Faculty of Chemical Technology

Department of Inorganic Chemistry

The Department of Inorganic Chemistry of the Faculty of Chemical Technology at the Institute of Chemical Technology, Prague, (ICTP) ranks among departments focused on material science, which is supported by the professional orientation of the majority of its staff. The primary role of the department is teaching the first chemical subjects to students at all faculties of the ICTP. The department also provides courses for experts in master's and postgraduate programmes focused on the chemistry and technology of materials and on inorganic chemistry.

Scientific activity at the Department of Inorganic Chemistry

Scientific activity at the Department of Inorganic Chemistry is mostly oriented on basic research, with its prevailing part being financed from grants. Industrial research relates mostly to the solution of problems concerning reactivity and the properties of inorganic substances.

In the field of basic research, the Department of Inorganic Chemistry closely cooperates with individual institutes of the Academy of Sciences of the Czech Republic, and with numerous universities, institutes of higher learning and research institutes both within the Czech Republic and abroad. Cooperation with foreign institutions also embraces exchanges of students, university teachers and researchers.

Research subjects

Research at the Department of Inorganic Chemistry is currently focused primarily on:

- Study of magnetic and thermoelectric properties of materials based on mixed oxides.
- Searching for stable and effective composition of high-temperature supra-conductors.
- Preparation and characterization of planar optical wave-guides.
- Synthesis and decomposition of substances in plasma-chemical reactors.
- Effect of superficial substitutions on the morphology and properties of inorganic pigments.
- Preparation and characterization of thin layers gained by the MO CVD method or electrochemically.
- Study of stereochemistry and modelling of coordination compounds centres.

Assumed future orientation

The professional orientation of the staff and the perspective character of research subjects create preconditions for maintaining the current basic direction of research at the Department of Inorganic Chemistry also in the future period.

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The Department of Inorganic Technology represents a long-standing workplace traditionally educating young specialists for production of inorganic compounds. The department staff is represented by 2 professors, 3 associate professors, 11 teaching and scientific staff and 7 students in Ph.D. study programme. Research covers a broad range of different topics. Besides main field of research, i.e. inorganic technologies, the attention has recently turned to highly specialised technologies, for example fuel cells applications, membrane separation processes, catalyst development etc. The economical point of view and relation between chemistry and environment is emphasized too. From the historical point of view there were established three research groups dealing with technical electrochemistry, heterogeneous catalysis and heterogeneous non-catalytic reactions.

**Present research**

Current research activities are focused on the following main themes:

**Research group “Technical electrochemistry”** under supervision of Prof. Bouzek:

- PEM fuel cells
  - new types of non-fluorinated ion selective membranes
  - conductive polymers as the alternative catalyst support
  - testing of the new types of electro catalysts
  - development of new electrode preparation methods
  - alternative catalyst supports
- water electrolysis
  - intensification of the recently available technology
  - development and testing of novel polymer electrolytes
  - development and testing of the electrodes
  - alternative catalyst supports
- semiconductor photocatalysis
  - thin transparent titanium dioxide films with self cleaning properties
  - application of powder TiO₂ photocatalysts for air and water treatment
  - standard tests of photo catalytic properties (liquid and gaseous phase)
  - composite photo catalytically active materials for environmental applications
- treatment of waste and drinking water
  - treatment of waste and rinsing water from electroplating by electrodialysis
  - selective removal of metals from waste water
  - synthesis of ferrates(VI) as strong oxidant and efficient disinfectant
  - denitrification of drinking water
  - production of high purity water by electrodeionization
- surface treatment processes
  - surface treatment of metals and alloys
- mathematical modelling
  - optimisation of the industrial processes
  - understanding of the industrially relevant systems on the local scale
  - description of the laboratory systems
• dimensionally stable anodes – activated titanium anodes (RuO$_2$ + TiO$_2$ and Ir$_2$O$_5$ + Ta$_2$O$_5$)

Research group “Heterogeneous catalysis” under supervision of Doc. Bernauer:
• study of the catalytic reactions involving micro- and meso-porous materials on the basis of molecular sieves
• development and testing new catalyst for methane aromatization
• micro-porous and meso-porous materials research
  ✓ development of ceramic supports for inorganic membranes
  ✓ synthesis of zeolite based membranes
  ✓ permeation characteristics of membranes
• testing of inorganic membranes for industrial applications
• mathematical simulation
  ✓ design and optimisation of chemical processes
  ✓ simulation of micro-channel reactor for the production of hydrogen
  ✓ kinetic and diffusional parameters estimation from stationary and dynamics experiments
  ✓ thermodynamic parameters estimation for adsorption processes
  ✓ modelling of mass transfer in micro- and meso-porous materials
  ✓ membrane reactor modelling

Research group “Heterogeneous non-catalytic reactions” under supervision of Doc. Vídenský:
• kinetic study of industrially important reactions in the system solid phase-fluid
  ✓ decomposition of phosphates by nitric or phosphoric acid
  ✓ decomposition of magnesite by sulphuric or nitric acid
  ✓ regeneration of ammonium chloride by magnesium oxide
  ✓ reprocessing of ferrous sulphate to magnesium sulphate
• processes for environmental technology
  ✓ desulphurisation of coal gases
  ✓ waste sulphuric acid disposal by limestone

Expected future orientation
Above mentioned research activities will be continuing in the near future. It is necessary to notice that the majority of projects is being solved in close coordination with other research institutes. Workers of the Department Inorganic Technology are involved in Czech and European projects, for example WELTEMP, IMPULSE and NanoMemPro. Topics in the field of TiO$_2$ – photocatalytic applications is carried out within the scope of research centre NANOPIN supervised by Prof. Krýsa. Participation of students of bachelor, master and Ph.D. programmes in research activities is obvious choice.

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Department of Metals and Corrosion Engineering

The department is a material-oriented workplace of the Faculty of Chemical Technology, ICT Prague. In addition to the subjects focused at metallic materials, their production, processing and degradation, the Department staff conducts research activities in three areas:

- **Chemical metallurgy** – development of procedures of metal separation from untraditional ores and metal-containing wastes
- **Physical metallurgy** - production of high performance materials.
- **Corrosion engineering** - study of physiochemical principles of degradation of metallic materials

**Significant research projects**
- new hydrometallurgical procedures of deep-sea nodules processing,
- recovery of electrolytic zinc from waste sludges, dusts and batteries,
- recycling of lithium-content scrap,
- up-to-date metallurgical processes of steel refinement,
- titanium-based alloys for high-temperature applications,
- high-strength aluminium-based alloys with improved casting properties,
- surface nitridation of titanium alloys, preparation of silicide surface layers and intermetallic phases at the titanium alloys,
- hard surface layers on tool steels,
- preparation and properties of nanocrystalline metallic materials,
- corrosion of metallic materials for concrete reinforcement,
- causes of deterioration and processes of conservation and restoration of metallic historical objects,
- relation between corrosion resistance of metallic materials used in humane medicine, rate of corrosion products release and biocompatibility.

**Expertise activity**
Proposing and examination of processes of metal recovery from metal-containing materials and scrap, heat treatment of iron alloys and alloys of non-ferrous metals, examinations of casting alloys properties, examination of structure and mechanical properties of materials, identification of defects and determination of their origin, causes of corrosion deterioration of metallic construction materials, and corrosion protection designing.

**Future orientation**
Light and high-strength materials resistant to high-temperature expositions, surface layers at metals with high utility properties, nanocrystalline metallic materials. Research of waste material recycling technologies. Methods of examining localized forms of corrosion. Mechanism of cathodic polarization effect on corrosion resistance of metals. Comprehensive evaluation of the environmental effect on service-life of the industrial equipment. Corrosion problems of metal application in humane medicine.

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Department of Glass and Ceramics

Department of Glass and Ceramics, provides education in bachelor, master and PhD programmes in the field of chemistry and technology of inorganic materials, technology of pharmaceuticals (biomaterials) and restoration and conservation of glass and ceramic objects. The department is also active in science, research and development in these fields.

History of the Institute’s research

The department has a long tradition both in science and education. The glass technology courses have been held since 1807 at the Royal Polytechnic Institute, the independent Department of Glass, Ceramics and Technology and Testing of Construction Materials was established at 1909. Scientific and research of the department activity is connected with many important changes and achievements in glass and ceramics area in both national and international scale – e.g. oxide ceramics, electrical melting of glass, physical and mathematical modelling of glass melting, modelling of glass corrosion and glass structure, biomaterials.

Present research

Present research at the Department of Glass and Ceramics is oriented especially on:
Development of new types of glass and ceramics – biomaterials for dental and surgical purposes, construction ceramics, glasses for waste immobilization, lead-free crystal glass, fast ion conducting glasses, flexible glasses for membranes in fuel cells, glasses and layers for photonics and for space telescopes, refractory fibrous composites, alkali-activated inorganic binders (geopolymers), immobilisation industrial waste in geopolymers
Transport and colloid-chemical phenomena in ceramic technologies, calculation of micromechanical properties of composites and porous materials
Physical and mathematical modelling of glass melting processes and furnaces
Chemical durability of glasses, mathematical modelling of glass corrosion
Functional layers prepared by biomimetic or sol-gel method (bioactive, chemically durable, photoactive, antibacterial layers)
New applications of electron microscopy and micro-analytical methods for the assessment of inorganic materials and for the analysis of solid surfaces
Modelling of glass structure (ab initio methods, molecular dynamics)

Expected future orientation

It is supposed that the current research activities will be kept in the near future.

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Department of Solid State Chemistry

Department of Solid State Chemistry is focused to material, methodical (X-ray diffraction analysis) and applied research. The students in Bc., Mgr. and PhD. programs are trained either on a chemistry and technology of inorganic and organic materials including the distribution of heavy metals in the environment, or on pharmaceutical applications of X-ray diffraction methods.

Present research
Scientific research at the Department is focused to three thematic directions:

- Applications of X-ray diffraction methods in pharmaceutical research, development, manufacture and control (polymorphism, cocrystals, structure solution from both powder and single crystal data, phase analysis, software development)
- Applied mineralogy (zeolites, geopolymers, hydrotalcites)
- Distribution and migration of heavy metals in the environment

X-ray diffraction methods were strengthened by buying of modern facilities (powder diffractometers – Laboratory of X-ray diffractometry of Central Laboratoires ICT, Prague) and single crystal diffractometer with CCD detector, which serve for both phase and structure analyses of all other Departments of the Institute. Department of Solid State Chemistry is involved in applications of X-ray diffraction methods mainly to pharmaceutical industry in cooperation with leading producers of pharmaceuticals in the Czech Republic (Zentiva, Ivax Pharmaceuticals, Interpharma etc.). The important problem of polymorphism of solid substances and their dosage forms is monitored and solved.

The applied mineralogy group is focused in the research and development of inorganic materials usable in various applications, especially zeolites and hydrotalcite-like compounds (layered double hydroxides). Zeolites are prepared from various raw and waste materials (fly ashes, kaolines). The zeolite formation is studied also in the composite materials including geopolymers. The technology of hydrotalcite production was developed by this group and the product is used as an additive in polymer processing. At present, the mixed oxide based catalysts, applicable in the catalytic combustion of volatile organic compounds and nitrous oxide decomposition processes, respectively, are developed at the department.

Inorganic materials should be also used in environmental development and protection, primarily in sorption processes. The physical, chemical and geochemical properties of toxic contaminants are studied. The oxyanions of non-metals and metalloids from VA and VIA groups, such as P, As, Sb and Se, are important, because their chemical behaviour requires specific methods of decontamination. The next part of research represents the specification of suitable natural and/or synthetic sorbents for oxyanionic contaminants and the determination of optimal sorptive conditions in measured system. Moreover, the possibility of stabilization of saturated sorbents in kaoline-like geopolymers is also investigated.

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Department of Organic Chemistry

Department of Organic Chemistry is focused on basic and applied research in organic chemistry, pharmaceutical chemistry, materials chemistry, and cooperation with the chemical industry. The Bc. students are educated in programs Chemistry and Chemical Technologies, and Drug Synthesis and Production. The MS study offers education in branches Organic Chemistry, Drug Synthesis, and the PhD study in Organic Chemistry.

Scientific topics

- Design and synthesis of supramolecular systems (calixarenes, liquid crystals, macrocyclic polyamines) – P. Lhoták, J. Budka, I. Stibor, J. Svoboda, V. Kozmík, F. Hampl, J. Hodačová, R. Holakovský
- Organocatalysis and their utilization in oxidation reactions – R. Cibulka, T. Martinů, F. Hampl
- Micellar catalysis, synthesis and application – F. Hampl, R. Cibulka
- Preparation and utilization of fluoroorganic compounds – J. Kvičala, M. Rybáčková
- Heterocyclic compounds, synthesis, reactivity and materials application – J. Svoboda, V. Kozmík
- Chirality, photochemistry and quantum chemistry of heterocyclic systems – S. Böhm
- Studies of reaction mechanisms by quantum chemistry methods – S. Böhm
- Synthesis of DNA adducts and their utilization in DNA diagnostics – I. Linhart, A. Šilhánková, J. Krouželka, M. Himl
- Transition metals in organic chemistry – D. Dvořák, T. Tobrman, R. Keder

Teaching

All activities encompass the above cited study programs and branches.

Scientific Co-operation

- Well established projects with:
  - Institute of Organic Chemistry and Biochemistry (Academy of Sciences)
  - Institute of Physical Chemistry J. Heyrovského (Academy of Sciences)
  - Microbiology Institute (Academy of Sciences)
  - Physical Institute (Academy of Sciences)
  - Cayman Pharma Ltd. (Neratovice)
  - Ecole Nationale Supérieure de Chimie de Montpellier, France
  - Université Angers, France
  - University of Minnesota, Minneapolis, USA
  - Universität Regensburg, Germany

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Department of Organic Technology

The Department of Organic Technology at ICT-Prague has been involved in teaching and research in chemical technology, chemistry and industrial chemistry for nearly 80 years. Over this period the members of staff have achieved and maintained the highest standards in teaching coupled with a strong commitment to research and industrial cooperation. Throughout the years the departmental deep scientific commitment has supported a vibrant fundamental and applied research community.

Traditionally the undergraduate teaching and graduate students' courses have been highly rated and appreciated (high scores in students' marking, alumni's appreciated gained knowledge, graduates are successful job seekers, etc.), original research papers and patents have been frequently published (40 in average per year), and many technologies have been successfully designed, developed and implemented in the industrial practice (Aroma Prague, Duslo Sala, Unipetrol RPA Litvinov, Chemical Works Ostrava, TAMINCO Gent, HUNTSMAN Basel, NCH Corp. Texas, etc.).

The research in the Department is wide-ranging and innovative, encompassing these traditional areas:

- Chemical technology (crude oil fractions processing, ethylene pyrolysis, rubber additives, reactive distillation, fine chemicals production, process design and the process scale-up, chemical technology risk and safety assessment)
- Reactor modelling and reactor engineering (pyrolysis, trickle bed reactors, reactive distillation units.)
- Catalysis (development of highly selective tailor-made catalysts, asymmetric and regioselective catalysis, applied catalysis in fine chemistry, fundamental catalytic research, green catalysis)
- Pharmaceutical technology (optimisation, scale-up and control of manufacturing solid pharmaceutical dosage forms, assessment of pharmaceutical active mixtures homogeneity and segregation, validation of cleaning processes)
- Applied physical chemistry (transport phenomena in porous media, including zeolites and other ordered structures modelling and characterisation)
- Materials chemistry (nanotechnologies in preparation of active and multifunctional organised structures, noble metal active species and their physical and functional characterisation.) Organic chemistry (fine chemicals for pharmaceuticals, food additives, agrochemicals, perfumes and flavours.)
- Computational chemistry (stochastic optimisation methods, artificial neural networks, ab initio and other approximate theories for description of active site-reactant interactions, computer graphics in chemistry, computer aided technology tools such as Aspen.)
- Environmental chemistry (wet oxidation processes, environmental photooxidation, waste water treatment).

As well as multidisciplinary areas including:
- environmental chemistry (wet oxidation processes, environmental photooxidation, waste water treatment, etc.),
- green technologies (green catalysis),
- chemical technology risk and safety assessment and
• analytical chemistry (e.g. mass spectroscopy as a fundamental research tool in biochemistry or catalysis).

Throughout the history of the Department there has been a strong commitment to maintaining a mutually supportive culture between the research and teaching staff and postgraduate community (PhD) and the students (MSc). The result is an active, friendly Department with a teaching programme addressing students with various scientific and educational needs and interests.

Students research work in the Department spans both the traditional areas (industrial catalysis, technology process design, reactor engineering, process scale up, pharmaceutical unit operations) with the newer areas of fine chemistry (e.g. asymmetric catalysis), computational chemistry (\textit{ab initio} methods, neural networks), materials chemistry (nanotechnologies, particulate solids in pharmaceutical processes). The students of the Department have access to excellent experimental and support facilities as well as to extensive (vast) electronic information sources.

The Department of Organic Technology at ICT-Prague offers Bachelors (BSc) programme (mostly teaching, three years long undergraduate degree), Masters (MSc) programme (teaching and research, two years lasting academic degree, following the initial/required BSc) and the Doctoral (PhD) programme devoted to bring up high quality scientists (teaching and mostly research, usually three years, longer if funding available).

To these students the Department offers a number of soundly-based degree courses, many recognised also internationally. The lectures and teaching cover a broad range of topics and transferable skills. The courses provide students (undergraduates and graduates) with theoretical background (e.g. in toxicology, fine chemistry and chemical specialities, catalysis, reactor design, in pharmaceutically oriented subjects including pharmaceutical engineering, environmental chemistry, chemical technology) and also with training in current laboratory techniques and skills particularly applicable in research. In the MSc programmes the training is, by means of individual research projects, chosen to give a range of hands-on experience in synthesis, manipulation, analysis, reactivity and investigation of physico-chemical properties of many practical and theoretical systems. Instruction at the bench is supplemented by a lecture programme on a wide range of topics including and independent use of library facilities and databases. The award of the diploma (MSc degree) is determined by the student's performance in examinations based on the lecture programme, on finishing successfully the research project (refereed), together with the final oral examination and the Diploma Thesis defence. The system for the PhD students is similar. Their coursework is assessed by formal examination (usually five courses required), finals (covering the studied topics) and the defence of the refereed dissertation. If successfully completed the PhD degree is awarded.

The Department offers a number of other ways to students to extend their experience while completing the chosen degree (conferences, exchanges, foreign experience, interdisciplinary cooperation with departments of the Academy of Sciences). The Department has numerous contacts with other universities and with industrial partners all over the world.

\textbf{Contacts}

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Department of Polymers

The Department of Polymers was established in 1971 as a successor of Department of Plastic Materials founded in 1949 by Professor Otto Wichterle and Department of Rubber and Plastics Technology founded in 1953 by Professor Ivan Franta. Current research of the department covers all polymer science from macromolecular synthesis to polymer processing, stabilization and recycling. Commodity plastics and rubbers as well as special polymers like high performance and biodegradable polymers are investigated. Students are trained to become well experimentally and theoretically prepared polymer experts that could either follow industrial or scientific career after graduating bachelor, master or Ph.D. study programme.

CURRENT RESEARCH PROJECTS

1. Micro- and nanofibers from biodegradable polymers
   Our research activity is focused on the synthesis of biodegradable copolymers suitable for the preparation of nanofibres: poly((R)-3-hydroxybutyrate modified with poly(ε-caprolactone) or poly(L-lactic acid), aromatic-aliphatic copolysters based on waste poly(ethylene terephthalate) and lactic or glycolic acid, polyesteramides based on ε-caprolactone and ε-caprolactam, and aliphatic (co)polyesters based on cyclic monomers. These copolymers are utilized for preparation of nanofibers by electrospinning from both polymer solutions and melts (in cooperation with Technical University of Liberec).
   Expected future orientation: The effect of chemical structure and molar mass of the copolymers on characteristic parameters of nanofibres will be investigated. Biodegradability of materials prepared will be evaluated and correlated with polymer structure.

2. Nanocomposites polymer - layered silicate
   The preparation of polyesteramide and polyamide 6 layered silicate nanocomposites is studied. Two procedures are carried out: intercalation of the layered silicate within the polyesteramide matrix (exfoliated adsorption) and in situ procedure based on conducting of the anionic (co)polymerization of ε-caprolactam and ε-caprolactone in the presence organically modified silicates. Nanocomposite properties will be correlated with chemical composition of matrix, filler used, morphology and crystalline structure of nanocomposites.
   Expected future orientation: We will target the melt blending technique in the near future or utilization of less cost extensive homoionically exchanged layered silicates than organophillic modified ones.

3. Polymerization and copolymerization of lactams
   Research is concentrated nowadays preferably to the study of anionic polymerization of lactam especially ε-caprolactam. Research work is focused on the detail kinetic study of the activity and behaviour of the initiation systems for activated polymerization (two component system) and nonactivated polymerization (only different salts of lactams as initiators), on possibilities of nanocomposite preparation by in situ anionic lactam polymerization and on preparation of tough polyamide materials by synthesis of polyamide-block-elastomer copolymer by anionic mechanism. Results are applicable in areas connected with mold casting in laboratory and in companies in Czech Republic and abroad.
   Expected future orientation: Continuation in the determination of the role of initiator ε-caprolactam-magnesium-bromide and special ecologically acceptable activators (lactones, CO₂) for (co)polymerization of ε-caprolactam and ω-laurolactam. Study of nonactivated
(co)polymerization of lactams. Cooperation on different technological problems connected with mold casting.

4. **Controlled olefin polymerizations**
The research is focused on olefin polymerization with aim to prepare tailor-made materials with controlled molar mass and chain branching degree. Living/controlled polymerization of alk-1-enes initiated mainly by nickel diimine catalysts is investigated both under homogeneous and heterogeneous conditions. Effects of diimine ligand structure, cocatalyst and reaction conditions on polymerization activity, molar mass, molar mass distribution and branching degree are explored. Transformation of living growing centers to functional groups and preparation of block copolymers is also investigated. Mechanism and kinetics of olefin polymerization is studied.

*Expected future orientation:* Chain shuttling transfer processes in catalytic systems based on nickel diimine complexes for efficient preparation of new materials. Use of micelles as nanoreactors for preparation of polyolefins with controlled morphology.

5. **Study of preparation and characterization of modified polyimides**
Our research is focused on the preparation, basic characterization and tests of potential applications of the polyimides and their modified forms. The hyperbranched polyimides based on commercially available 4,4’,4’’-triaminotriphenylmethane in the form of self-standing films were prepared. These membranes, having no weight loss up to 250 °C, show nearly by two order higher permeability coefficient of hydrogen than of nitrogen, oxygen and a very promising nitrogen/oxygen selectivity. To improve other properties of these hyperbranched polyimides they were combined with up to 50 wt% of silica. The silica was formed in situ via a sol-gel process and a coupling agent was used to link up organic and inorganic phases in some cases. The glass transition temperatures and thermal stability of the hybrids increased with a content of silica.

*Expected future orientation:* Polyimide materials filled with silica (nano)particles will be prepared and their properties (namely thermal and transport) compared with hybrids. The structure-property relationships of polyimides containing zeolites and cucurbiturils have been also studied.

6. **Interaction of siloxane polymer with fillers and application of siloxanes in biotechnology**
The research deals with preparation of composites of siloxane polymer with traditional and layered fillers (based on montmorillonite) and investigation of their interactions. Fillers are used for improvement of mechanical (especially tensile strength), barrier and rheological properties of siloxane mixtures. The synergism of fillers is also studied. For biotechnology the oligosiloxane mixtures, which can be used as a carrier of microbial population, are used for hydrofobisation of glass.

*Expected future orientation:* The future research will oriented to explanation of several still not fully understood aspects accompanying the reinforcing of siloxane polymer by fillers, to improve material properties and hydrofobisation of glass surface with organo-functional low-molecular siloxanes (with hydroxy-, mercapto-, amino- groups) for improvement of the bacteria adhesion.

7. **Processing of rubber compounds and blends**
Formulation of rubber compounds and rubber blends with thermoplastics including blends with properties of thermoplastic elastomers, study of their preparation, crosslinking and properties
of resulting materials (mechanical, thermal, morphology). Covulcanisation of different rubbers is investigated as well. Study of possibilities of utilisation of waste rubber in rubber industry as well as in other fields of rubbery goods manufacture including devulcanisation of rubber. Study of the processability of natural rubber - investigation of molecular parameters, correlation of the data from novel instrumental techniques with classic ones and behaviour of elastomers and rubber compounds in the real industrial conditions.

**Expected future orientation:** Investigation of rubber compounding materials from the point of view of environmental problems including crosslinking agents, activators, accelerators, and processing oils as well as a study of new trends in devulcanisation and revulcanisation of rubbers.

8. Polymer blends
The aim of our research is to study the behaviour of immiscible polymer blends. Polymer blends from PVC, PA and polyolefins are prepared by melt mixing technique in Brabender Plastograph. The structure and properties are studied using scanning electron microscopy (SEM), dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC), IR spectroscopy and Charpy impact tester. Blends are compatibilized with liquid polybutadiene terminated by -NCO, -COOH, -OH functional groups. An addition of the latter shows one of the possibilities how to get the desired properties from brittle and immiscible blends.

**Expected future orientation:** The structure, mechanical properties and morphology of PVC, PE, and PP based nanocomposites prepared by various methods of processing will be studied.

9. Degradation and stabilization of polymeric materials
Research activity is oriented toward the degradation and stabilization of polymeric materials with focus on PVC mixtures. The stabilizing mechanism and the effectivity of stabilizing system based on lead stabilizers and hydrotalcite-like compounds is investigated. The influence of different plasticizers on thermal and light stability, mechanical properties and the resistance to aging of plasticized PVC blends has been studied. Miscibility, stability and properties of blends of PVC and copolymers on ε-caprolactone basis have been investigated.

**Expected future orientation:** Investigation of PVC/hydrotalcite-like compounds composites or nanocomposites and processing of waste PVC.

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The Department of Solid State Engineering was established at ICT in 1984 with the aim of providing high quality courses in Electronics Materials. During the creation of new study programs at ICT within the 1989 to 1992 period, the program of the Department was broadened. Today the Department provides courses in the study branch Materials Science and Engineering at both undergraduate and postgraduate level. Technology and diagnostics of electronics materials, technology and properties of chemical sensors, biocompatibility of polymers and their applications in medicine and thermodynamic modeling of materials processing are the main research topics.

The research facilities are utilized for the deposition of thin metallic layers (Leybold Univex evaporation, Balzers sputter coater), dielectric layers by PACVD, AIII-nitride layers by MOVPE, layers of oxides and acetylacetonates by the pulsed laser deposition technique as well as for the modification of layers by YAG laser. The diagnostic equipments enable the measuring of the layer thickness (Taylor Hobson Talystep model 112-103M), and electric and optical properties such as the electric resistance, free carriers concentration and mobility, dopant profiles in semiconductors or the refractive index. The SEM with digital image processing, AFM and laser confocal microscopy is utilized for surface analyses. The computer system MSETHERMO joining up the database of thermodynamic data and calculation software is used for various thermodynamic calculations and modeling of materials processes.

Current research activities are focused on the solution of particular projects financially supported by the Grant Agency of the Czech Republic, the Grant Agency of the Ministry of Education of the Czech Republic (FRVS) and some other institutions.

**Current research**
- Mixed oxides thermodynamical properties and equilibrium in oxide systems
- Nitrides of III. element subgroup for application in electronics and optoelectronics
- Modification of thin metal films on semiconductors (focused on ohmic contacts)
- Preparation and study of Schottky contacts
- Preparation and study of optical waveguides
- Technology of thin film preparation by pulsed laser deposition (PLD)
- Chemical sensors and their electrophysical parameters
- Semiconducting properties of corrosion layers in nuclear fuel cells
- Electrophysical material parameters (focused on semiconductors)
- Surface morphology of selected polymers after biodegradation
- Electric and dielectric properties of thin polymer films
- Biocompatibility of modified polymers
- Electric and dielectric properties of thin polymer films

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Laboratory of Inorganic Materials

Joint workplace of the Institute of Inorganic Chemistry, ASCR and the Institute of Chemical Technology, Prague

History
Laboratory of Inorganic Materials ensued in 1995 as a joined scientific and pedagogical workplace focused on the material research of glassy and ceramic materials and on the development of their technologies. The Laboratory linked to the older history of the former Laboratory of Silicates, founded as a common workplace between above mentioned institutions in 1961. The members of the Laboratory are preferentially oriented to the research in the field of special glasses with target optical properties, ceramics for medical applications and technology of glass melting. In the framework of pedagogic activities, they train the students of the MSc and PhD study programmes in the MSc course Technology of glass and PhD course Mathematical modelling of glass melting. They are conducting the student MSc and PhD works.

Present research
The research of special glasses involves the high purity glasses based on SiO₂, chalcogenide and heavy metal oxides with high optical transparency from the UV up to far IR spectral range. The glasses are used for drawing optical fibers which serve as transmission media for laser and fluorescence emission. The significant research position of the group lies in its ability to prepare basic glass samples of high purity and with required structural, optical, fluorescence and electric properties. The characterization of glass samples is realized in collaboration with other international groups. The research workers are solving the project of the Czech grant agency.

Preparation of the leucite ceramic is the topic of another Laboratory group. The aim of their work is to prepare the composite material with high fracture toughness, usable for the ceramic-fused-to-metal restorations in dental medicine. Using the low temperature hydrothermal synthesis, the leucite material has been prepared which is suitable precursor for the preparation of leucite ceramics with mechanical and chemical properties required for the mentioned dental applications. The group solves the project of the Czech grant agency.

The contemporary challenge to develop new conceptions of the industrial glass melting process and new design of industrial melting facilities on different scales has led to the development of modular and special theoretical models of glass melting processes, especially these describing behavior of mixtures of particles (gaseous and solid) in glass melt. The use of modular and special models appeared as a rational way to the development on new melting conceptions. The members of the glass technology group analyzed the melting process from the chemical engineering point of view and marked out some ways to more efficient glass melting process: the definition and evaluation of the efficient glass flow structure in the melting space, the application of centrifugal force for bubble removal from glass melts and the application of chemical accelerators of the melting process. The Laboratory of Inorganic Materials is coordinating the grant project of the Ministry of Industry and Trade, entitled „New glass and ceramic materials and advanced concepts of their preparation and manufacturing“. The members of the group have frequent experience with solution of research and technological
problems of world glass producers. Another activity of the group includes the development of new types of commercial glasses.

The Laboratory of Inorganic Materials is particularly equipped for the high temperature chemistry: laboratory glass melting furnaces, facilities for glass cooling, sawing, grinding and polishing. Other experimental facilities involve the IR and VIS spectrometry, facilities for the analytical chemistry of gases in glass melts – high temperature melt extraction coupled with gas chromatography and mass spectrometry, electrochemical measurement of the oxygen activity in glass melts and facilities for the high temperature observation and image analysis of processes in glass melts. The last facility was developed in the Laboratory and the method and facility have been exported for the needs of world glass producers.

**Expected future orientation**

Biomaterials on the ceramic and glassy base, new types of optical glasses for the photonic applications, new principles of the industrial glass melting.

**Contacts**

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Department of Chemical Technology of Monuments Conservation

The main object of work of Department of Chemical Technology of Monuments Conservation is a study of degradation causes and development and application of methods and meanings for conservation of organic and inorganic material of monuments. Another field of research is using of analytical methods for technological investigation of monuments.

Since the beginning of existence of department (1974) the research was focused on following areas:

- Consolidation and hydrophobization of stone,
- Artificial stone and materials for fillings,
- Possibilities of modification of mortars based on lime or hydraulic lime by polymer compounds,
- Modification of Portland cement based mortars by polymers and its using for consolidation of back side of wall painting transfers,
- Materials for consolidation of wood,
- Ageing of color layer of paintings,
- Conservation of archive materials as paper, parchment and leather.

Present state of research

In the present time the main objects of research work are:

- Modification of stone consolidants based on ethyl silicate,
- Effect of salts on polymerization of silanes,
- Development of hydraulic lime based mortars modified by polymers,
- Effect of visible light on archive documents,
- Study of catalytic effect of pigment on polymerization and ageing of vegetable oils,
- Study of wood consolidants penetration and its identification in wood,
- Effect of climate and microclimate on stability of materials of monuments.

Application area

The research work of department will be focused mainly on following areas in the future:

- Study of degradation of materials of color layer of paintings,
- Degradation of materials based on collagen,
- Study of degradation of synthetic materials used for consolidation of monuments,
- Effect of catalytic system on behavior of silanes.

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