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»

6D074000 – «Nanomaterials and Nanotechnologies» / 8D07114 – «Nanomaterials and Nanotechnologies»

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:

- Tashmukhanbetova Indira - KazNITU named after K. I. Satpaev
- R.Zh. Abuova- KazNITU named after K. I. Satpaev
- Diana Tolubayeva - Karaganda Industrial University
- Merkibayev Yerik Serikovich - KazNITU named after K. I. Satpaev
- Dyussebekova Maral Adelbekovna - 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	Tashmukhanbetova Indira	«Thermal insulation coatings based on finely dispersed mineral granular systems»	6D071000 – «Materials Science and Technology of New Materials»
2	R.Zh. Abuova	«Development of chromium-nickel vanadium steels with dissipative properties and their surface modification by deposition of nanostructured wear-resistant TiN-Cu coatings»	6D074000 – «Nanomaterials and nanotechnology»
3	Diana Tolubayeva	Electrochemical and structural properties of nanostructured semiconductor oxides	8D07101 – «Nanotechnologies in Engineering»
4	Merkibayev Yerik Serikovich	«Processing of low grade, difficultly enrichable complex lead-zinc ores and industria enrichment products»	6D070900 Metallurgy
5	Dyussebekova Maral Adelbekovna	Development of slag depletion technology for autogenous smelting of copper sulfide concentrates	8D07204 - "Metallurgical Engineering"

4.1 Analysis of the subject of the work of Tashmukhanbetova Indira « Thermal insulation coatings based on finely dispersed mineral granular systems », submitted for the degree of Doctor of Philosophy (PhD) on speciality 6D071000 – «Materials Science and Technology of New Materials». Saving fuel and energy resources is a popular task in the field of housing and construction complex. One of the most effective ways to achieve this goal is the development of energy-saving liquid thermal insulation coatings based on polymer binders. Traditional thermal insulation materials have a number of disadvantages: the inability to protect

structures from corrosion, fire resistance, giving additional load to structural elements in construction and mold resistance due to the likelihood of water permeability – reduce the durability of their thermal insulation properties. In addition, liquid thermal insulation coatings significantly reduce labor costs when performing maintenance work and are convenient for insulating even hard-to-reach places in elements of complex structures. The development of the composition of a liquid thermal insulation coating using mineral fillers allows you to reduce the cost of production without compromising performance characteristics. This significantly increases the attractiveness of this approach and its relevance at the present time.

The solution to the problem of reducing the number of microspheres without loss of performance is possible with the use of modified binders containing finely dispersed mineral fillers. It is known that finely dispersed mineral powders have high porosity, which makes it possible to create effective thermal insulation materials based on them. Therefore, the use of micro- and nanoscale finely dispersed mineral granular fillers can significantly reduce the consumption of microspheres and create effective compositions of liquid thermal insulation coating.

In this work, a new liquid thermal insulation coating has been developed using local raw materials of the Republic of Kazakhstan as a filler with a complex of improved performance characteristics. For the first time, in the process of obtaining a liquid thermal insulation coating, full-scale climatic studies were carried out, this is a new direction for our country.

As a result of the research, it was found that ED-20 and microsilicon composite are the most effective compositions in a ratio of 80:20, the proposed technology allows to obtain liquid thermal insulation coatings based on modified epoxy resin with a thermal conductivity coefficient of 0,081-0,088 W/(m·K). This indicator is a popular task in the field of housing and construction complex – saving fuel and energy resources. The maximum performance characteristics of the created liquid thermal insulation coating have been established when applied to various surfaces in accordance with the standards.

The results obtained are of great importance in fundamental and applied materials science in the production of liquid thermal insulation coatings based on finely dispersed mineral granular systems.

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 topic of the dissertation corresponds to the scientific direction "Rational use of natural resources, including water resources, geology, processing, new materials and technologies, safe products and structures".

The dissertation work was carried out jointly with the University of Mordovia in the research laboratory of Architecture and Construction of the non-profit joint stock company KazNITU named after K. I. Satpayev within the framework of the program "Grant financing of scientific and (or) scientific and technical projects for 2020-2022 with a duration of 27 months" AP08855714 based on the project "Liquid thermal insulation coatings based on fine mineral granular systems". In addition, the implementation of the target financing program of the Ministry of Science and Higher Education of the Republic of Kazakhstan BR21882292 – "Integrated development of a sustainable construction industry: innovative technologies, production optimization, efficient use of resources and creation of a technology park" for 2023-2025 is connected.

Analysis of the level of implementation of the results of the dissertation in practice. According to the results of the dissertation research, 10 papers have been published, which are 2 articles in journals indexed in Scopus and Web of Science databases (CiteScore percentile of more than 25%), 2 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 2 papers in the collections of International and Republican scientific and practical conferences.

According to the results of the study, a protocol of experimental tests, an Act of introduction into the educational process of LLP "International Educational Corporation" and an Act of introduction (use) into the production of LLP "All Construction" were drawn up.

4.2 Analysis of the subject of the work of R.Zh. Abuova «Development of chromium-nickel vanadium steels with dissipative properties and their surface modification by deposition of nanostructured wear-resistant TiN-Cu coatings».

The strategic development of engineering in Kazakhstan, associated with technical re-equipment, increased labor productivity, and the quality of machining parts, is largely determined by the implementation of technologies based on automatic lines and flexible manufacturing systems. The reliability of their operation is conditioned by heightened requirements for the cutting tool in terms of strength, wear resistance, economic indicators, and the significant role played by mechanical impact noise. Noise in the production environment is a harmful and hazardous factor. To reduce the noise level at its source, it is necessary to replace impact processes with non-impact ones, substitute metallic materials with non-metallic ones, and employ a range of other methods that effectively combat noise levels. Despite the widespread use of technological processes, the application of damping non-metallic materials is limited due to their insufficient strength characteristics. Therefore, the question of creating iron-based alloys with enhanced damping capacity through changes in chemical composition and special heat treatment is highly relevant. However, the modification of structural materials by coating application is rarely used in practice.

Within this study, a comprehensive approach to problem-solving was proposed: the development of new steels and subsequent modification of their surfaces through the deposition of nanostructured coatings. One direction of this work is the creation of nanostructured coatings. Particularly promising is the approach to forming nanostructured coatings based on hard nitride phases with the addition of ductile metals that do not form stable nitrides and do not have solubility in the component. The metallic phase, located at the boundaries of the nucleating nitride phase, restricts their growth. Nanostructured materials with high grain boundary area exhibit high viscosity and resistance to the initiation and development of "brittle" cracks, enabling prolonged resistance to breakdown under complex external stresses. The design of a new generation of nanostructured composite coatings with a high grain boundary area envisages the ability to set a complex of high physico-mechanical properties. Given the aforementioned, this work on the development and study of properties of nanostructured ceramic-metallic coatings, aimed at creating coatings with increased hardness, adhesion, high fracture toughness, and low levels of macro-stresses to enhance the operational characteristics of structural steels, is relevant.

The objective of the study is the development of chrome-nickel-vanadium steels with dissipative properties and their surface modification through the deposition of nanostructured wear-resistant

TiN-Cu coatings. Based on the analysis and scientific level presented in the dissertation, it can be concluded that nanotechnologies are innovative and correspond to global technical indicators and development trends.

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 work corresponds to the priority direction of science development in the Republic of Kazakhstan, namely "Energy and Engineering," under the priority "Alternative Energy and Technologies: Renewable Energy Sources. Nuclear and Hydrogen Energy, Other Energy Sources," and the scientific direction of "Nanomaterials and Nanotechnologies" under the priority "Production and Processing of Metals and Materials" as outlined by the National Scientific Council under the Government of the Republic of Kazakhstan.

The research was conducted in accordance with the state program of industrial-innovative development of the Republic of Kazakhstan for 2020-2025 and was carried out within the framework of the following programs and projects:

Research grant project funded by the Ministry of Education and Science of the Republic of Kazakhstan under the registration number AR08956794 on the topic "Investigation of the Physico-Mechanical Properties of Damping Alloys with Nanostructured Coatings for Critical Automobile Parts."

Analysis of the level of implementation of the results of the dissertation in practice. activities indicates that as a result of the dissertation research, 16 works have been published, including: 3 articles in publications indexed in the Scopus and Web of Science databases (with a CiteScore percentile indicator of more than 25%); 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, and 9 papers in the proceedings of international and republican scientific-practical conferences.

4.3 Analysis of the subject of the work of Diana Tolubayeva.«Electrochemical and structural properties of nanostructured semiconductor oxide», submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D07101 – «Nanotechnologies in Engineering».

In the framework of this work, methods for the synthesis of nanostructured semiconductor oxides were substantiated: low-temperature hydrothermal method, chemical deposition method, thermal decomposition method. It was revealed that the samples obtained as a result of low-temperature synthesis have a larger specific surface area, since they are presented in the nano-range. Due to their electrochemical and structural properties, the resulting nanostructured semiconductor materials are promising for use as the basis of sensor electronics devices.

The methods proposed in this dissertation for the synthesis of semiconductor nanostructures demonstrate excellent photoluminescence, UV absorption and a high band gap. In other words, synthesized zinc oxide nanoforms are able to effectively absorb or refract light. Due to their high optical properties and thermal stability, synthesized zinc oxide nanoforms are promising for the creation of optoelectronic and sensor devices.

The formation of zinc oxide in various synthesis methods is based on the following processes: germination, diffusion growth, Ostwald maturation, aggregation and sintering. The size of the zinc oxide particles is influenced by the temperature, the duration of synthesis and the concentration of the solution components. It should be borne in mind that impurities can reduce the degree of aggregation. In general, chemical synthesis methods are more preferable due to their flexibility, which is due to the greater variability of the properties of the obtained zinc oxide samples.

It is shown that nanostructured arrays of zinc oxide nanorods grown by the low-temperature hydrothermal method can be used as a basis for creating an efficient, economical, stable, highly sensitive non-enzymatic electrochemical biosensor for the detection of ascorbic acid.

It is noted that thermal annealing in air followed by short-term treatment in hydrogen plasma cleanses ZnO samples from moisture and OH ions, affects various optical recombination channels and increases the concentration of passivated states, which leads to activation of the surface and an increase in the role of surface reactions with the analyte, that is, to an increase in the sensitivity of the biosensor.

The results of the study of the elemental composition of the surface and the chemical state of the considered ZnO samples by X-ray photoelectron spectroscopy showed that thermal and plasma treatments lead to a shift of the Auger peak to a region of lower energies, while the peaks Zn2p3/2 and Zn2p1/2 shift towards higher energies, which indicates that the samples of ZnO NW AT+PT the densities of the valence electron cloud of the Zn and O surfaces decrease, and the binding energy of the valence electron and the electron of the backbone level increases. An increase in the intensity of the O2 oxygen band corresponding to non-lattice O2 ions or O2

ions in oxygen vacancies is consistent with an increase in the concentration of free carrier carriers in ZnO AT+PT samples, therefore, the concentration of recombination centers in ZnO AT+PT samples decreases after H–treatment.

In addition, it was noted that H-treatment of ZnO samples with pre-annealing in the atmosphere helps to stabilize the surface, as a result of which these samples do not show a noticeable aging effect. The ZnO NW/ITO electrode retained 98.7% of its initial response after 10 days, 97.8% after 20 days and 96.8% after 30 days, indicating the high stability of these ZnO layers.

The structural, photoluminescent and optical properties of samples consisting of zinc oxide nanorods vertically oriented relative to the substrate, synthesized by a low-temperature hydrothermal method, initial ones subjected to thermal annealing in a muffle furnace at 450 °C for one hour, as well as processed in hydrogen plasma with pre-annealing in air, were compared. It is shown that the samples treated in hydrogen plasma had the lowest absorption coefficient, and the initial ZnO samples had the highest. It was noted that synthesized ZnO samples subjected to thermal annealing with subsequent treatment in hydrogen plasma had the highest photoluminescence intensity.

Thus, the results presented in the dissertation work are promising for use in the creation of sensory bioanalytical electronic devices in order to ensure safety in the field of healthcare and biomedicine.

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.

According to the State Program for Industrial and Innovative Development of the Republic of Kazakhstan for 2020–2025, it is necessary to create a competitive manufacturing industry of the Republic of Kazakhstan in the domestic and foreign markets. Therefore, the study of the electrochemical and structural properties of nanostructured semiconductor oxides for use in sensor electronics will expand the range of processed goods that are in demand in the domestic and foreign markets.

The research was carried out within the framework of the project AP08856173 «Synthesis and study of the properties of low-dimensional semiconductor materials for the creation of highly sensitive biosensors».

Analysis of the level of implementation of the results of the dissertation in practice. 7 scientific papers have been published on the topic of the dissertation work, including: 1 (one) article in a peer-reviewed scientific publication on the scientific direction of the dissertation topic, indexed in the Science Citation Index Expanded database of the Web of Science (Clarivate Analytics) and according to CiteScore in the Scopus database (Elsevier) IF = 5.4 Quartile (Web of Science) – Q1, Percentile SCOPUS-78%, 3 (three) articles in domestic publications in the field of physics, nanomaterials and nanotechnologies, recommended by COXON MES RK, 3 (three) works in collections of International conferences.

4.4. Analysis of the topic of the work of MerkibaevY.S. «Processing of low grade, difficultly enrichable complex lead-zinc ores and industrial enrichment products», submitted for the degree of Doctor of Philosophy (PhD) under the educational program 6D070900 – Metallurgy.

Within the framework of this work, the development of the lead-zinc industry requires the expansion of the raw material base of modern non-ferrous metallurgy. One of the critically important reserves in this direction is the involvement in the exploitation of difficult-to-enrich ores, in particular oxidized and mixed, as well as liquid tailings of enrichment. A significant part of polymetallic, lead-zinc ores currently contain less than 3% zinc and less than 1% lead, they are also characterized by difficulty in enrichment due to thin inclusions and close mutual germination of ore and non-metallic minerals, as well as significant oxidation of the near-surface part of ore bodies. In world practice, when processing ores of this composition, there is a

tendency to use combined methods, including hydro- or pyrometallurgy operations in combination with flotation or gravity enrichment, depending on the characteristics of the material composition of ores. One of the effective activating methods of preparing oxidized minerals for flotation is sulfiding roasting. Sulfidizing firing in a fluidized bed furnace is proposed using pyrite concentrate as a sulfidizer and fuel, which ensures the transfer of minerals from an oxidized form to an easily enriched sulfide one, with a significant reduction in metal loss than using other activation schemes, followed by magnetic and flotation enrichment of firing products. This technology is particularly relevant in the context of a rapid decrease in the content of lead and zinc in ores.

For the first time, the results of thermal analysis of TG/DSC and (SEM) and (EDS) spectroscopy established the mechanism of sulfidation of oxidized zinc compounds with pyrite: stage 1 - primary formation of ZnS at a temperature of 450 °C; stage 2 - at the maximum degree of sulfidization at 700-750 °C, a stable ZnS film is formed with the formation of pyrrhotines of the composition $Fe_{1-x}S$, which dissolve in ZnS to form a compound (Zn, Fe)S in the form of $Fe_2Zn_3S_5$ at a temperature of 750 °C; Stage 3 at a firing temperature above 750 °C with the formation of the mineral ZnS, which not only aggregates with $Fe_{1-x}S$to produce a compound (Zn, Fe)S in the form of $Fe_2Zn_3S_5$, but also with aggregation with elements of waste rock, which negatively affects the efficiency of flotation.

Proposed in this dissertation work for the first time by experimental thermodynamics, electron microscopy (SEM) in combination with energy dispersive spectroscopy (EDS), the mechanism of zinc oxide sulfidation and the formation of intermediates at 800 °C in the form of franklinite ($ZnFe_2O_4$) and zincosite($ZnSO_4$), according to the following transformation mechanism: $ZnO \rightarrow ZnFe_2O_4 \rightarrow ZnSO_4 \rightarrow ZnS$.

It is shown that for the first time using NMR and EPR methods, the dependence of the magnetization of pyrrhotines$Fe_{0.855}S$, $Fe_{0.862}S$, $Fe_{0.877}S$, $Fe_{0.901}S$, $Fe_{0.911}S$ on the firing temperature was established, it was found that the magnetization increases from 4.5 $Gs \cdot cm^3/g$ at 600 °C of firing to 12.5 $Gs \cdot cm^3/g$ at 800 °C with a further decrease to 3.0 $Gs \cdot cm^3/g$ and values of 0 Gs·cm3/g at temperatures above 1000 ° C due to a decrease in the number of vacancies in even basic planes of the pyrrhotite structure.

The compositions, magnetic susceptibility of pyrrhotines ($Fe_{0.855}S$ = 3,75; $Fe_{0.888}S$ = 5,43; $Fe_{0.909}S$ = 2.18 SI units), as well as their structural properties for the transition from magnetic, ferromagnetic and paramagnetic states have been established, which allowed the development of methods for firing magnetic enrichment under conditions of sulfidating firing in a fluidized bed and in a fixed layer.

It is noted that for the first time a method of thermal activation of zinc-oligonite ore has been developed, including high-temperature, sulfidizing roasting in the presence of a high-sulfur sulfidizer in the form of a pyrite concentrate at a ratio of 2:1 to ore, in an air-blown fluidized bed furnace at a flow rate of 10 to 20 l/min, at a temperature of 650 °C, to obtain the maximum magnetic pyrrhotides, whose magnetic susceptibility is equal to 1020 - 1330 $\cdot 10^{-6}$ Si / g, with a degree of sulfidization of 88% and their extraction by magnetic separation into a magnetic fraction of more than 90%.

In addition, it was noted for the first time that after sulfidating ore treatment in a CS furnace and separation of the magnetic fraction in a cinder. the zinc content increases to 3.5-4.0%, flotation of the non-magnetic fraction without special selection of flotation reagents in an open cycle allows to increase zinc extraction by 2.5-3 times, and the zinc content in the foam product by 4-7 times.

Thus, for the first time, a technological scheme has been developed for activating sulfidating firing of zinc-containing and lead-containing industrial enrichment products in a fixed layer containing pyrite in its own composition of at least 50-54%, used as a sulfidizer, to produce pyrrhotines with a maximum magnetic susceptibility equal to: $Fe_{0.855}S$ = 3,75; $Fe_{0.888}S$ = 5,43; $Fe_{0.909}S$ = 2.18 SI units.

The connection 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. According to the State Program of Industrial and innovative Development of the Republic of Kazakhstan for 2020-2025, it is necessary to create a competitive manufacturing industry of the Republic of Kazakhstan in the domestic and foreign markets. The conducted research was carried out as part of the implementation of the grant financing project for 2020-2022. AP08052829 "Development of hybrid technology for complex processing of oxidized, hard-to-enrich zinc, lead-containing ores and industrial products enriched with sulfidizing roasting followed by enrichment of the stub" and is a continuation of the research of the applicant as a postdoctoral fellow and head of the ZhasGalym project for 2022-2024 AR15473200 "Development of technology for processing oxidized ores with preliminary high-temperature sulfidization" and PCF IRN BR21881939 "Development of resource-saving energy-generating technologies for the mining and metallurgical complex and the creation of an innovative engineering center".

Analysis of the level of implementation of the results of the dissertation in practice.15 scientific papers have been published on the topic of the dissertation in peer–reviewed scientific journals and publications identified by KOKNVO of the Ministry of Internal Affairs of the Republic of Kazakhstan, including: in the WoS database – 2 articles, in the Scopus database – 2 articles, in journals recommended by KOKNVO of the Ministry of Education and Science of the Republic of Kazakhstan – 4 articles; in other scientific journals and publications - 1 article. A list of published works. The results of the work have been tested at 4 international scientific and practical conferences.

There is a patent for invention 1 and 1 monograph.

4.5 Analysis of the subject of the work of Dyussebekova Maral «Development of slag depletion technology for autogenous smelting of copper sulfide concentrates», submitted for the degree of Doctor of Philosophy (PhD) on speciality 8D07204 - "Metallurgical Engineering". Currently, more than 24.6 million tons of waste containing copper have accumulated on Earth as a result of anthropogenic activities. This is due to the fact that the production of non-ferrous metals by pyrometallurgy is characterized by significant slag formation compared to the amount of metal extracted during the smelting process. Sometimes the amount of slag produced during smelting exceeds the output of valuable industrial products by more than ten times. It is reported that more than 20 million tons of copper smelting slag are generated annually, and slag reserves in Kazakhstan reach 130 million tons. For every ton of matte produced, about 2.2 tons of slag are generated. The solid waste of mining and metallurgical enterprises contains about 2 million tons of copper, which is already comparable to the proven and estimated world copper reserves of 650 million tons. The average content of zinc in them is 2%, copper 0.5%, iron 35%, and lead 0.8%.

To solve the problem of processing metallurgical slags and obtaining a metallized phase and a metal-depleted silicate part, it is necessary to create a process with deep reduction of slag melts. However, to date, this task has not been fully resolved. To create new technologies for processing non-ferrous metallurgy slags, it is necessary to conduct a set of physicochemical studies using modern scientific equipment.

In light of the above, it is necessary to conduct scientific research aimed at studying the main reasons for the loss of copper with slags, as well as developing effective methods that allow for more complete extraction of valuable components.

In this work, the main reasons for the loss of copper with slag are established; also, based on the current state of copper production, a brief analysis of autogenous processes of smelting sulfide copper-containing raw materials and an in-depth analysis of existing methods for depleting slag, the justification and choice of direction for scientific research was carried out.

The physicochemical characteristics of the flux ore were studied, where a high content of Al_2O_3 was revealed, which binds silica into various aluminosilicates: Al_2SiO_5; $(K,Na)AlSi_3O_8$,

$Al_2Si_4O_{10}(OH)_2$; $KAl_2[Si_3AlO_{10}](OH)_2$; and significantly reduces the fluxing ability of these ores.

As a result of research, it has been established that not all coal burns with the release of heat, some of it enters into endothermic reactions interacting with metal oxides: $C+MeO=CO+Me -\Delta H$ and reducing them.

Based on all the findings obtained, the design of a two-zone Vanyukov furnace with an electrically heated reduction zone was proposed, which contributes to a significant depletion of copper from 0.81% to 0.043%. A specialized device for supplying the reducing agent is also proposed, which ensures its uniform distribution and effective interaction with the slag. This method prevents the process of peroxidation, reduces dust emissions, and binds excess oxygen from the blast.

The results of research on the processing of copper smelting slag are important for solving the problem of slag depletion in valuable metals.

As noted, a significant amount of copper, zinc, lead and other metals are contained in metallurgical slags formed during the pyrometallurgical production of non-ferrous metals. The development of effective technologies for the deep processing of such slags will make it possible not only to extract valuable components, but also to obtain slag materials depleted in metals.

Metal-depleted slags can find application in various industries, for example, as raw materials for building materials. This will contribute to the rational use of resources, reducing the environmental load and expanding the range of products.

Thus, the complex processing of metallurgical slag is an important scientific and technical task that requires further research and the development of new technological solutions.

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 work's theme aligns with the priority direction for the development of science "Ecology, environment, and rational natural resource management"; it corresponds to 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 is in accordance with the Classifier of scientific directions "Engineering and technology; Materials engineering; Metallurgy". The dissertation work was carried out within the framework of the project for program-targeted financing of scientific research for the years 2019-2021 "Development of technology for autogenous smelting of sulfide copper raw materials in conditions combining in the melt zones of charge loading, oxidizer introduction, and heat release" on the topic: "Study of the thermal regime of autogenous smelting in the Vanyukov furnace using additional fuel when it is fed through tuyeres into the liquid bath of the melt" (AR08855511).

Analysis of the level of implementation of the results of the dissertation in practice. According to the results of the dissertation research, 8 papers have been published, which are 3 articles in journals indexed in Scopus and Web of Science databases (CiteScore percentile of more than 35%), 1 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 4 papers in the collections of International and Republican scientific and practical conferences.

Based on the results of the study, a utility model patent No. 8335 dated 05/05/2023 was obtained, and 2 pilot test reports were drawn up at the production of Kazakhmys Smelting LLP.

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

№	Full name of the doctoral student	Reviewers	
		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	Tashmukhanbetova Indira	Aidar K. Kenzhegulov – PhD, Head of the Laboratory of «Metallology» of the Institute of Metallurgy and Ore Beneficiation, there are more than 5 scientific publications in (Scopus) CiteScore above 35 in the specialty 6D071000 – «Materials Science and technology of new materials».	Bagdat B. Teltaev – Doctor of Technical Sciences, Professor, Corresponding Member of the National Academy of Sciences of the Republic of Kazakhstan, Chief Researcher of the «Institute of Mechanics and Machine Science» named after Academician U. A. Zholdasbekov, there are more than 5 scientific publications in (Scopus) CiteScore above 35 in the specialty 6D071000 – «Materials Science and technology of new materials».
2	R.Zh. Abuova	Bakhytzhan T. Lesbaev – Candidate of Chemical Sciences, Associate Professor, Chief Researcher, Gorenje Institute of Combustion Problems, there are 5 scientific publications in the specialty 6D074000 – «Nanomaterials and Nanotechnologies».	Zhuldyz B. Sagdoldina – PhD, leading researcher at the Sarsen Amanzholov East Kazakhstan University, there are more than 5 scientific publications in (Scopus) CiteScore above 35 in the specialty 6D074000 – «Nanomaterials and Nanotechnologies».
3	Diana Tolubayeva	Bakranova Dina I. - Doctor of Philosophy PhD in specialty 6D074000 - Nanomaterials and nanotechnologies, Deputy Dean of the School of Materials Science and Green Technologies Assistant Professor (physics) of the School of Natural and Social Sciences of the Kazakh-British Technical University JSC, there are more than 5 scientific publications on educational program 8D07101 – «Nanotechnologies in engineering».	Lesbaev Bakhytzhan T. - Candidate of Chemical Sciences, chief researcher at the RSE at the PVC «Institute of Combustion Problems», there are more than 5 scientific publications on the educational program 8D07101 – «Nanotechnologies in Engineering».

4	Merkibayev Yerik Serikovich	Shevko Viktor Mikhailovich – Doctor of Technical Sciences, Professor, Head of the Department of "Metallurgy" NJSC South Kazakhstan University named after M. Auezov, (Shymkent, Kazakhstan), there are more than 2 scientific publications in (Scopus) CiteScore above 35- ty in specialty 6D070900 – Metallurgy.	Sergey Arkadyevich Kvyatkovsky – Doctor of Technical Sciences, Academician of KazNAEN, Head of the Laboratory of Pyrometallurgy of Heavy Non-Ferrous Metals at the Institute of Metallurgy and Beneficiation at the Kazakh National Research Technical University named after K. I. Satpayev. (Almaty, Kazakhstan), there are more than 2 scientific publications in (Scopus) CiteScore above 35 in the specialty 6D070900 - Metallurgy.
5	Dyussebekova Maral Adelbekovna	Shevko Viktor Mikhailovich – Doctor of Technical Sciences, Professor, Head of the Department of "Metallurgy" NJSC South Kazakhstan University named after M. Auezov, (Shymkent, Kazakhstan), there are more than 2 scientific publications in (Scopus) CiteScore above 35- ty in specialty 8D07204 – "Metallurgical Engineering".	Feruza Asanovna Berdikulova – Candidate of Technical Sciences, Head of the R&D Department, Republican State Enterprise "National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan" (Almaty, Kazakhstan), there are more than 2 scientific publications in (Scopus) percentile on CiteScore higher 35 in specialty 8D07204 – "Metallurgical Engineering".

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**		
	6D074000 – Nanomaterials and Nanotechnologies	6D070900- Metallurgy	6D071000 – Materials science and technology of new materials
Dissertationsacceptedfor defense	2	2	1
Includingdoctoralstudents fromother universities	1	-	-

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	–	–	–	

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