Introduction of the Department of Foundry Processes and Materials Science of the NMSTU

During the training at the Department, students acquire not only theoretical knowledge, but also practical skills on the basis of our laboratories in the field of jewelry and industrial casting technologies. Knowing jewelry and industrial casting processes, graduates ready to work at companies operating in machinery, ore mining and smelting, aerospace, tool making and other industries.

In addition, the Department provides its advanced laboratory facilities for research, practical and experimental work to participants in the educational process and research of other universities that do not have their own laboratories.

In the laboratory, work can be carried out from the smelting of alloys to the study of mechanical and operational properties, microstructure.

Also, on the basis of the casting laboratory, it is possible to obtain almost any experimental sample of the cast product.

Our graduates are in demand and successfully work at research and engineering institutes, research centers, analytical laboratories, consulting companies and dealer firms selling steel products and equipment in Russia and abroad.

In the course of training, students learn the theoretical material, and practical skills are fixed in the laboratory:

Laboratory of industrial casting:

Laboratory equipment: specialized software, induction furnaces (capacity 2, 15, 60 kg), resistance furnace, arc furnace, centrifugal machine, thermal furnaces, model and optics equipment, molding equipment.

The equipment allows students to fully simulate the technological process of production of cast products from the development of casting technology to heat treatment of finished products.

Jewelry casting and prototyping laboratory:

Laboratory equipment: injector, resistance furnace, hand tool sets, vulcanizer, 3D printer, CNC machine, etc.

The laboratory is equipped with all the necessary technological equipment for the production of jewelry based on manufactured models. The prototyping process is carried out on a 3D printer and a CNC milling machine.

<u>The program includes the following subjects:</u>

History, foreign language, philosophy, economics, team building and personal development, life safety, mathematics, physics, chemistry, ecology, metrology, standardization and certification, thermal physics, production management, metallurgical heat engineering, fundamentals of metallurgical production, materials and processes research methods, simulating processes and facilities in metallurgy, physical chemistry, basic jewelry technologies, materials science, theory of casting processes, casting technology, designing new and revamping existing, foundry shops, manufacturing non-ferrous alloy castings, special casting methods, technological equipment of foundry shops, structure formation in castings, 3D design of casting molds, computer simulation of casting processes, computer analysis of casting technologies, special cast iron, resource- and energy-saving in casting, jewelry metals and alloys casting technologies, fundamentals of alloy synthesis, art casting technique for metallic and nonmetallic materials, design of accessories, process lines and complexes for industrial and jewelry products, patternmaking, fundamentals of design of cast parts, jewelry casting technique, practical introductory training, practical training for acquiring initial professional competence and skills, including initial research competence and skills, industrial pre-graduation practical training.

To consolidate the acquired skills students undergo practical training at Magnitogorsk factories that produce rolls, replacement equipment and spare parts for technological units of metallurgical, mining and processing industries, also produce new units and parts, develop structures and modernize them.

The program ends with the protection of the final qualification work with the presence of leading specialists of industrial enterprises.

The main Direction of scientific research in the field of foundry production are:

- synthesis of casting alloys with a given level of properties;
- improvement and optimization of foundry technology for the production of shaped products;
- improvement the production of rolling rolls;
- continuous casting of steel.

1. Synthesis of cast alloys with a given level of properties.

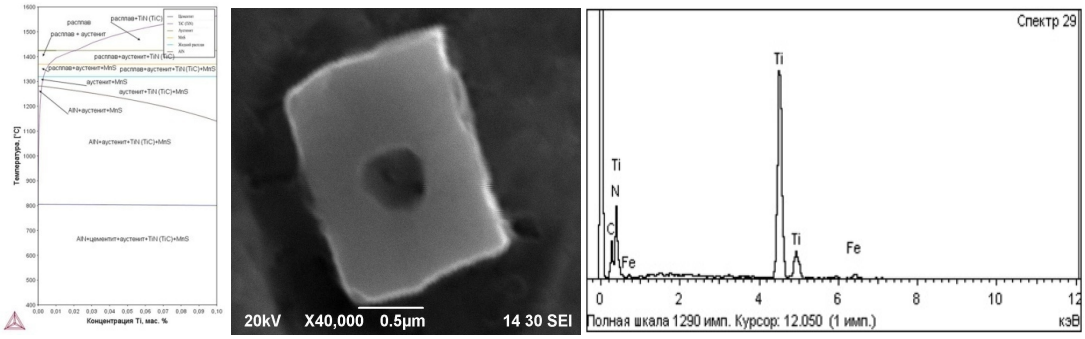
Development of chemical compositions of alloys that have a high level of mechanical and special properties: heat resistance, heat resistance, wear resistance (impact and abrasive), acid resistance. All research is conducted at the foundry laboratory. When developing the composition of alloys with special properties, much attention is paid to conducting metallographic studies, which are carried out at the research Institute "Nanosteel" of NMSTU.

Major projects implemented recently:

- development of the composition of heat-resistant and heat-resistant cast iron for grates of sintering bogies of sintering production;

- development of corrosion-resistant cast iron for working in hydrochloric acid;

- development of technology for alloying high-manganese steel by nitrided ferroalloys and internal form modification by titanium carbonitride to improve the wear resistance of castings (funded by the Russian scientific Foundation).



2. Improvement and optimization of foundry technology for the production of shaped products.

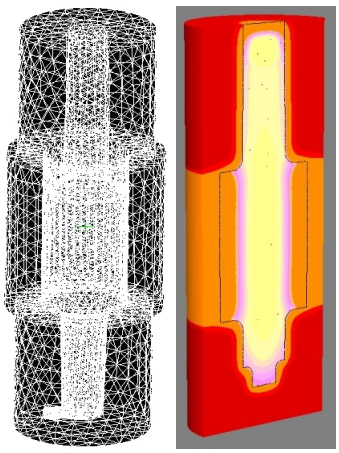
The aim of scientific reseach in the field of improving casting technologies is to reduce the number of defective products, the use of new materials for the manufacture of molds and casting rods, or to optimize its formulation, the development of cost-effective technology for melting casting alloys, as well as the use of new ligatures and modifiers.

An important part of improving this direction is computer analysis of foundry technologies in specialized software "Polygon Software". The results of the computer analysis validates in the foundry laboratory for physical modeling.

Major projects implemented recently:

- the technology of centrifugal casting of two-layer rolling rolls made of cast iron has been developed;
- elimination of the "hot crack" defect on slag bowls (volume =16 m^3, m = 25 t).

3. Improvment the production of rolling rolls.



Currently, continuous work is being done to improve the technology of manufacturing rolling rolls. The key areas of work are: reducing the cost of the technological process, increasing the level of mechanical and operational properties of roll alloys, optimizing heat treatment modes to prevent crack formation and reduce its duration, optimizing the technology of smelting roll alloys, obtaining a given microstructure of rolls, etc. The research has been carried out for more than 20 years, which is confirmed by numerous monographs, as well as publications in Russian and foreign scientific publications.

Major projects implemented recently:

- developed a technology for using nitride ferrovanadium for alloying and modifying rolled cast iron in order to reduce its cost, as well as increase the level of operational properties;

- developed a mathematical model and software for predicting the thermal stress state of rolling rolls in order to reduce the heat treatment mode and prevent cracking.

4. Continuous casting of steel.

This direction is focused on improving the continuous casting of steel by changing the hydrodynamic conditions in the intermediate bucket, installing filter baffles, etc. In addition, another area of research is the development of engineering of the crystallization torus of the continuous casting machine for the purpose of increasing the service life, reducing the consumption of the copper billet, and applying a strengthening coating.

Implemented project:

- development of technology for using refractory structures in an intermediate buckets;
- development of a mold design with an upgraded cooling system that reduces the consumption of the copper billet.

The main areas of work of the Department are:

- Development of technology of foundry alloys and processes.
- Synthesis of new metallic and non-metallic alloys for pre-defined properties for special purpose castings.
- Development of technology for producing castings from high-quality cast iron and steel; modification, refining, development of new types of modifiers.
- Development of technology for manufacturing slag-stone castings.
- Design and reconstruction of foundries.
- Use of oxide waste from metallurgical production in technological processes.
- Development of technology for improving the wear resistance of metallurgical and machine-building equipment.
- Development of technology for the production of complex alloyed white cast iron for a wide range of purposes. Research, development and implementation of complex alloyed white cast iron with increased wear resistance and heat resistance.
- Development of technology for modifying the surface of metal products. Research, development and implementation of effective modes of thermal and thermomechanical processing of sheet steel (low-carbon, pipe, etc.).
- development of technology for plasma hardening of metals.
- Modification and microalloying of industrial steels in order to improve their complex mechanical and service properties (reducing the number and size of non-deformable non-metallic inclusions, liquation phenomena, etc.). research, development and implementation of thermal and thermomechanical processing modes (including strengthening and softening, with the effect of thermal adjustment of shaped profiles and the use of pre-deformation heating heat) of rolled products for a wide range of purposes. Metal science of welded joints.
- Development of technology for obtaining nanostructured materials.
- Design and reconstruction of thermal workshops and sites in mechanical engineering and metallurgy, including for thermal and thermomechanical processing in the production flow.
- Modeling and prototyping in the foundry and jewelry industry.