

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:

A significant portion of precision parts for medium and heavy engineering in Kazakhstan is currently imported from abroad, placing the country in economic dependence. Meanwhile, the level of development of the metallurgical and foundry industries in Kazakhstan allows for the production of domestic precision parts from appropriate materials. The development of domestic technologies for manufacturing precision parts is a relevant task for Kazakhstan, carrying strategic importance.

Project Objective:

The development of the composition of a quasi-high-entropy alloy (QHEA) using Kazakhstani raw materials and the technology for producing precision parts based on it.

Expected and Achieved Results

Expected Results:

- Development of the QHEA composition;
- Investigation of the phase composition and structure of the experimental QHEA;
- Study of the properties of the experimental QHEA and adjustment of the alloy composition;
- Publication of three articles in foreign journals from the first three quartiles by impact factor in the Web of Science database or with a percentile of at least 50% by CiteScore in the Scopus database, four articles in journals from the KOKSON database, and two patent applications in Kazakhstan related to the program topic.

Achieved Results:

As a result of the conducted research, the feasibility of smelting QHEA based on the FeCrMnNiCo system with a partial replacement of pure metals by ferroalloys has been established. The properties of the experimental alloy are close to those of HEA based on a similar system but smelted from pure metals with fivefold remelting. The obtained results demonstrated that despite the presence of a small amount of silicate phase in the structure and some impurities in the initial charge, the properties of the experimental alloy are comparable to those of an alloy smelted from pure metals.

The conducted research has shown the feasibility of partially replacing pure metals with ferroalloys when smelting high-entropy alloys, which will positively impact their cost. Preliminary calculations indicate a cost reduction in charge materials by approximately 20%. This suggests that the experimental alloy has potential attractiveness for further research to refine its properties for industrial applications.

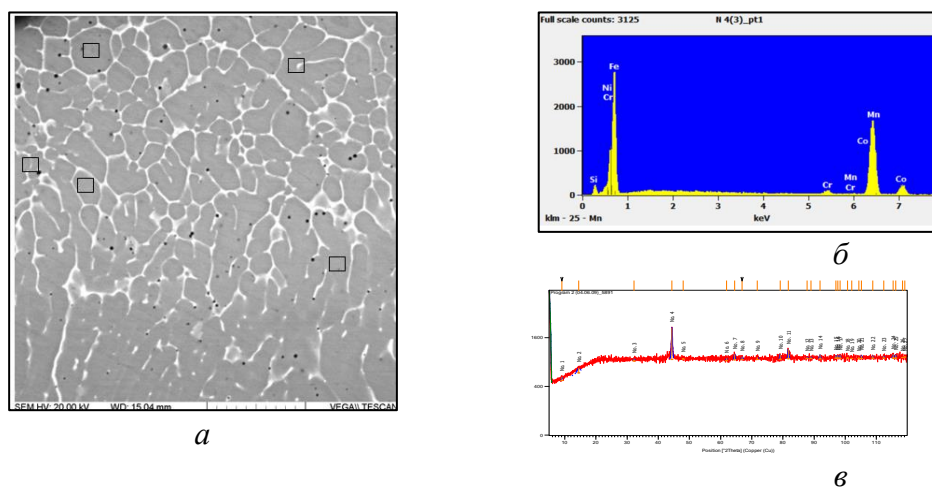


Figure 1 - a) Structure of the experimental alloy; b) EDS (Energy Dispersive Spectroscopy) analysis; c) X-ray diffraction (XRD) pattern

List of Publications

1. Квон Св.С., Исагулов А.З., Аринова С.К., Аубакиров Д.Р. Информационный анализ развития и проблем высокоэнтропийных сплавов // Труды университета, Караганда: Изд-во КарГУ имени Абылкаса Сагинова. – 2024. – № 3. – С.3-10
2. Квон Св.С., Исагулов А.З., Куликов В.Ю., Аринова С.К., Использование ферросплавов для выплавки квазивысокоэнтропийного сплава // CIS Iron and Steel Review, Москва – 2024. - № 2 (Vol.28) (База Scopus, проценитиль 62).
3. A.Issagulov, P. Kovalev, S. Melnik, V. Kulikov*, S. Kvon and S. Arinova, The effect of complex extra-furnace treatment of metal melts on the formation of non-metallic inclusions in large-sized ingots// Materials Research Express 2024(База Scopus, проценитиль 74).
4. Құрылымдық материал жасаудағы жаңа сөз-квази-жоғары энтропиялық қорытпалар // Газета «Qaragandy Habary», № 2 (137) от 11.01.2024 г. Стр. 6. (Публикация в СМИ).

Research Team

The research group consists of 25 members, including 11 under the age of 40 and 17 with academic degrees.

Consultants:

- PhD, Prof. J. Michaud (Institute J. Lamure, Lorraine University, Nancy, France)
- PhD, Prof. O. Chernysheus (Vilnius Gediminas Technical University, Lithuania)
- PhD in Engineering, Associate Prof. P.V. Kovalev (Peter the Great St. Petersburg Polytechnic University, Russia)

Information for Potential Users

New scientific knowledge gained through this research will contribute to the development of the national school of metallurgy and metal physics, elevating Kazakhstan's metallurgical science to a fundamentally new level.

Application Area

The program's application scope includes metallurgical and mechanical engineering industries, specifically for enterprises such as:

- LLP "Kazakhmys Corporation"
- JSC "Qarmet"
- LLP "KMZ named after Parkhomenko"
- And other industrial companies.

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