BR21882240 “Creation of quasi-high-entropy alloy using Kazakhstani raw materials and technology of production of precision parts on its basis” – p.m. Issagulov A.Z.

Relevance: The majority of precision parts for medium and heavy machine building are currently supplied to Kazakhstan from abroad, which puts the country in economic dependence. Meanwhile, the level of development of metallurgical and foundry production in the Republic of Kazakhstan allows producing its own precision parts from appropriate materials. The development of own technologies for the production of precision parts is an urgent task of strategic importance for the Republic of Kazakhstan.

The second circumstance determining the relevance of this program is the fact that the possibilities of improving the existing alloys by traditional methods are actually exhausted. Meanwhile, the world trend in metallurgy is the creation of a new class of alloys, the so-called high-entropy alloys (HEA). The interest shown to these alloys is related to the possibility of obtaining higher level of operational properties compared to traditional alloys. However, despite the demonstration of high-performance properties, high-entropy alloys have not yet received practical and industrial application, because the production of HEA is a complex and expensive process. This program proposes the creation of a quasi-high-entropy alloy (QHEA), i.e. an alloy close in composition and properties to HEA, but simpler to produce and, therefore, more commercially attractive.

The project purpose*:* development of the composition of quasi-high-entropy alloy (QHEA) using Kazakhstani raw materials and technology of production of precision parts on its basis.

Expected and achieved results*:*

- new composition of QHEA using Kazakhstani raw materials;
- development and implementation of the technology of production of precision parts made of QHEA for medium and heavy engineering, in particular for mining and metallurgical complex;
- obtaining prototypes on the developed technology of precision parts production;
- publication of 3 articles in foreign journals from the first three quartiles of impact factor in the Web of Science database or having the percentile of CiteScore in the Scopus database not less than 50%, 4 articles in journals from the CQAES database, 2 applications for patent of RK and the program subject.

For 2023.

-Objects and subject of research were determined;

-consumables and ThermoCalc software with an extended database were purchased;

-Program website was created to highlight the scientific results of the Program implementation, transparency of the research group activity and to attract potential consumers of the developed technology;

-studies on QHEA smelting using ferroalloys were conducted;

- 1 article “Qūrylymdyq material jasaudağy jaña söz-kvazi-joğary entropialyq qorytpalar" // Newspaper “Qaragandy Habary”, No. 2 (137) from 11.01.2024 Page. 6.

For 2024.

-thermodynamic calculations of phase transformations of experimental QHEA on the basis of Kazakhstan content depending on chemical composition were carried out;

-basic experiments were conducted and the experiment matrix was developed;

-studies of phase composition and structure of experimental QHEA are carried out;

- studies of properties of experimental QHEA are carried out;

- tests on melting of the experimental alloy at the production site of SPA “Manganese” were carried out, the test report was received;

1 article was published in the journal Q2 by impact factor in the Web of Science database.

List of publications:

1. Kvon Sv., Issagulov A., Kulikov V., Arinova S. Niobium's Effect on the Properties of a Quasi-High-Entropy Alloy of the CoCrFeMnNi System // Metals, 2024, 14 (5), 564. doi 10.3390/met14050564 , IF Q2.

2. Kvon Sv., Issagulov A., Ibatov M., Kulikov V., Arinova S. Investigation of the properties of the cocrfemnni alloy developed on the basis of the entropy approach // Metalurgija, 2024, 63 (3-4), 366-368.

3. Issagulov A., Kvon Sv., Kulikov V., Arinova S.K. Market monitoring and prospects for the production of precision parts of mining and metallurgical equipment // Proceedings of the University, 2024, No. 1 (94), 77-80 doi 10.52209/1609-1825_2024_1_77;

4. Issagulov A., Kvon Sv., Kulikov V., Tulegenova Sh. Influence of technological modes of melting on mechanical properties of quasi-high-entropy alloys // Foundry,2024, No. 4, 2-4;

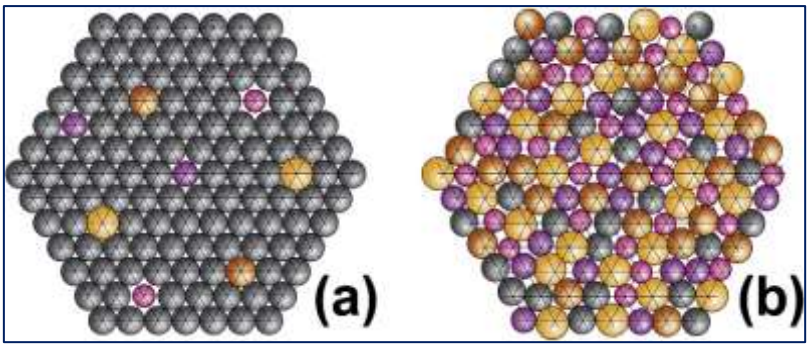

Figure 1 - Illustration of the arrangement of atoms:
a - in the “classical” alloy and b - WES

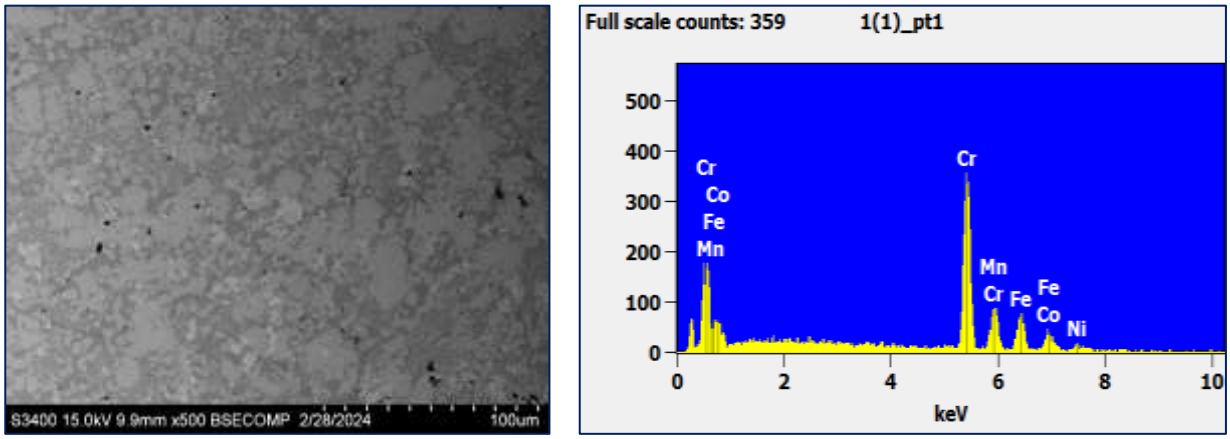

Figure 2 - Structure of the experimental alloy

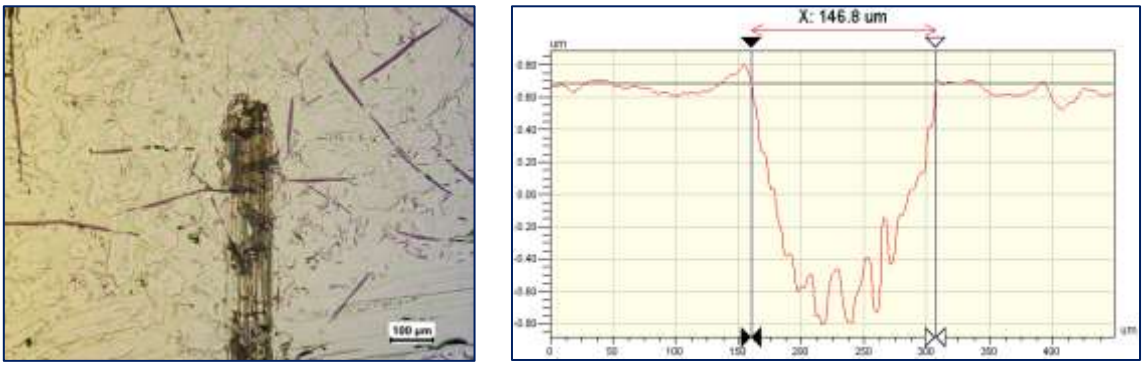

Figure 3 - Structure of the experimental alloy

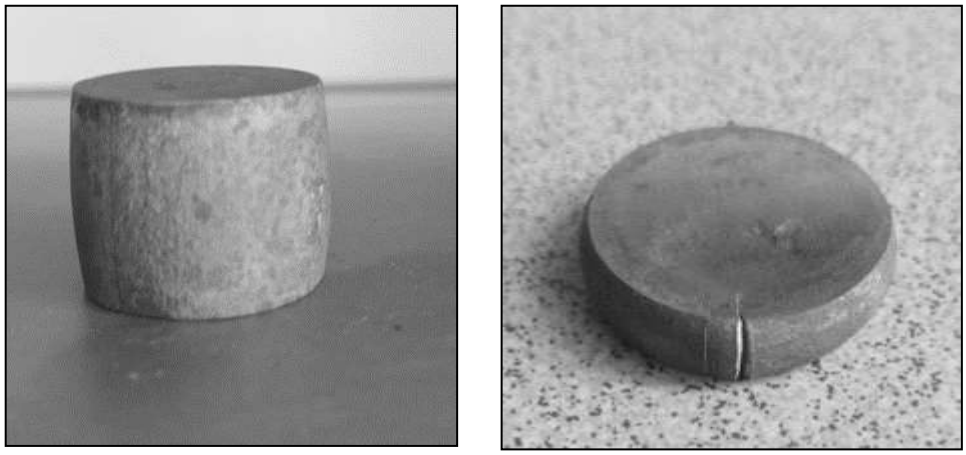

Figure 4 - Experimental samples before and after compression testing

Research team:

Includes 25 performers, 11 of whom are under 40 years of age and 17 of whom have advanced degrees.

The consultants are:

- PhD, Prof. J.Michaud (Institute J.Lamure, Lorrein University Nancy, France);
- PhD, Prof. O. Chernysheus (Vilnius Gediminas Technical University, Lithuania);
- Candidate of Technical Sciences, Associate Professor P.V. Kovalev (Lorrein University, Nancy, France); Ph. P.V. Kovalev (Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia)

Information for potential users:

The new knowledge will contribute to the development of the national school of metallurgy and metal physics, which will bring the national metallurgical science to a fundamentally new level.

Scope:

The area of application of this program is metallurgical and machine-building production for such enterprises as Kazakhmys Corporation LLP, ArcelorMittal Temirtau JSC, Parkhomenko KMZ LLP and others.

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