Research Activities

- Research and development activities in the field of materials engineering, with strong emphasis for metals and alloys cast technologies and composite materials
- Development of novel technologies for new engineering materials for use in foundry industry
- Accredited research of material structures and properties
- Comprehensive studies of metals and alloys in liquid state
- Prototyping and projecting by the RPS system (Rapid Prototyping System) with usage of the latest technologies in computing simulation environment (computer simulated environments)
- Designing of recycling systems for the materials used in foundry industry
- Designing of utilisation systems for wastes produced during technological foundry processes
- Statistical analysis associated with foundry industry
- Dissemination of knowledge related to foundry institute
- Certification of products, casting machines and supporting documents for foundry industry
- Workshops, conferences and seminars
- Scientific publications
Telephone rooms

Foundry Research Institute has 3 new conference rooms with state of the art tele conference facilities, the largest of which can accommodate up to 160 visitors. These rooms are suitable for conferences, symposia, and other meetings held in the Foundry Research Institute.

Integrated management system „eInstytut”

The integrated management system "eInstytut" is a multifunctional ERP system supporting management introduced throughout the Foundry Research Institute from August 2010. The introduced system is adapted to research and development centres. The system is fully operational with continuous developments and improvements carried out periodically.

We offer a welcome to interested companies and institutions who wish to introduce a similar system.

Library and Foundry Research Institute Reading Room

The technical library can be located under the Centre of Information and Promotion within Foundry Research Institute. The library resources are collected from 1946. This collection includes scientific literature from the field of metallurgy and metal casting, chemistry, physics, the history of techniques, natural environment protection, IT, marketing, quality systems, and production management. The resources of Foundry Research Institute are one of the largest collections of national and international books and scientific publications related to casting industry. Non members of Foundry Research Institute can use the library resources only in the reading room.

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Centre of Designing and Prototyping

Activities:
- Realisation of new models, constructions of castings and other components by fast prototyping methods
- 3D scanning of real models for restoration of technical documentation, dimensional control, archiving
- Design and prototyping of technologies using numerical methods
- Designing and implementation of casting precise technologies (Lost-wax casting, lost foam method, Shaw process)
- Investigation of materials for precise casting

Bureau for designing of technological processes

- Investigation of physical and chemical properties during the formation of a ceramic layer, in order to enhance quality of castings
- Design of technology for liquid ceramic masses to be used as a form for Ti, Ni, Co castings, as well as for composite materials in the centrifugal vacuum induction furnace (Super-Cast)
- Investigation of phenomena within castings and composite materials at high temperatures and pressures – hot isostatic press (HIP AIP30-10H)
- Investigation of thermophysical properties of ceramic materials dedicated for layered ceramic forms

Bureau of prototyping

Rapid prototyping

- Adjustment of proper technologies for production of prototype parts
- Model preparation by fast prototyping techniques: 3D printing, FDM, LOM, DotJet (Solidscape)
- Performing (performance? Or production of ?) of prototype castings by traditional and precise techniques
- Performing (same as above) of silicon dies and wax models
- Design of foundry technologies and preparation of constructional documentation for foundry instrumentation
Scanning (digitalisation) 3D

- Regeneration of technical documentation for the existing components
- Dimensional control of displacements based on colour map
- Conversion of the scanned objects for CAD format
- Archiving of carvings and museum objects in 3D

Art castings

- Development and implementation of art casting technologies
- Manufacturing of small-sized art castings

Bureau for computer assisted design of casting processes

Integrated modelling system

- CAD modelling – Solid Works, Solid Edge
- Analysis and optimisation of construction – ANSYS
- Analysis and optimisation of casting technology – MAGMASoft, Flow3D
- Modelling of casting properties
- Modelling of exploitation properties CAD-Ansys-MAGMA-Flow 3D-Ansys
Centre for High Temperature Studies

Activities:

- Investigation of high temperature kinetics of wetting and spreading of liquid metals and alloys in contact with the solid materials
- Investigation of high-temperature stability and reactivity of chemical systems metal/metal, metal/ceramic, metal/glass, glass/ceramic
- Investigation of joint durability between varieties of materials.
- Investigation of material thermal analysis with the intention of further activities:
  - Identification and analysis of phase transitions
  - Determination of heat treatment and parameters for casting alloys
  - Construction of CCT diagrams for steels and ductile iron ADI
  - Define the dependence of specific heat and density of the temperature
  - Determination of the coefficient of linear expansion
  - Determination of the heat (enthalpy) of phase transitions
  - Determination of the kinetic parameters of phase transitions

Provided services in the following areas:

- Materials selection for metallurgical instrumentations (crucibles, moulds, casting mixers etc.)
- The selection of the components of the composite Composite component selection
- Technological parameter selection with the purpose of joining variety of materials: metal/ceramic, metal/metal; metal/glass; glass/ceramic
- Technology and protective coating selection
- Verification of thermocouple accuracy and other instruments for temperature measurements by comparative method. (certified)
- Thermophysical property determination associated with temperature gradient for metals, alloys and ceramic materials, investigation of metal droplets on a ceramic surface
- State of the art facility for comprehensive studies of the properties of liquid metals and alloys at high temperatures

Metal-ceramic studies

State of the art facilities for surface phenomenon investigations of liquid metals and alloys with broad spectrum of capability:

- Studies at temperature up to 1500°C
- Vacuum pressure up to $10^{-6}$ hPa or ambient atmosphere
- Observations and recording of the wetting kinetics in the vertical plane

Additional (in situ studies)

- Purification of a droplet from an oxide by extrusion of the droplet from specially designed capillary
- Implementation of thermal stresses

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Investigations regarding the surface morphologies and the cross-sections of non exposed and exposed materials: metals, alloys, composites, joints metal/metal, metal/ceramics, and conductive powders performed by scanning electron microscope (SEM). Chemical analysis of the materials carried out using energy x-ray dispersive spectroscopy (EDS).

Corrosion Studies

- Investigation of oxidation/reduction kinetics in wide range of temperatures (20–1600°C)
- Investigation into monolithic and composites materials; solids and powders
- Studies in inert gas atmospheres
- Studies in oxidising atmospheres (air oxidation, air mixtures)
- Studies in aggressive atmospheres (SO₂, H₂S, CO₂, ammonia up to 1% per volume)
- Studies in vacuum atmospheres up to 10⁻⁶ hPa
- Characterisation of ceramic materials (determination of the purity and degradation)
- Characterisation of building materials (glass transition temperature)
- Thermal decomposition of polymers
- Phase transformation analyses
- Thermal stability studies and energetic effects of a chemical reaction
- Explosive reactions studies (reaction of sublimation)
- Identification of gaseous products of decomposition reaction

Our work is cited by NASA!

The results of the investigations performed in the Centre for High Temperature Studies are located in the NASA citations database. This achievement testifies about the importance of the centre in the world of the advanced future materials.
Laboratory of Chemistry and Moulding Materials

- Determination of the content of the following elements: Al, Ag, As, Ba, Be, Bi, Ca, Ce, Cd, Co, Cr, Cs, Cu, Fe, P, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Si, Sn, Sr, Te, Ti, V and Zn (basic components and trace elements) in metals, ferroalloys, and other casting materials done by common methods and by spectrophotometry, flame atomic absorption spectrometry and electrothermal atomization (SOLAAAR M6 spectrometer).

- Determination of the content of the following elements: Ag, Al, As, B, Be, Bi, C, Ca, Cd, Co, Cr, Cu, Li, Fe, Mg, Mn, Mo, Nb, Na, Ni, P, Pb, S, Sb, Si, Sr, Sn, Ti, V, W, Y, O, N, Zr, Zn, La, Nd, Pr (depending on the alloy type) in solid samples by the method of spark emission and glow discharge atomic emission spectrometry (ARL MA and GDS 850A spectrometers): low- medium- and high-alloyed steels, low- medium- and high-alloyed cast steels, gray, ductile and high-alloyed cast irons, and nickel, cobalt, aluminum, copper, magnesium, titanium and tin alloys.

- Determination of carbon and sulfur content in iron, cobalt and nickel alloys and in ferroalloys (chips) by the method of high-temperature combustion with IR detection – CS analyzer.

- Determination of oxygen, nitrogen and hydrogen content in iron, titanium, copper and cobalt alloys by the method of high-temperature extraction with IR detection (oxygen) and measurement of thermal conduction (nitrogen) – LECO TCH 660 analyzer.

- Testing of foundry molding materials:
  - full range of testing for foundry sands: water and clay binder content, chemical composition, content of carbonates, pH; sieve analysis with the determination of main fraction, homogeneity index, grain shape index; dry and green sand permeability,
  - auxiliary materials tested in the following range: sieve analysis, sintering point, gas evolution rate, time of skin hardening, time of through hardening, arbitration testing of bentonite, mechanical testing.

- Molding and core sands – common type, chemo-setting and thermo-setting tested for technological properties, i.e. water content, permeability, Pw, Ps, Pu; friability, compression, tensile, bending and shear strengths; sand bench life, and testing of sands for shell molding.

- Organic and inorganic binders and their respective hardeners tested for resin flowability, setting time of resins for coated sands, gelling time of sodium silicate with flodur hardener.

- Protective coatings for molds and cores, glues and release agents – determination of the sintering point of coatings, gas evolution rate from the components of coatings and from the ready coatings, hardening rate, abrasive wear resistance and adhesion of protective coatings, density, sedimentation, testing the strength properties of foundry glues and gas evolution rate;

- Testing of reference materials (reference calibration and recalibration samples for spectrometers) manufactured by Foundry Research Institute on request.

- training in the scope of chemical analytics: • optical emission spectrometry, • atomic absorption spectrometry, • testing of molding materials properties
Laboratory for Structure Analysis and Mechanical Testing

- Microscopic examination of metals, alloys, composites, ceramics, and metal-ceramic and metal-metal systems using a unique technique of selective color etching for revealing and identification of phases and microstructural constituents
- SEM examination methods using X-ray microanalysis technique for the identification of local chemical composition
- Determination of crack formation mechanism and propagation path in metallic materials based on fracture morphology identification
- Mechanical testing: static tensile test in the temperature range from -60°C to 1000°C, compression test at ambient temperature, bending test (also low-cycle fatigue test), including the use of extensometers and resistance tensonometry methods to determine, e.g. apparent elastic limit and yield strength, E modulus, Poisson’s ratio
- Impact resistance test at ambient, high and low temperature
- Hardness measurements according to Brinell, Vickers and Rockwell
- Product certification tests

Laboratory for Non-destructive Testing

- Research work performed with non-invasive procedures in order to identify the structure design and notice possible defects within this design
- Research work in order to increase the accuracy and precision of types of noticed internal defects and the accurate localization of those defects
- Research work that tries to expand scopes and mechanization of research with magnetic particle method for molds and elements made from ferromagnetic materials
- Research work concerning measurement of infrared radiation emitted by objects
- Research work connected with the usage of x-ray computed tomography in materials engineering, reverse engineering and measurement engineering
- Research work that is to fully make use of computed tomography in such issues like: detection and assessment of the size of defect, tests concerning the structure, analysis concerning the accuracy of the geometrical description, digitalization of real objects
- Science and research work that is to make a wider use of undamaging methods in tests of composite materials and other modern materials

Laboratory of Environmental Studies

- Studies of the workers safety and health protection - noise, vibration, dust, concentration of chemical compounds, microclimate, lighting of work stands, energy expenditure
- Studies of the emission rate of dust and gas pollutants
- Survey of industrial waste (determination of the contaminants leachability from a waste, determination of the waste impact on environment, waste classification, development of design guidelines for organized landfills)
- Studies of the toxic effect of molding materials (gas evolution rate during thermal decomposition of molding sands, qualitative and quantitative analysis of chemical compounds formed during the decomposition of materials)
- Development of guidelines for air protection
Department of Non-Ferrous Metals and Alloys

Activities:

- Developing new and optimizing the existing, non-ferrous, casting alloys, composites included
- Selection of technology to produce castings from non-ferrous alloys, from melting, refining and modification, through melt control and in heat treatment ending
- Selection of technological parameters of the casting process and of modern foundry machinery, equipment and tooling
- Fabrication and processing of metal matrix composites by casting techniques
- Development of new auxiliary materials, especially for die casting, and their implementation in foundries; assessment of the applicability of imported products under the conditions of domestic foundry shops
- Developing guidelines for the mechanization and automation of technological processes in the non-ferrous metalcasting industry
- Reviewing applications for funding and expertises
- Developing guidelines for technology projects to build new foundry plants or upgrade the existing ones
- Manufacture and homogenizing of metal-ceramic mixtures, including nanomaterials
- Recycling of foundry process scrap of non-ferrous alloys
- Studies of the thermal shock resistance of various materials
- Studies of the electrical conductivity of non-ferrous metals and their alloys
- Workshops, seminars and conferences on the advanced methods of casting non-ferrous metals, with particular emphasis on the high-pressure die casting process
- Production potential to perform small-lot production of castings from non-ferrous alloys by sand mold casting technique, gravity and high pressure die casting, and squeeze casting (Al and Mg alloys), including thixocasting process
- Measurement of hydrogen content, non-metallic inclusions and density of aluminum alloys
- Thermal-derivative analysis (TDA) of aluminum alloys
The composite passive armour protection

Passive composite armor protection, according to the original engineering thought is built with a special multi-layer structure embedded in a metal matrix alloy in the outer layer topped with a metal or ceramic geometric solids.

More information can be found at www.iod.krakow.pl/pancerz/

Fly ash cordierite

The high temperature cordierite moulder produced by the low-temperature synthesis of coal power plant fly ash.

Video recording of cooling processes by infrared camera

Infrared cameras allow analysis in heat escape from the technological processes.

- The use of FLIR SC620 thermovision camera
- Resolution 640–320 pixels
- Measurement range 50–1500°C
- Sensitivity 0.0035K
- Recording rate 30 frames/s

Thermal stresses studies
Department of Ferrous Alloys

In the field of metallurgy and technology

- upgrading of departments for cast-iron and steel production,
- development and implementation of technology for various type of cast-iron: vermiculared, spheroidized alloyed and cast-steel,
- Development and implementation of the production spheroidizators, modifiers and de-oxidants for cast-iron and cast-steel.

In terms of melting, measurements and heat treatment

- Melting and casting alloys based on Fe, Co, Ni in a laboratory scale test sample, small scale production,
- Erosion studies for metals, alloys and ceramics,
- Spectrometric performance standards for cast-iron alloys (offer),
- Measurements of physical quantities during melting processes,
- Pouring and solidification using computer technology,
- Manufacturing of thermocouples Pt-Rd-Pt, Ni-Cr and engineering advice on temperature measurements.

Thermal stresses analysis

The following measurements are possible:

- number of thermal fatigue cycles
- effective resistance
- elongation
- thermal stresses
- voltage
- current
- temperature
Department of Technology

Activities:

- Production of moulds and cores (cold-box, warm-box, forming shell, the same weight and chemically hardened),
- Classic technology of forms,
- Regeneration of spent sand moulding and core,
- Sand processing for use in other industries,
- Recycling of post industrial scrap for foundry needs
- Development of modern machinery and equipment for the foundry industry

Refractometer RX-7000 α

Features and benefits:

- Up to 1.7000 in nD measurement
- Up to 70°C in measurement temperature
- Equipped with a Peltier thermo-module for maintaining a constant measuring temperature, eliminates the need for an external water-bath
- The measurement starts automatically after the sample reaches the targeted temperature
- The refractive index and Brix, at your targeted temperature, are quickly displayed
- Top and bottom limit bar graphic is displayed together with the measurement value, when top and bottom limits of a standard value are set
- Manual calibration is possible to compensate for the difference between standard liquids and measured values by other refractometers
- Flash memory, capable of recalling the last 30 measured values for display, printing and/or exporting to a computer

Dusttrak DRX Aerosol Monitor 8533

Real-time dust monitoring takes a giant leap forward. Only the DustTrak™ DRX Aerosol Monitor 8533 can simultaneously measure both mass and size fraction – no other monitor can do both. The DustTrak DRX desktop monitor is a battery operated, data-logging, light-scattering laser photometers that gives you real-time aerosol mass readings.

It uses a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. It is suitable for clean office settings as well as harsh industrial workplaces, construction and environmental sites and other outdoor applications. The DustTrak DRX monitor measures aerosol contaminants such as dust, smoke, fumes and mists.

Features and benefits:

- Simultaneously measure size-segregated mass fraction concentrations corresponding to PM$_{1}$, PM$_{2.5}$, Respirable, PM$_{10}$ and Total PM size fractions
- STEL alarm setpoint
- Automatic zeroing (with optional zero module) minimizes the effect of zero drift
- Perform in-line gravimetric analysis for custom reference calibrations
- Manual and programmable data logging functions
- Desktop unit
- Aerosol concentration range 0.001 to 150 mg/m$^3$
Product Certification and Standardisation Office

Certification and Standardization Office is responsible for:

✓ Certification
✓ Standardization

CERTIFICATION

Certification and Standardization Office as a product certification body has been operating since 1995. At present it operates basing on the Law of 30 August 2002 on the conformity assessment system with later amendments, and in accordance with the requirements of PN-EN ISO/IEC 17065:2013.

The confirmation of the competence of the Certificate of Accreditation AC 030, issued by the Polish Centre for Accreditation.

The unit conducts certification:

✓ in the area of voluntary – certification of conformity of products, in particular:
  - products for sewer systems and securing roads,
  - pipes and piping components,
  - plumbing fixtures and installation of central heating,
  - the coupling parts,
  - other products and cast iron, cast steel, aluminum and other non-ferrous metals,
  - auxiliary materials for foundries and steel,
  - machinery and equipment for foundry,

✓ in the area of regulated domestic – certification of construction products and factory production control in accordance with the Regulation of the Minister of Infrastructure dated 11.08.2004 on the method of declaring the conformity of construction products and how they are marking a construction sign, in particular:
  - pipe, piping components, metal fasteners, fittings used in potable water systems,
  - fasteners for structural wood products.

STANDARDISATION

Standardisation activities covers all of the tasks associated with running the secretariat of the Technical Committee No. 301 for Foundry appointed by the Polish Committee for Standardization.

Basic tasks performed by KT No. 301 include: the introduction of European standards (EN) and international (ISO) to PN, the development of national standards (PN) on behalf of the industry, the share of in the development of EN and ISO standards, the provision of information on standards developed by KT No. 301

Filed under standards developed by KT No. 301 covers all issues of casting from the scope of the Committee Technical No. 301, with particular emphasis on casting and casting alloys and their research, the supply of castings, safety requirements and equipment for the production of metal shaping, molding and auxiliary materials.
Centre of Information and Promotion

Activities:

- Library
- Transcription of Foundry Institute
- Workshops, trainings, seminars (including promotional seminars for companies)
- Information services
- SINTE data base
- Database analysis of foreign articles
- Apprenticeships and research internships

Transcription of Foundry Institute

In the „Articles of Foundry Institute” publishes the original articles related to:

- Advanced casting engineering materials,
- Analyses of alloys coagulation and crystallization processes,
- Design and development of foundry product by computer support,
- Modelling studies of castings processes.

More information can be found at www.prace.iod.krakow.pl

Book publishing

Publishers send by post. The price of publications will be added shipping cost depends on the size of the order. To be sold over the Internet.

SINTE database

SINTE catalogue established at 1977 is a bibliographic database devoted to casting industry. The database containing abstracts of more than 38 000 articles originated from casting magazines (American, English, French, German, Czech, Slovenian, Russian, Ukrainian). In addition SINTE database containing work performed during conferences and research work performed by members of Foundry Research Institute in Krakow.
