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

Relevance:

Currently, most precision components for medium and heavy mechanical engineering in Kazakhstan (e.g., pipeline fittings, pump parts, metallurgy and mining equipment components) are imported, leading to economic dependence. Meanwhile, Kazakhstan possesses a sufficiently developed metallurgical and foundry infrastructure to produce such parts domestically. Advanced techniques like Investment Casting (IC) and Lost Foam Casting (LFC) are well-established and capable of producing complex-shaped parts with high dimensional accuracy and surface finish.

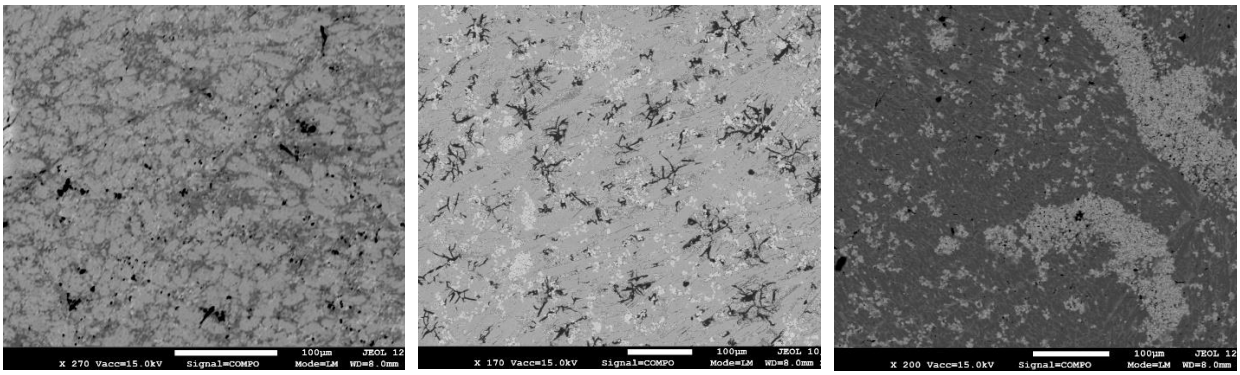
Thus, the development of indigenous technology for precision part production is of strategic importance for Kazakhstan.

Project Objective:

To develop the composition of a quasi-high-entropy alloy (QHEA) based on domestically sourced raw materials and establish a production technology for precision components applicable in medium and heavy machinery manufacturing.

As part of the Program:

Experimental laboratory samples were obtained. Based on the conducted laboratory tests, a preliminary technological map of the process was obtained. (technical card 12-2025 KVES alloy, technical card 13-2025 Shell mold for LVM casting). Studies of the structure, hardness, and wear resistance of quasi-high-entropy alloys of the Fe-Co-Cr-Ni-Mn-Nb system with Mo additives have been conducted. As a result of the study, it was shown that the Fe-Cr-Mn-Ni-Co-Nb CES systems, smelted with partial use of ferroalloys and additionally alloyed with Mo in an amount of 5-15% by weight, demonstrate very high hardness (about 730HV) and wear resistance, which is almost 2 times higher than the hardness and wear resistance of alloys of this type. systems without Mo additives. Studies have been conducted on the effect of the molybdenum content on the fluidity of quasi-high-entropy alloys of the Co-Cr-Fe-Ni-Mn-Nb system. The spiral test method was used to evaluate the fluidity. The results showed that the addition of Mo in concentrations of 5...15% significantly increases the hardness of the alloys, changes the nature of the structure, and slightly reduces the fluidity of the melt. With a content of 5...10% Mo fluidity changes slightly, but at a concentration of 15% Mo fluidity decreases by ~ 12%. Based on the data obtained, the technology for obtaining castings from this experimental CES was adjusted.



Sample 1 Sample 2 Sample 3

Figure 1 - Microstructures of the prototypes

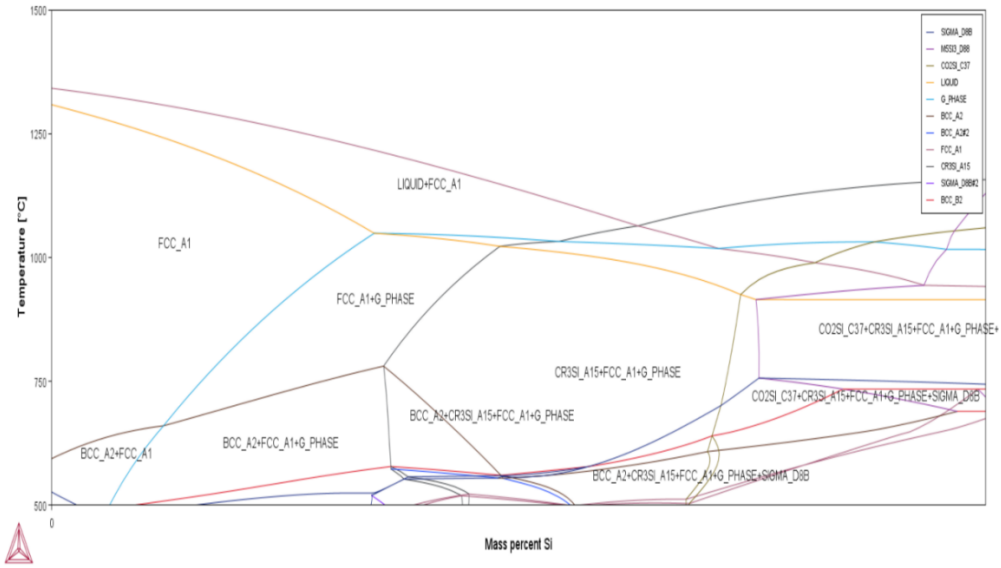


Figure 2 – Equilibrium phase diagram of the Fe-Cr-Mn-Ni-Co-Nb system

List of publications

1. Kvon St.S., Kulikov V.Yu., Isagulov A.Z., Kovaleva T.V., Abildina A.R. The molybdenum effect on the structure and properties of the quasi-high-entropy alloy of the Fe-Co-Cr-Ni-Mn-Nb system // Acta Metallurgica Slovaca, 2025. – No. 2. – pp. 119-123 (Scopus 53 percentile).

2. Abildina A.R., Isagulov A.Z., Shcherbakova E.P., Kvon St.S. Using the Method of Probabilistic Deterministic Experiment to Assess the Impact of Alloying Elements on the Properties of the Quasi High-Entropy Alloy of the Fe-Cr-Ni-Co-Mn System // Material and Mechanical Engineering Technology, Karaganda: Publishing House of the Map named after Abylkas Saginov. - 2025. – No. 1. – pp. 56-64. (KOKSNVO).

3. Abildina A.R., Kulikov V.Yu., Kvon St.S. The influence of molybdenum on certain properties of a quasi-high-energy alloy of the Co-Cr-Fe-Ni-Mn-Nb system // Foundry Production, Moscow: Foundry Production Publishing House. – 2025. – No. 1-2. – pp. 34-38. (KOKSNVO).

The Research Group

It includes 25 performers, 11 of them are under the age of 40, 17 people have an academic degree.

The consultants are:

• PhD, Prof. Michaud (J.Lamure Institute, Lorrein University, Nancy, France);

• PhD, Prof. O.Chernysheyus (Vilnius Gediminas Technical University, Lithuania);

• Candidate of Technical Sciences, Assoc. Kovalev P.V. (Peter the Great SPbPU, Saint Petersburg, Russia)

Information for potential users:

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

Scope of application:

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

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