasticity.

Developing a domestic aluminum-lithium alloy production technology as an analogue to the 1420 alloy remains a relevant task for our country. This is due to the need to replace imported, expensive armor materials in domestic personal protective equipment and military vehicles. In particular, replacing the heavy foreign steel hulls of the domestic armored vehicles "Arlan" and "Barys," produced by Kazakhstan Paramount Engineering LLP, and the steel armor plates in bulletproof vests manufactured by Tynys JSC with domestic aluminum alloys will not only increase maneuverability but also significantly enhance bullet resistance efficiency.

The aluminum-lithium 1420 alloy has high mechanical properties, with a tensile strength of $\sigma v \geq 415$ MPa, which classifies it under export control for missile, dual-use, and nuclear products and technologies. For this reason, information about the production technology of these alloys is not published in open scientific literature, although data on their mechanical properties, applications, and elemental composition are available. Considering this, the alloy can be produced based on conventional and widely known aluminum alloy production technology: charge preparation, melting and casting in a vacuum or inert gas atmosphere in an induction furnace, degassing and filtering methods, thermal and thermomechanical treatment regimes, and welding techniques.

The technological challenges in reprocessing this alloy include: specific features of melting in an inert atmosphere, and the difficulty of chemically introducing lithium and zirconium into the aluminum-magnesium melt. These elements are typically introduced only via two- or three-component master alloys; ensuring uniform distribution of alloying elements; technologies to reduce harmful impurities; degassing and filtering, as well as other melt handling operations; optimization of plastic deformation regimes; and improvement of heat treatment regimes.

The chemical composition of the 1420 alloy by mass (%) is: Li – 2.1; Mg – 5.2; Zr – 0.11; the remainder – Al. In this alloy, the technology of introducing lithium and zirconium into the aluminum melt is one of the most complex issues. These elements can be introduced in pure form or via two- or three-component master alloys. In the initial experimental phase, the charge is prepared using different combinations and sequences of element introduction into the melt. During these experiments, the most effective methods of adding alloying elements are determined. Due to the presence of lithium, the alloy is highly prone to oxidation during melting and casting, and the introduction of high-temperature-resistant zirconium requires special technological techniques.

Experimental development of melt degassing and filtration processes also presents certain challenges. For this purpose, vacuum degassing and filtration through ceramic foam filters are used. Plastic deformation of alloy specimens is carried out on a special press under specified deformation rates and heating regimes. Thermal treatment operations for the alloy specimens are relatively simple and easy to implement. For the 1420-type alloy, plastic deformation can be performed in both cold and hot conditions. In general, this alloy has sufficient plasticity for cold deformation; however, depending on the ratio of alloying components, hot deformation may be required. Welding of the 1420-type alloy is performed using argon arc welding, which simultaneously protects the welded joint from exposure to air and moisture.

The results of the dissertation work are of significant practical importance, as the development of high-strength, ultra-light aluminum-lithium alloys and technologies for their application in the manufacture of hulls for armored vehicles, body armor, aircraft, unmanned aerial vehicles, as well as ultra-light-class launch vehicle structures for space and geophysical purposes, represents a relevant task in domestic materials science for defense and aerospace applications.

Relationship of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and/or state programs. The dissertation topic aligns with the priority scientific directions determined by the Supreme Scientific and Technical Commission under the Government of the Republic of Kazakhstan and/or with state programs, based on paragraph 3 of Article 18 of the Law "On Science."

The dissertation is connected to the 2021–2023 research program "Applied Scientific Research in the Field of Space Activities" (Republican Financial Program 008) – "Development of Basic Technological Operations for Obtaining Domestic Lightweight Alloy for the Defense and Aerospace Industry" (Republican Budget Program, IRN 00037/GF).

Analysis of the level of implementation of the dissertation results in practical activities. Based on the conducted research, 5 scientific articles have been published, including 2 articles in journals indexed in Scopus/Web of Science and 3 articles in other scientific journals and publications.

Thus, the solutions presented in the dissertation have high scientific and practical significance and make a relevant contribution to the development of aluminum production technologies.

4.11 Analysis of the topic of the dissertation by B.M. Baiserikov "Research of ways to create domestic prepreg", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07103 – "Materials Science and Engineering".

The development of technology for producing high-strength carbon prepregs with extended shelf life is a strategically important task for the aerospace and defense industries of the Republic of Kazakhstan, as it provides a foundation for the production of spacecraft hulls, load-bearing elements, components of unmanned aerial vehicles, and ultralight launch vehicles. This area of research is especially relevant in the context of the rapid development of the domestic aerospace sector, the need to reduce dependence on imported high-strength prepregs, and the restricted access to information on their manufacturing technologies due to international controls on dual-use export technologies. At the same time, existing literature on prepreg manufacturing technologies is largely generalized and insufficiently reflects key technological processes—impregnation, pre-curing, and the composition of binders—which limits their implementation and adaptation under domestic conditions.

High-strength prepregs are produced using epoxy resins, reinforcing fibers, and modifiers. However, comprehensive and reliable data on the effects of curing agents, diluents, and solvents on the mechanical properties and shelf life of prepregs, as well as on impregnation parameters and pre-curing regimes, are lacking. These factors determine the strength of the final material, its operational characteristics, and suitability for aerospace and defense applications.

To address this scientific and technical problem, the dissertation proposes a set of scientifically grounded solutions aimed at studying the effects of latent curing agents and diluent-modifiers on the mechanical and operational properties of binders, optimizing the technological regimes of carbon fabric impregnation and pre-curing, and developing a laboratory setup for prepreg production and technology development. Experimental studies have shown that the introduction of 25% diaminodiphenyl[illegible] ensures a tensile strength of 140 MPa, compressive strength of 150 MPa, and shelf life of up to 55 days. Modification of the binder with 10% pentaerythritol tetraglycidyl ether increases the binder strength from 150 to 160 MPa, reduces viscosity from 92 to 45 cP, and increases prepreg impregnation from 80 to 94%, allowing the strength of the resulting composite to rise from 560 to 590 MPa. Optimized impregnation conditions (temperature 65 °C, diluent content [illegible]%, roller gap 0.2 mm) and pre-curing regimes (temperature 120 °C, duration 20 min) ensure a maximum plate strength of 630 MPa.

Based on the comprehensive experimental studies, a methodology has been developed for the fabrication of experimental rocket hulls and tubular frames for unmanned aerial vehicles. This methodology includes prepreg lay-up, vacuum application at a residual pressure of 0.1 Pa, and curing at 170 °C for 5 hours. The resulting experimental products demonstrated tensile/compressive strengths ≥ 530/460 MPa and stability during flight tests, confirming the technological effectiveness of the proposed methodology.

The developed scientific approaches and technological solutions have significant practical value, as they enable the creation of a domestic high-strength prepreg production base, ensure the manufacture of aerospace and defense products with the required mechanical and operational characteristics, reduce import dependence, and lay the foundation for the future scale-up of the laboratory process to industrial production.

Relationship of the dissertation topic with the directions of scientific development formed by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science" and/or state programs. The dissertation topic corresponds to the priority areas of science defined by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan in accordance with paragraph 3 of Article 18 of the Law "On Science", namely: "Applied Scientific Research in the Field of Space Activities".

The dissertation was carried out within the framework of the following research project: Republican Budget Program 007 for 2021-2023 — "Development of Software and Hardware Tools and Technologies for Designing a Prototype of Solid Rocket Propellant and Internal Systems of Light and Ultralight Launch Vehicles" (Project Code BR109019/0221/PCF).

Analysis of the level of implementation of the dissertation results in practical activities. As a result of this work, five scientific publications have been produced, including three articles in journals indexed in the Scopus database and two articles published in journals recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan.

Thus, the solutions proposed in this study possess a high degree of scientific and practical significance and represent a relevant contribution to the development of high-strength composite material technologies.

5 Analys is of the work of official reviewers (with examples of the most low-quality reviews)

№	Full name of	Review ers

	the doctoral student	Full name of the first reviewer (position, academic degree, title, number of publications in the Specialty for the last 3 years)	Full name of the second reviewer (position, academic degree, title. number of publications in the specialty for the last3years)
1	Paltusheva Zhaniya Urazgalievna	Bakranova Dina Igorevna - doctor PhD, Asistent Professor of the Faculty of Engineering and Natural Sciences, Suleiman Demirel University	Atamanov Meiram Karataevich - doctor PhD, Leading Researcher and Head of the Laboratory «Energy-intensive Nanomaterials» of the Institute of Combustion Problem, there are more than 5 scientific publications on educational program 8D07103 – «Materials Science and Engineering»
2	Yessirkegenov Meirbek Ibragimovich	Aigul Kayrgeldievna Kozhimova – Candidate of Technical Sciences, Head of the Laboratory of Special Methods of Hydrometallurgy named after B.B. Beysembayev JSC «Institute of Metallurgy and Ore Beneficiation» of NPJSC «K.I. Satbayev KazNRTU» (Almaty, Kazakhstan)	Bauyrzhan Nurzhanovich Surimbaev – PhD, Deputy Director for Research at Kazmekhanobr LLP. Scientific Secretary, Senior Researcher. Almaty, Republic of Kazakhstan.
3	Utegenova Meruyert Erkinovna	Kvyatkovsky Sergey Arkadievich – Doctor of Technical Sciences, Head of the Laboratory of Pyrometallurgy of Heavy Non-Ferrous Metals of JSC «Institute of Metallurgy and Ore Beneficiation» of NPJSC «K.I. Satbayev KazNRTU» (Almaty Kazakhstan)	Dostaeva Ardak Mukhamediyevna – PhD, Professor of the Department «Nanotechnology and Metallurgy» of the NPJSC «Abylkas Saginov Karaganda Technical University» (Karaganda, Kazakhstan)
4	Abdikerim Bekzat Erubayuly	Bakranova Dina Igorevna - doctor PhD, Asistent Professor of the Faculty of Engineering and Natural Sciences, Suleiman Demirel University	Atamanov Meiram Karataevich - doctor PhD, Leading Researcher and Head of the Laboratory «Energy-intensive Nanomaterials» of the Institute of Combustion Problem
5	Makhanbetova Baktygul Alimzhanovna	Sergey Arkadyevich Kvyatkovsky – Doctor of Technical Sciences, Head of the Laboratory of Pyrometallurgy of Non-Ferrous Metals, JSC "Institute of Metallurgy and Ore Beneficiation", Satbayev University (Almaty, Kazakhstan).	Zhenisgul Telmanovna Bagasharova – Candidate of Technical Sciences, Senior Lecturer, Department of Analytical, Colloidal Chemistry and Technology of Rare Elements, Faculty of Chemistry and Chemical Technology, Kazakh National University named after Al-Farabi (Almaty, Kazakhstan).

6	Tastanova Aisha Yerbulatovna	Aitkulov Dosmurat Kyzylbiyevich – Candidate of Technical Sciences, Professor, RSE "National Center for Complex Processing of Mineral Raw Materials of the Republic of Kazakhstan.	Zhumagaliyev Erlan Ulanovich – Candidate of Technical Sciences, Associate Professor, Head of the Department of Metallurgy and Mining K. Zhubanov Aktobe Regional University.
7	Yeshmanova Gaukhar Bauyrzhankyzy	Gulmira Sharifovna Yar-Mukhamedova – Doctor of Physico-Mathematical Sciences, Professor at the Department of Solid State Physics and Technology of New Materials, Al-Farabi Kazakh National University.	Zhakanbayev Eldar Askhatovich – Candidate of Physico-Mathematical Sciences, Head of the Laboratory of Ion Plasma Technologies RSE «Institute of Nuclear Physics».
8	Kuspanov Zhengisbek Boranbayuly	Bakranova Dina Igorevna - doctor PhD. Asistent Professor of the Faculty of Engineering and Natural Sciences, Suleiman Demirel University	Shakieva Tatiana Vladimirovna – Candidate of Chemical Sciences, Director of the Scientific Research Institute of New Chemical Technologies and Materials, Al-Farabi Kazakh National University (Almaty, Kazakhstan).
9	Turar Kusmanovich Sarsembekov	Saule Amangeldyyevna Abdulina – PhD, Associate Professor of the Faculty of Metallurgy and Mineral Processing, Non-profit Joint-Stock Company "D. Serikbayev East Kazakhstan Technical University".	Bauyrzhan Nurzhanovich Surimbaev – PhD, Academic Secretary, Senior Researcher of the branch of the RSE "National Center for Complex Processing of Mineral Raw Materials", State Scientific and Production Association for Industrial Ecology "Kazmekhanobr".
10	Ablakatov Ilyas Kabylashimuly *(DOU)- Documents for Official Use	Tulepov Marat Iztleuovich – Professor, Vice-Rector for Academic Affairs at the Kazakh Automobile and Road Institute	Atamanov Meyram Karataevich – PhD, Kazakh National Women's Pedagogical University
11	Baiserikov Berdiyar Meiirzhanuly *(DOU)- Documents for Official Use	Bakhytzhan Tastanovich Lesbayev – Candidate of Chemical Sciences, Professor, "Institute of Combustion Problems".	Gulmira Sharifovna Yar-Mukhamedova – Doctor of Physical and Mathematical Sciences, Professor, Al-Farabi Kazakh National University.

6. Proposals for further improvement of the system of training scientific personnel.Increasetherequirementsfortheworkofscientificconsultants(especiallyfrom Kazakhstan)doctoralstudentsintermsoftheproposedtopicsofdissertationresearchandtheirleadershipinthetrainingofscientificpersonnel.

Data on the considered dissertations for the degree of doctor of philosophy PhD, doctorofprofile

DissertationCouncil	Code and title of specialty	
	6D070900 – Metallurgy; 8D07204 – «Metallurgical engineering»	6D071000 –Materials science and technology of new materials
Dissertationsacceptedfor defense	6	5
Includingdoctoralstudents fromother universities	2	-
Dissertationswithdrawnfromconsideration	–	–
Including doctoralstudents fromother universities	–	–
Dissertations that received negative reviews fromreviewers		–
Including doctoralstudents fromother universities	–	–
Dissertationswithanegativedecisionontheresultsofthe defense	–	–
Including doctoralstudents fromother universities	–	–
Dissertations aimed at completion	–	–
Including doctoralstudents fromother universities	–	–
Dissertations aimed at repeated defense	–	–
Including doctoralstudents fromother universities	–	–

Chairman of the dissertation Council **B. Kenzhaliyev**

Scientific Secretary of the dissertation Council **A. Mamayeva**