
iMT

INSTITUTE OF METALS AND TECHNOLOGY

The Institute of Metals and Technology (IMT) is a public research institution for fundamental and applied research in natural, technical and environmental sciences. The IMT's programs are mainly funded from the state budget of The Ministry of Education, Science and Sport of the Republic of Slovenia through its program and project financing (70%), with the rest of the support coming from the Slovenian Steelworks and external contracts. Following the program of The Ministry of Education, Science and Sport the institute educates young scientists to the level of Master's and Ph.D. degrees. Some of the Institute's experts are involved in the education process at the University of Ljubljana, in both undergraduate and postgraduate studies. The applied and developmental research being carried out at the IMT is partly or entirely supported from private, governmental and industrial enterprises as well as other ministries.

History

The Slovenian Government established the Institute of Metals and Technology, formerly the Institute of Metallurgy, Ljubljana, in 1950, in order to provide a foundation for research and development in metallurgy. Priority was initially given to extraction metallurgy. Later it shifted gradually towards the development of alloys, their processing and improvements to their properties. For this reason, in 1990, the Institute's name was changed to its present form, which better corresponds to the work undertaken by the IMT. In 1997 the Institute was transformed into a public research institute by The Ministry of Science and Technology of the Republic of Slovenia. In terms of the number of employees the IMT represents a small public research institute but it nevertheless possess an advanced research potential in both fundamental and applied research in the field of material science, especially metals, alloys, composites and vacuum science.

Researchers

In 2002 the IMT had 61 employees:19 with a Ph.D. degree, 4 with a Master's degree, 6 young researchers, 4 university diploma engineers, with the rest being either technical or administrative staff.

Basic work of IMT

The basic work of the Institute covers a number of different research fields.

Fundamental research in the field of natural sciences especially metals, alloys, composites and vacuum technique:

- Fundamental research in the field of natural sciences, especially metals, alloys, composites and vacuum techniques;
- Fundamental research in technical sciences, especially metallurgy;
- Studies of emission and imission for environmental protection;
- Studies of scrap from steelworks and industry in Slovenia and the surrounding region;
- Applied research in metallurgy, casting, energy, mechanical engineering, metal-working and other industries;
- Research & development and the introduction of new solutions in the metallurgical, metal-working, casting, and electro-machining industries as well as the energy sector;
- Prediction of the lifetimes of devices and structures in different branches of industry and traffic infrastructure combined with improvement recommendations and the introduction of new materials;
- Education of post-graduate researchers;
- Professional training and education;

- Informatics work: special library, databases in the field of metallurgy, material science, and vacuum science;
- Advice and infrastructure services;
- Publishing of a scientific journal in the field of material science research;
- Organization of scientific and professional conferences, workshops and congresses.

The work is organised into three research programs and one research group, individually they cover different fields, but in overlapping areas they carry out cooperative studies.

- **Metallic materials and process technology**
- **Applicability and lifetime of metallic materials and products**
- **Surface engineering and applied surface science**
- **Vacuum science and opto electronics**

Other activities:

- Center for surface and microstructure characterization of materials
- Center for physico-chemical research of metallic materials

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LABORATORY FOR ANALYTICAL CHEMISTRY

Activities

- Research and development of analytical methods for the characterization of metallic and inorganic materials (flame, electrothermal and hydride atomic absorption spectrometry, optical emission spectrometry),
- Determination of the composition of metals, alloys, and other metallic and non-metallic materials, including the determination of trace elements in concentrations as low as 1 µg/g,
- Chemical analysis in connection with environmental problems,
- Cooperation in inter-laboratory comparative test programmes with authorized foreign laboratories,
- Conformation with the general requirements for the competence of testing and calibration laboratories (EN ISO/IEC 17025:2000).

Major Equipment

- Flame (Perkin Elmer 2380) and graphite furnace (GBC 902) atomic absorption spectrometers,
- ARL OES 3460 optical emission spectrometer,
- ELTRA CS800 equipment for carbon and sulphur determination and ELTRA ON900 equipment for oxygen and nitrogen determination,
- Optical emission spectrometer (ARL 3460),
- Inductively coupled plasma atomic absorption spectrometer ICP-AES (PERKIN ELMER Optima 3100 RL).

Head of Laboratory

Dr. Aleksandra Kocijan
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ON and CS analyzers

LABORATORY FOR CORROSION

This laboratory focuses on fundamental and applied research on the corrosion degradation of iron-based and other alloys, and the solving of corrosion problems in industry. Apart from their research studies, the staff of this laboratory also present lectures, train technicians, and educate undergraduate and postgraduate students about corrosion and its effects.

Activities

Corrosion research and expert studies carried out in the Laboratory for Corrosion are closely connected with corrosion in the following forms:

- Uniform corrosion (atmospheric corrosion, galvanic corrosion, corrosion in molten salts, high-temperature corrosion);
- Metallurgically influenced corrosion (intercrystalline corrosion, selective dissolving of elements);
- Local corrosion (crevice corrosion, pitting corrosion);
- Corrosion cracking (stress-corrosion cracking, hydrogen-induced stress-corrosion cracking);
- Mechanically assisted degradation (erosion corrosion, cavitation, corrosion fatigue).

Major Equipment

- EG&G PAR 352 Soft Corr computer-assisted electrochemical corrosion measurement equipment, with one steady and one rotating electrode;
- Three tensile testing machines with a constant-load facility for research into stress corrosion cracking and hydrogen embrittlement using anodic or cathodic polarization;
- A double-cell system for measuring the permeability of metals to atomic hydrogen;
- A Hewlett Packard gas chromatograph for determination of the content of atomic hydrogen in metals by means of high-temperature vacuum extraction;
- An autoclave for the performing of stress corrosion tests in chloridic and other aggressive media at high temperatures and pressures;
- A wet corrosion chamber;
- A saline-spray corrosion chamber.

LABORATORY FOR MECHANICAL TESTING

Activities

The Laboratory for Mechanical Testing performs mechanical tests on all kinds of semi-finished and finished metallic products. The tests are performed according to SIST, EN, DIN and ISO standards, whereas some tests are also carried out using non-standard methods. The mechanical examinations are mainly supplemented by chemical and metallographic examinations that are complemented by a knowledge of the metals' properties.

The laboratory is authorized to certify chains and their components by The Ministry of Education, Science and Sport of the Republic of Slovenia, and is in an accreditation process for this activity.

Major Equipment

- 500 kN INSTRON static-dynamic testing machine;
- 300 and 20 kN AMSLER universal tensile testing machine;
- Charpy device for impact tests at different temperatures;
- Hardness testers, according to Rockwell, Brinell and Vickers;
- Electronic equipment for the calibration of machines that measure forces up to 1000 kN (tensile testing machines, compression testing machines and dynamometers), composed of electronic amplifier DK 38 (Hottinger) and six electronic measuring load cells with a measuring error below 0.05 %;
- Test etalons for the calibration of hardness testers by Brinell, Rockwell, Vickers and Shore.

Head of Laboratory

Boris Arzenšek, B.Sc. (Metall.)
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Static-dynamic testing machine INSTRON 1255 500/250 kN

LABORATORY FOR CREEP

Activities

- Research on the creep deformation of metallic materials, and the development of constitutive creep equations,
- Research and development of new test methods for creep measurement on small-scale specimens,
- Development and application of methods for the prediction of the remaining life-time of power-engineering components,
- Standard creep measurements in a protective atmosphere at temperatures up to 700 °C.

Major Equipment

- Two test devices for creep measurements at constant load,
- One test device for creep measurements at constant stress,
- One small-punch test device for creep measurements on small disc-shaped test specimens.

Head of Laboratory

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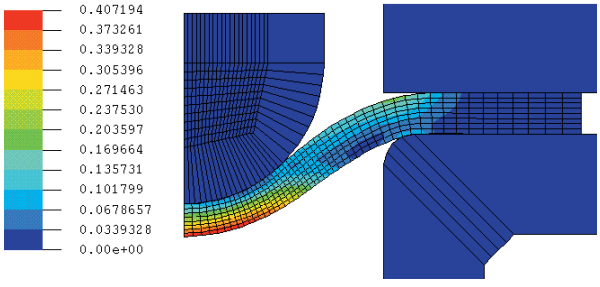

FEM distribution of effective strain in the disk test specimen at Small Punch creep measurements (in cooperation with C3M, Ljubljana)



Constant-load creep measurement test devices in Creep Laboratory

LABORATORY FOR PROCESS METALLURGY

Current research involves the optimisation of processes by means of process sensors, process modelling and computer-assisted process control. Particular attention is paid to the development of a thermo-chemical computer model of steelmaking and gas-burning processes:

- verification of the technological specification of steelmaking processes on the basis of modern steelworks technology,
- evaluation of various technologies from the technical and economic points of view,
- application of modern technologies, such as melts refining in a ladle furnace and vacuum devices, and the introduction of deoxidants and additives such as CaSi and Ti to the melt,
- computer simulation of steelmaking processes, with the aim of improving the quality of production and raising the level of process management (ladle furnaces, VOD/VAD, AOD converters, electro slag remelting),
- complete technical support using appropriate measuring and controlling equipment for the successful management of steelmaking processes (direct method for oxygen measurement and automatic sampling of melts and slag, control of vacuum treatment in VOD by means of the PAT measuring technique),
- development of mathematical models for steelmaking processes, such as the oxidation of carbon, development of algorithms for the deoxidation of melts, the selection and management of the modification of non-metallic inclusions, and the dosing of additives,
- advising about the optimisation of alloying and the selection of optimal alloying technologies,
- advising about the optimisation of the use of refractory materials and assistance in the preparation of databases for technical-marketing analyses,
- training of smelters and key workers in the field of steel production.



Oxygen sensor for direct measurement of active oxygen in molten steel

LABORATORY FOR THERMAL ENGINEERING

Activities

Heat-engineering measurements in industry, calibration of thermocouples, real-time simulation of heating and cooling processes.

Heat-engineering measurements in industry

The aim of these measurements is to achieve a reduction in energy consumption, as well as to improve the technology and quality assurance of the operation of all industrial heating furnaces.

A portable measurement system is being developed for efficient heat-engineering measurements in industry. This system will make it possible for measurements to be performed without any disturbance to normal production processes.

Major Equipment

- 2 Dataloggers (40-channel Schlumberger Datalogger and HP 34970A),
- 2 Oxygen probes (Westinghouse, Enotec),
- Trail thermocouples with lengths up to 150 m, suitable for all continuous furnaces,
- 3 pressure-measuring converters,
- Industrial Portable Computer.

For calibration purposes the following items are used:

- a GERO laboratory furnace,
- a HP 3458A measuring system,
- a standard thermocouple type B,
- a standard PT 100,
- software for calibration purposes.

Head of Laboratory

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Laboratory for thermal engineering

Department for the Technology of Metallic Materials

NON-FERROUS METALS AND ALLOYS

The activity of the laboratory involves both, fundamental and applicative research, as well as the development of products for industrial use, at laboratory or industrial level, optimisation and advising in the following fields:

- Research and development of new alloys and composites of non-ferrous metals;
- Research, development and optimisation of technologies for the manufacturing and the processing of non-ferrous metals and alloys;
- Research and development of alloys with special properties;
- Development and production of sintered contact materials, as well as of electrodes for erosion;
- Development and production of small metallic filters with controlled fluid flow;
- Development and manufacture of primary reference materials and standards;
- Advising on the selection and use of non-ferrous metals and alloys;
- Research, development and optimisation of technologies for the manufacturing and processing of special alloys: anti-friction metals, water-lubricated bearings, bio-compatible materials; dental alloys, Stellite alloys, soft and hard solders; soft and hard magnetic alloys for electrical engineering, copper, aluminium, silver and gold-based alloys;
- Expert studies.

Head of Laboratory

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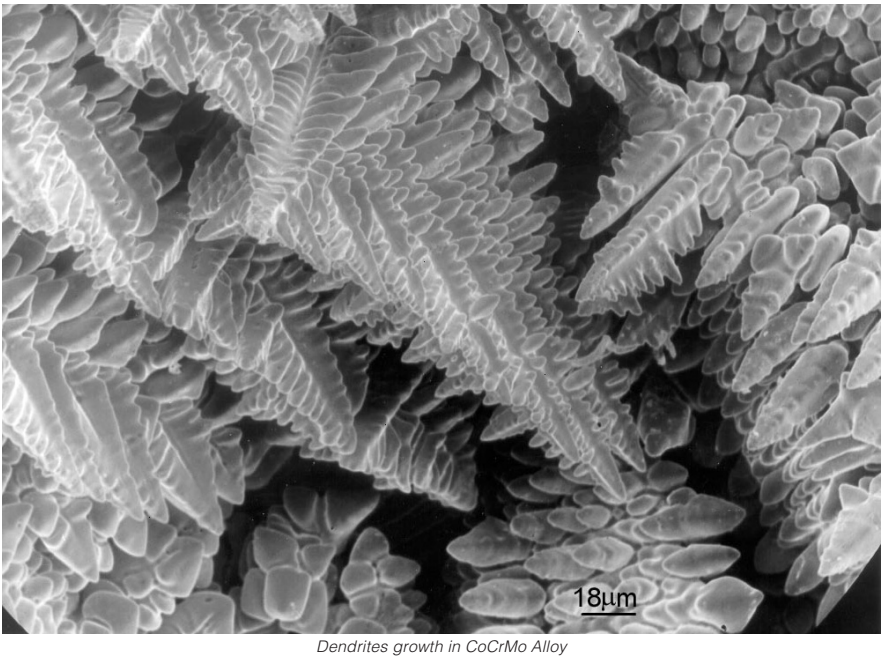

Dendrites growth in CoCrMo Alloy

VACUUM HEAT-TREATMENT AND SURFACE ENGINEERING CENTRE

The Laboratory performs vacuum heat treatment, heat treatment in a fluidised bed and ion nitriding in pulsed plasma, and provides services in the fields of the thermal and thermo-chemical treatment of industrial tools with weights of up to 400 kg. The Laboratory also undertakes research and development projects.

Major Equipment

- An Ipsen VTTC-324R single-chamber high-temperature vacuum furnace, with uniform high-pressure gas quenching and a working volume of 610×910×350 mm.
- A Metaplas Ionon HZIW 600/1000 bell-type furnace with two bottoms for ion nitriding, nitrocarburizing, oxynitriding and sulfonitriding of steels as well as DC and pulsed-plasma nitriding of titanium and titanium alloys, with a working chamber of diameter 600 mm and height 1000 mm. The furnace is used to treat the surfaces of tools and machine parts, to increase the wear and corrosion resistance of metallic materials and to obtain decorative surfacing,
- An experimental inductively heated fluo-solid device for the heat treatment of steel parts in a fluidised bed, with a working diameter of 160 mm and a height of 300 mm, as a substitute for environmentally questionable heat treatments in molten salts.

Head of Laboratory

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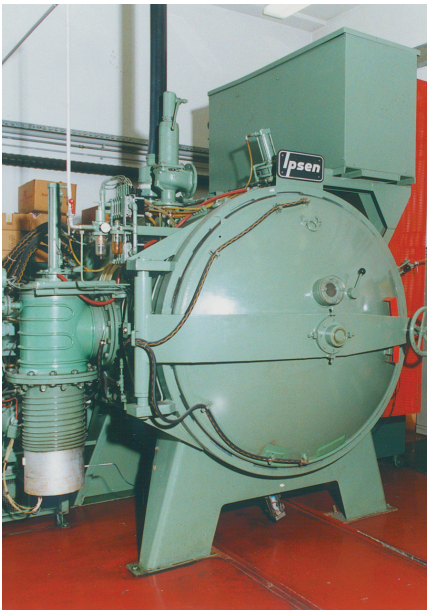

Vacuum furnace VTTC-324R



Furnace for pulsed-plasma nitriding

LABORATORY FOR POWDER METALLURGY

- Manufacturing of special metals and alloys by P/M;
- Manufacturing of powders for soldering, brazing and flame/plasma spraying, as well as for contacts and magnets;
- Manufacturing of metals and alloys by rapid solidification (amorphous and microcrystalline materials);
- Advising on the selection of materials and products synthesised from powders;
- Services to customers;
- Characterization of powders and P/M products (chemical analyses, determination of the morphological and other properties of powders, optical and electron microscopy, determination of mechanical and corrosion properties);
- Research and development of new metallic materials (magnets, composites, stainless steels, high-speed steels and other wear-resistant materials) from powders;
- Development of software for the simulation of atomization and other P/M processes.

Major Equipment

- Equipment for the production of metallic powders by water atomisation,
- Melt-spinner and a crusher for amorphous and microcrystalline ribbons,
- Cold isostatic press for metal and ceramic powders (max. pressure 400 MPa),
- Laboratory furnace for sintering in a protective atmosphere or in vacuum,
- Other laboratory equipment for the synthesis and characterization of powder materials.

Head of Laboratory

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Water atomizer and melt-spinner

METALLIC MATERIALS WITH SPECIAL PROPERTIES

Fundamental and applied research and development of metallic materials with special properties in close connection with the other laboratories of the Institute.

- Nickel superalloys,
- Biocompatible alloys,
- Fe- and Ni- aluminides,
- Metal-matrix composites,
- Protective coatings against high-temperature oxidation.

Material production techniques

- Melting and casting in a 25-kg-capacity vacuum induction furnace,
- Consolidation of powder materials,
- High-temperature reactive synthesis.

The available equipment is used for the research and development of new materials by casting, mechanical alloying, consolidation of powders, hot and cold working, microstructural characterization, chemical analysis, mechanical testing, corrosion resistance testing, and the testing of other properties.

Influence of a selected protective coating on the content of iron in the scale of various steels after annealing in an industrial furnace

Steel	W.Nr.[1]	Fe in scale		Heating	
		Uncoated	Coated	Time	Temp.
		(%)	(%)	(h)	(°C)
Č.0361	1.0122	75.0	61.0	4.5	1140
Ck 45	1.0503	85.3	66.3	4.5	1140
Ck 60	1.0601	74.0	57.0	4.5	1100
PŽ 70	1.0615	71.6	35.2	4.5	1100
OCR 4ES	1.2067	73.4	72.8	15	1290
OCR 4ES	1.2067	72.5	70.5	2	1170
UTOP Mo1	1.2343	57.8	47.0	10	1180
OSIKRO SP	1.2552	74.0	74.0	2	1270

[1] Werkstoffnumern, DIN 17007.

Head of Department

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LABORATORY FOR METALLOGRAPHY

In the Laboratory for Metallography, microstructures are examined for research purposes and for external users:

- Micro- and macroscopic investigation of metals and alloys,
- Qualitative and quantitative microstructural analyses,
- IDentification – definition and interpretation – of the micromorphology of fractures and surfaces,
- Macro- and microstructural examinations using optical and scanning microscopes,
- Study of solid phase transformations by dilatometry,
- Measurements of microhardness.

Major Equipment

- Nikon Microphot FXA optical microscope with Hitachi HV-C20A 3CCD video camera and AnalySIS software for metallographic image analysis,
- Leitz optical microscope,
- Struers automatic precision cut-off machine Accutom 50,
- Struers programmable mounting press ProntoPress-20,
- Struers apparatus for automatic grinding/ polishing Abramin with MD system,
- Jeol Scanning Electron Microscope – JSM35
- Leitz Durimet microhardness tester,
- Dilatometer.

Head of Laboratory

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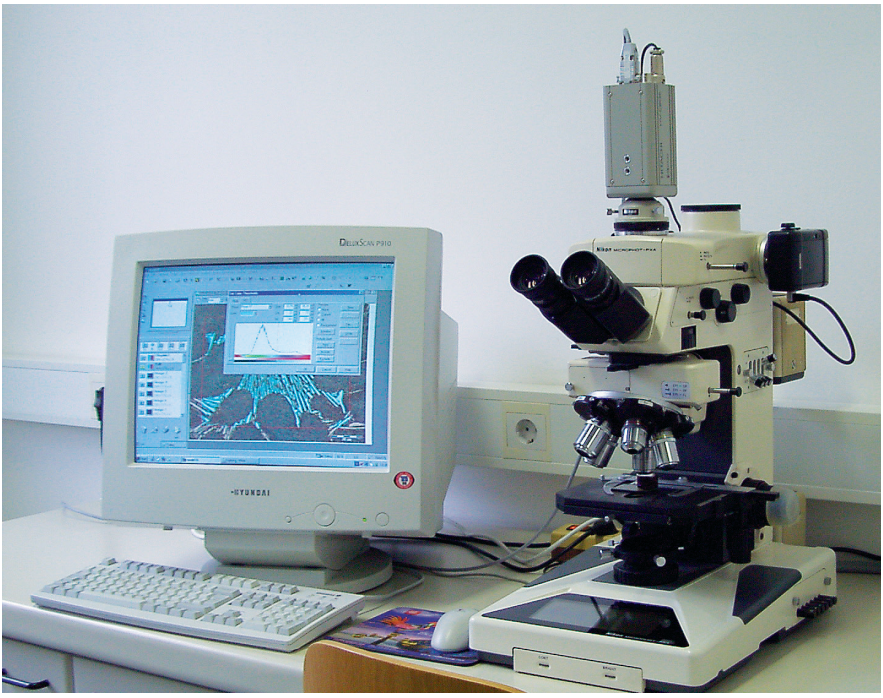

Nikon Microphot FXA optical microscope with Hitachi HV-C20A 3CCD video camera and AnalySIS software for metallographic image analysis

LABORATORY FOR THE SURFACE CHARACTERIZATION OF MATERIALS

Research and characterization of solid surfaces, boundaries, surfaces of grains and phases, the analysis of microstructures and nano features; research into physical-chemical phenomena on the free surfaces of metallic and inorganic materials: adsorption, segregation of surface-active elements, oxidation, corrosion, recrystallization, wear, catalysis and analysis of thin and ultra-thin films.

- Research, development and optimisation of the manufacturing of soft magnetic materials and electrical steel sheets,
- Characterization of nano carbide precipitates in steels and iron-based alloys,
- Investigation of the surfaces of metals covered by metallic or non-metallic films by means of in-situ analysis and measurements in ultra-high vacuum at temperatures of up to 1000 °C,
- Research into the interactions of the gas phase and the solid surface of materials,
- Characterization of surfaces after tribological testing,
- Magnetic measurement of soft-magnetic materials.

Major Equipment

- Microlab 310F VG-Scientific, a high-resolution field-emission Auger electron spectrometer (AES), scanning Auger microscopy (SAM), secondary electron microscopy (SEM), depth profiling, X-ray photoelectron spectroscopy (XPS) with “in-situ” fracturing device, for research of phenomena of surface segregation and boundaries between grains and phases,
- Steingrover Remagraph RE for measuring magnetic field magnitude, magnetic induction, permeability, coercitivity and hysteresis losses,
- Tempres furnace for the simulation of industrial environments, in the temperature range from 400 to 1200 °C, different gas at atmosphere such as H_2, N_2, Ar etc.

Head of Laboratory

A/Prof. Dr. Monika Jenko;
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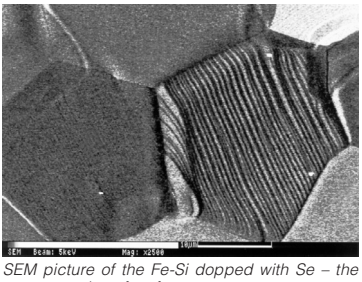
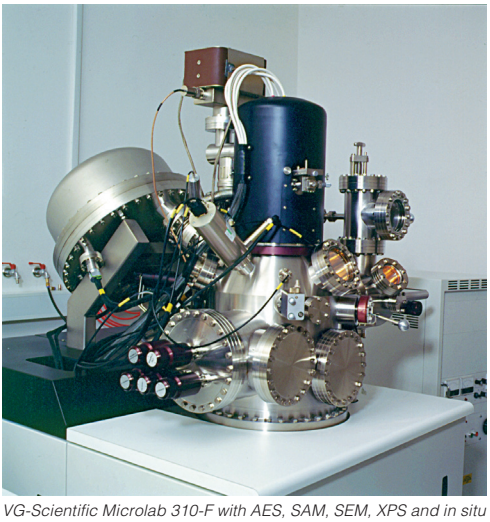


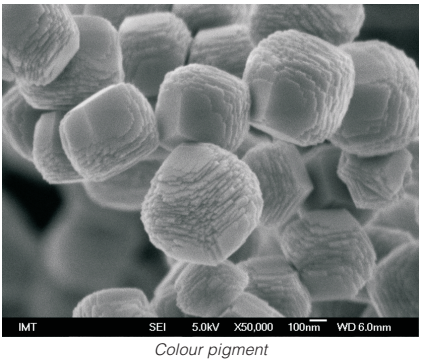
SEM picture of the Fe-Si dopped with Se – the reconstruction of surface



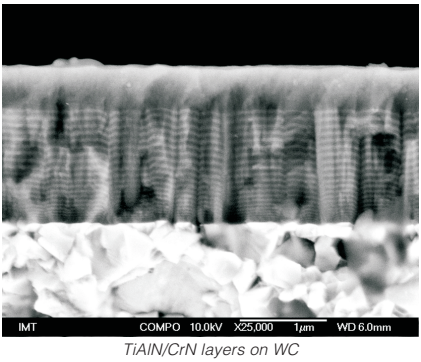
VG-Scientific Microlab 310-F with AES, SAM, SEM, XPS and in situ fracturing device



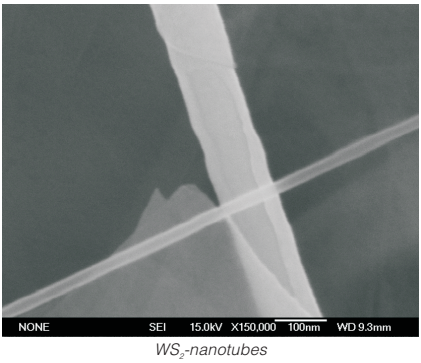
Field emission gun scanning electron microscope JSM-6500F with analytical attachment EDS, WDS and EBSD



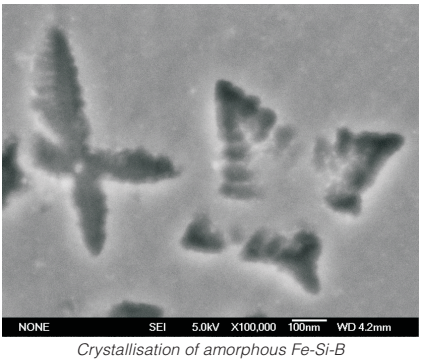
Colour pigment



TiAlN/CrN layers on WC



WS_2-nanotubes

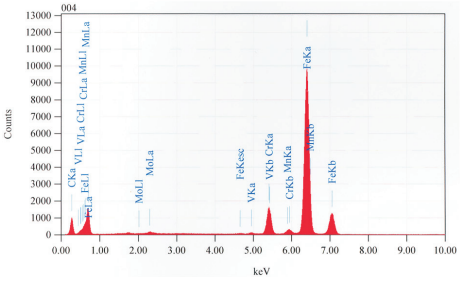


Crystallisation of amorphous Fe-Si-B

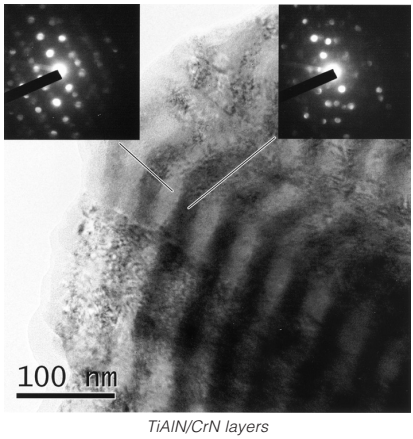


Transmission electron microscope JEM 2100 with EDS





Carbide precipitates in P91 steel



TiAlN/CrN layers

LABORATORY FOR EXPERIMENTAL DEVELOPMENT OF METALLIC MATERIALS

The following equipment is available: a 20-kg vacuum-induction melting furnace, an electric furnace operating up to 1300 °C, a hot- and cold-rolling mill, a hot- and cold-drawing device for bars and wires, conventional heat-treatment and annealing devices. The Laboratory's main task is the production and preparation of materials and samples that are needed for research and development studies at the IMT. Additional equipment capacities are used to provide services for outside customers.

Production program

- Melting and re-melting of metals and alloys in air, in a protective atmosphere or in vacuum,
- Casting in metallic moulds, as well as in cronning or CO_2 sand forms,
- Manufacturing soft- and hard-magnetic materials,
- Dental alloys based on cobalt or nickel,
- Other metallic materials with special physical characteristics,
- Hot and cold rolling,
- Hot and cold-drawing of rods and wires,
- Conventional heat treatment and annealing, including treatment in neutral, reducing atmospheres or Pb bath,
- Equipment for determining fast temperature changes from liquid to solid state, up to 1800 °C,
- Maintenance and improvement of laboratory devices, furnaces, and their regulation,
- Single- and multi-zone laboratory furnaces with low thermal capacities, with homogeneous temperature zones and protective atmospheres, with controlled heating up to 1000 °C,
- Normal or very precise (±0.5 °C) regulation of furnaces, with graphical records or computer control of the heating or cooling process,
- Laboratory furnaces with limited overheating of test specimens up to 1.5 °C from the calibrated temperature, and a temperature oscillation limited to ±0.5 °C on the surface of the specimen.

NATIONAL CENTRE FOR THE REVITALIZATION OF INDUSTRIAL STRUCTURES AND EQUIPMENT

Activities

- Prediction of the remaining life-time of steel structures and equipment in operation,
- Quality control of the manufacturing and erection of steel structures,
- Safety in the field of nuclear power production,
- Quality assurance for power-engineering equipment,
- Quality control of welds,
- Welding repairs,
- Attestation of welders and welding methods,
- Non-destructive testing (RTG, UT, ECT, MT, PT)
- Measurements of wall and painting thickness,
- Fracture analysis and Evaluation of failures,
- Measurement of fatigue-cracks propagation,
- Measurement of the threshold value of Δk_{th} for crack propagation,
- Evaluation of the microstructures via the replica method,
- Project design and project management,
- Research and development.

Major Equipment

Cracktronic resonant pulsator for measurements of fatigue crack propagation • Fractomat device for measurements of crack length • Software for the calculation of stresses in steel structures and equipment • Equipment for the preparation of replicas • Krautkramer DMS ultrasonic thickness gauge • Krautkramer USN 52 ultrasonic device • Hocking PHASEC 2200 eddy-current instrument • Portable industrial x-ray unit, YXLON SMART 225 kV (Andrex).

Head of the Centre

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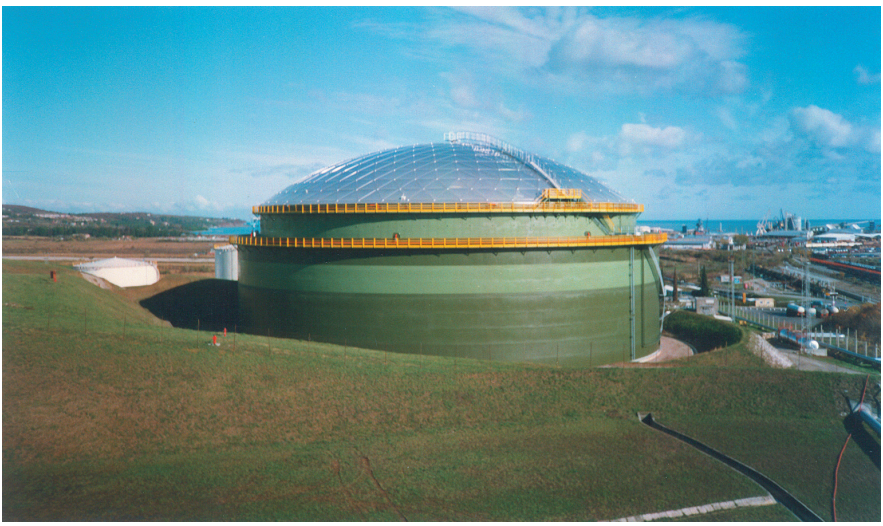


Vue of the 60.000-m³ reservoir

LABORATORY OF PRESSURE METROLOGY

The Laboratory of Pressure Metrology (LMT) at the IMT was established in 1999. The laboratory plays a key role in the Slovenian National Metrology System, which is organized as a distributed system and coordinated by the Metrology Institute of the Republic of Slovenia. Within this system the LMT is the top-level laboratory for the derived physical quantity of pressure. The laboratory provides international traceability of the highest-level reference standards for vacuum and pressure, and dissemination to lower hierarchical levels within the country. The range of the laboratory's capabilities extends from vacuum at 10^{-5} Pa up to a high pressure of 200 MPa. The laboratory gained accreditation from Slovenian Accreditation in 2002.

The Laboratory is also active in the field of scientific metrology of the physical quantity pressure. Research and development work is mainly focused on the development of horizontal traceability of a low-range piston gauge to Slovenian national standards of base quantities of the SI system, the extension of the pressure scale to lower pressures (vacuum) by static expansion and studies of the metrological characteristics of vacuum transfer standards.

Reference Standards	Measuring range	Best Measurement Capability
Pressure balance DH Instruments, Inc., Model PG 7302	5 MPa – 200 MPa	0.005 %
Pressure balance Ruska Instrument Corp., Model 2465A	1,4 kPa – 7 MPa	0.0032 %
Quartz Bourdon Gauge Ruska Instrument Corp., Model DPG 7000	100 Pa – 110 kPa	0.01 %
Capacitance Diaphragm Gauge MKS Instruments, Model 690	1 Pa – 1,4 kPa	0.5 %
Spinning Rotor Gauge MKS Instruments, Model SRG-2CE	10^{-5} Pa – 1 Pa	1 %

Head of Laboratory

Dr. Janez Šetina
E-mail: janez.setina@imt.si



SLOVENSKA AKREDITACIJA

št. / No. LK-012

akreditacijska listina
accreditation certificate

Inštitut za kovinske materiale in tehnologije
Laboratorij za metrologijo tlaka
Lepi pot 11, 1000 Ljubljana

Organizacija je akreditirana pri Slovenski akreditaciji (SA), kot kalibracijski laboratorij, S to listino se priznava izpolnjevanje zahtev standarda
SIST EN ISO/IEC 17025:2002
za dejavnosti, ki so opisane v prilogi te listine, označeni z isto številko.

Datum prve podelitve akreditacije: 18. februar 2002
Akreditacijska listina velja do: 17. februar 2011

Ta akreditacija velja do navedenega datuma pod pogojem, da akreditirani organ izpolnjuje zahteve SA za akreditacijo.

Slovenska akreditacija (SA) je podpisnica sporazumov o medsebojnem priznavanju akreditacij na področju kalibracijskih in preskuševalnih laboratorijev pri Evropskem združenju za akreditacijo (EA) in pri Mednarodnem združenju za akreditiranje laboratorijev (ILAC).

The above entity has been accredited by Slovenian Accreditation (SA) as a a calibration laboratory. This is to signify compliance with the requirements of the for the approved scope of accreditation as described in the Annex hereto marked with the same number.

Initial accreditation date: 18 February 2002
This certificate is valid until: 17 February 2011

This accreditation shall remain in force until the above date subject to continuing compliance with SA accreditation requirements.

Slovenian Accreditation (SA) is a signatory of the Multilateral Agreements of the European Co-operation for Accreditation (EA) and International Laboratory Accreditation Co-operation (ILCA) for calibration and testing.

Ljubljana, 16. februar 2006

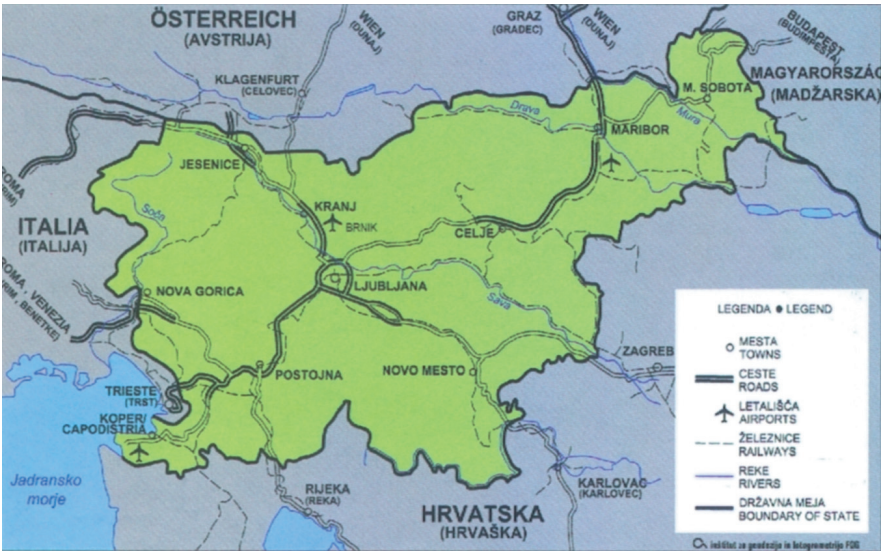
Direktor / Director
dr. Boštjan Godec

SLOVENSKA AKREDITACIJA

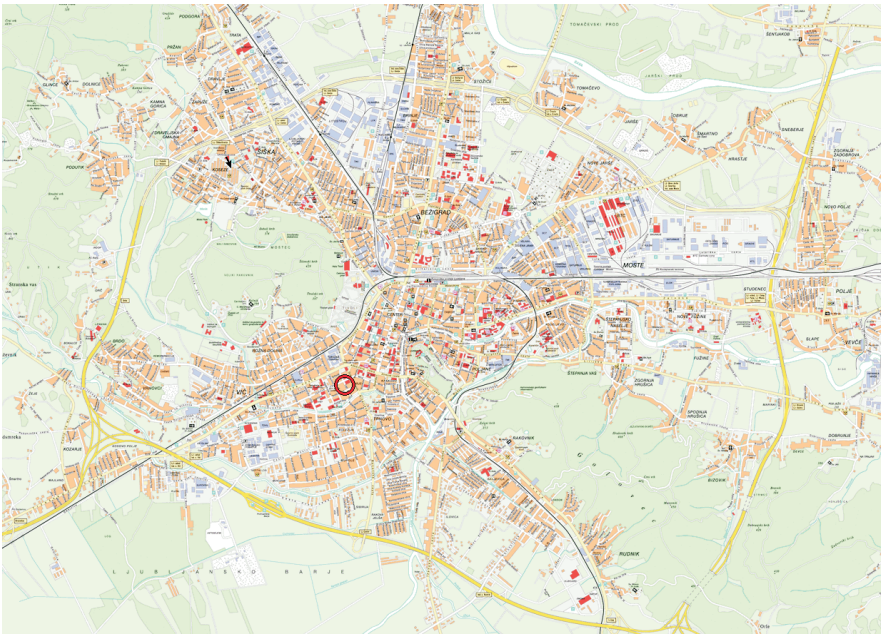
Acreditation certificate of the Laboratory of Pressure Metrology

Location of the Institute of Metals and Technology

The Institute of Metals and Technology is located in the south-western part of the city of Ljubljana, 2 km from the highway Trieste – Maribor. The walking distance from the centre of Ljubljana to the Institute is 15–20 minutes. To reach the Institute from the centre take bus No. 1 (direction “Mestni Log”) or 6 (direction “Dolgi Most”).



Map of Slovenia



Map of Ljubljana – the location of the Institute is indicated by the red circle

Print: Littera picta d.o.o., Ljubljana 2006