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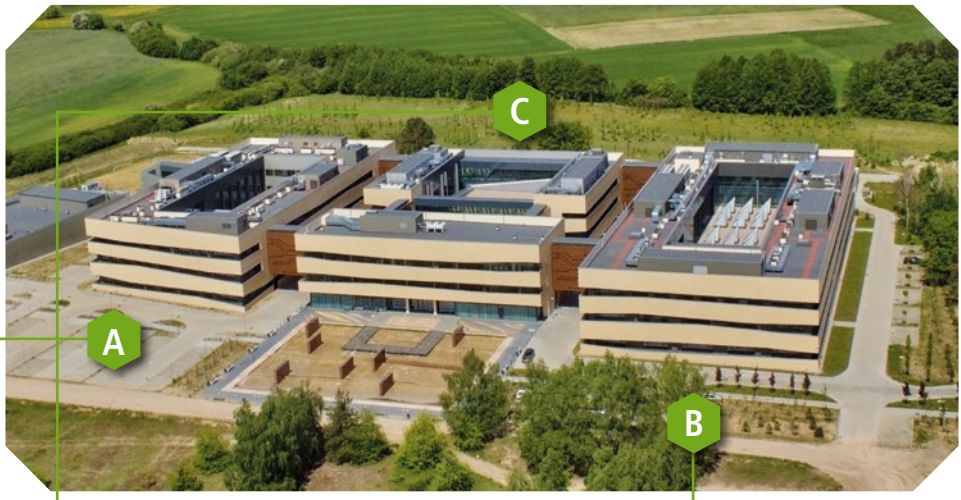
WIELKOPOLSKA CENTRE
FOR ADVANCED TECHNOLOGIES



MATERIALS SCIENCE

CHEMICAL TECHNOLOGIES AND NANOTECHNOLOGIES

BIOTECHNOLOGY

MATERIALS SCIENCE

Laboratory of Microscopy and Nanomechanical Measurements [1]

Equipment in this laboratory allows a comprehensive study of physical parameters of materials surfaces. It also enables investigation of local mechanical properties of materials surfaces and fibres.

Atomic Force Microscope Agilent 5500 [2]. Measurements AFM/STM in the air, any atmosphere, liquids with variable sample temperature (–20 to 200°C). Static and dynamic measurements, mapping surface properties (electrical, mechanical, magnetic), electrochemical cell, surface potential. Scan size up to 90 micrometers. Subnanometer resolution of x, y, z movements and cantilever deflection.

Nanoindenter Agilent G200 [3]. Determination of mechanical properties (modulus of elasticity, friction, hardness) of many materials. Offers the option of sample temperature variation from room temperature to 250°C. Mapping of mechanical properties and possible surface scanning before and after test. Scratch tests. Standard measurement head: maximum force 500 mN, force resolution 50 nN, dis-placement resolution 0.01 nm; DCMII head: maximum force 30 mN, force resolution 3 nN, displacement resolution 0.0002 nm.

Nanotensile Agilent T150 [4]. This apparatus permits tensile testing of natural, plastic or metallic fibres. Very high measurement precision allows testing single fibres (e.g. spider silk). Maximum force 500 mN, force resolution 50 nN, displacement resolution 0.01 nm, maximum extension 200 mm.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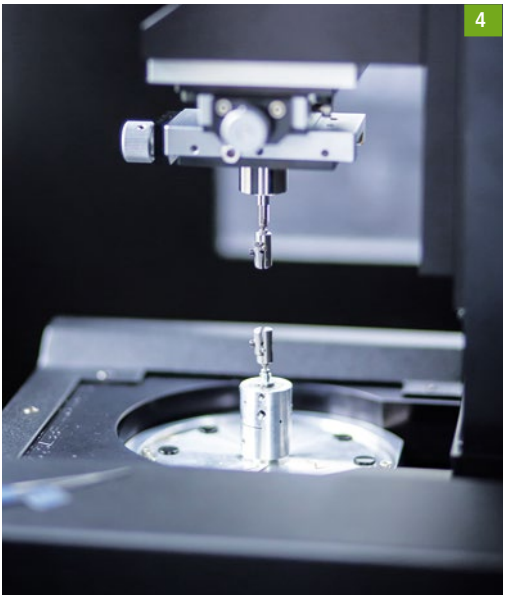
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Scanning electron microscope with analytic FEI Quanta 250 FEG [5]. High resolution FEG-SEM with ESEM end STEM technology. Characterisation of conductive and non-conductive samples with SE and BSE imaging possible in every mode of operation. Resolution in high vacuum 0.8 nm at 30 kV (STEM), 1.0 nm at 30 kV (SE), 3.0 nm at 1 kV (SE); low vacuum 1.4 nm at 30 kV (SE), 3.0 nm at 3 kV (SE); extended vacuum mode (ESEM) 1.4 nm at 30 kV (SE).
Analytical equipment: EDS, WDS, EBSD detectors (EDAX): allow determination of sample composition and crystallographic orientation. Possible mapping.
Preparation equipment: Leica EM TXP automatic trimmer, Q150T ES Combined Sputtering and Carbon Coating System.

Laser Scanning Microscope Olympus LEXT OLS4100 [6]. Non-contact 3D observations and measurements of surface features at 10 nanometer resolutions for height scale. It also features a fast image acquisition and a high-resolution image over a wide area. Light Source: 405 nm Semiconductor Laser, Total magnification 108× – 17,280×.

High-Performance Laser Scanning Microscope Olympus FV1200 [7]. Two GaAsP detectors, live cell imaging experiments, implementing real time Z-drift compensation and touch panel control. Confocal observation of fixed samples, with up to 5 simultaneous fluorescent detection channels, lasers: 405 nm, 458/488/515 nm, 559 nm, 635 nm.

Polarising light microscope Olympus BX-52 [8]. High quality polarizing microscope permits identification of isotropic and anisotropic materials, forensic analysis, thin film/polymer/crystal and extraneous particulates identification. Reflected/Transmitted light. Camera and measurements software. Objectives up to 100×.

Laboratory of nanotechnology (Clean Room). Deposition of layers and layer systems and their structuring using methods of optical and electron lithography. Preparation of arbitrary metallic structures in the nanometric scale.

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Scanning electron microscope with focused ion beam FEI Helios NanoLab 660 [9]. Extremely high resolution (XHR), with subnanometer resolution from 500 V to 30 kV, sharp and charge free contrast obtained from up to 6 integrated in-column and below the lens detectors. Fast and precise milling and deposition with critical dimensions of less than 10 nm. Schottky thermal field emitter. Gas injection system (Pt deposition, carbon mill, insulator deposition). EDX analytics.

Ion etching and metals deposition MicroSystems IonSys 500 [10]. Ion beam milling and ion beam deposition (Al). Sample size up to 150 mm diameter.

Optical maskless lithography Durham Magneto Optics MicroWriter ML [11]. It is a flexible photolithography machine designed for rapid prototyping and small volume manufacture in R&D laboratories and small clean rooms. Resolution 600 nm. 1 mm – 200 mm sample size. Up to 180 mm/minute writing speed. 405 nm exposure wavelength.

Equipment for the application processes and resists baking and chemical etching of samples. Sawatec SM-180 spin coater, Sawatec HP-200 hotplate ultrasonic bath.

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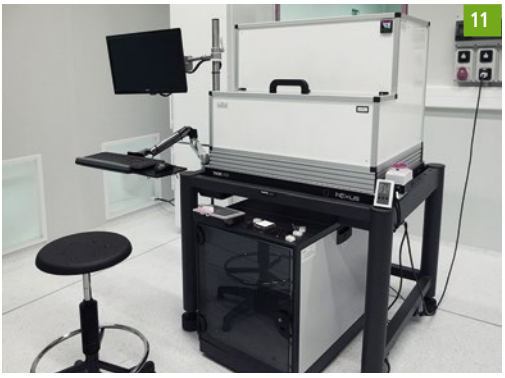
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Mass Spectrometry Labs

The laboratory is equipped with a series of user-friendly state-of-the-art mass spectrometers in different hardware configurations. The lab enables qualitative and quantitative analysis services, development of methods as well as new applications designed to meet the rapidly evolving needs in the field. The facility offers routine mass spec services, molecular weight determination, MSn, LC-MS, high resolution MS, and database search.

SCION TQ GC-MS System (Bruker). The SCION TQ GC-MS system with a triple quadrupole detector is a comprehensive solution for most demanding gas chromatography applications. This GC-MS system is designed to analyze samples from even the dirtiest matrices such as sewer run-off, food homogenates, oil field sludge, whole blood and tissue.

Impact HD ESI-Q-TOF mass spectrometer (Bruker) [12]. Impact HD is a Hybrid Quadrupole/Atmospheric Pressure Ionization orthogonal accelerated Time-Of-Flight mass spectrometer. This equipment sets the standard in ultra-high-resolution tandem mass spectrometry across a wide range of analytical applications. It ensures intact protein analysis and characterization of bio-pharmaceuticals, synthetic chemistry support, forensics and doping control, food products and many more. Samples can be introduced into API-electrospray ionization by syringe pump or liquid chromatographic system. The combination of LC (UltiMate 3000 LC System UHPLC^{+} Focused (Thermo Scientific/Dionex)) and MS allows detection of masses in complex matrices.

The LC system is routinely run in connection with a high-resolution MS spectrometer, however, it is also equipped with its own, fast (200 Hz) diode-array detector.

NexION 300D ICP-MS spectrometers (Inductively Coupled Plasma Mass Spectrometer) (PerkinElmer Inc.). The system is capable of detecting **metals** and

several **non-metals** at concentrations as low as one part in 10^{12}. The technique offers great speed, precision, and sensitivity and can be used for both qualitative and quantitative approaches. Possible applications are in medical and forensic field, toxicology, industrial and biological monitoring (metal analysis), radiometric dating, and more.

AB Sciex QTRAP 6500 System SelexION [13] coupled with an Eksigent LC100 UHPLC system is a triple quadrupole mass spectrometer with a linear ion trap technology. It is designed for **quantitative analysis** featuring scan speeds of up to 20,000 Da/s for optimized UHPLC measurements and a mass range of up to 2000 m/z upper mass limit. Additional unique features of the system include: MRM^3 workflows, peptide quantitation, targeted trace analysis of contaminants as well as great confidence in forensic toxicology applications. It is also equipped with a unique SelexION Differential Ion Mobility Technology designed for elimination of challenging co-eluting contaminants, and reduction of high background noise.

AB Sciex QTOF 5600+ [14] coupled with Eksigent LC200 micro LC system. This Triple TOF System (AB Sciex) is a high-resolution quadrupole TOF technology mass spectrometer. It integrates comprehensive, **qualitative exploration**, rapid profiling, and high-resolution quantitation workflows.

Basic features: MS and MS/MS modes of operation, dual ESI/APCI ion source, 100 Hz acquisition speed, low limits of quantitation (LOQ) for a high-resolution system, direct infusion or LC sample introduction.

MALDI TOF/TOF UltraflexXtreme (Bruker) mass spectrometer with unique Polymerix software package (Sierra Analytics) [15]. The new spectrometer offers ultrahigh performance and flexibility for a broad variety of complementary research, clinical and applied proteomics applications. The system is designed for high-throughput protein identification by MALDI-TOF peptide mass fingerprinting. The data can be readily searched through databases, allowing rapid identification of proteins, and further interpreted using the Biotools software suite. The system features up to 40,000 **mass resolution** and 1 ppm mass accuracy, high throughput analysis with **2 kHz laser** and 384 well sample target.

Possible applications include: routine peptide MW measurements, proteins up to 100 kDa, oligosaccharides, oligonucleotides, soluble proteins from microorganisms. Synthetic polymer analysis using **Polytools Software** and more advanced Polymerix software package (Sierra Analytics).


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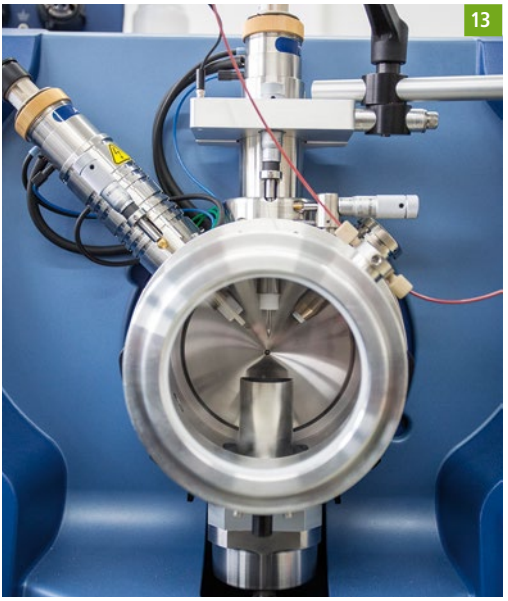
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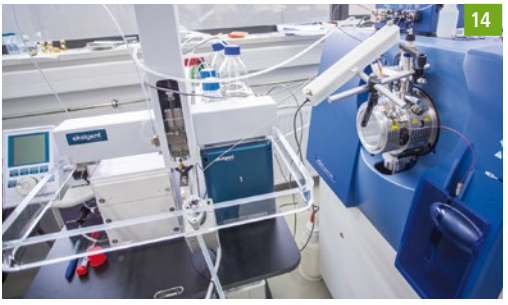
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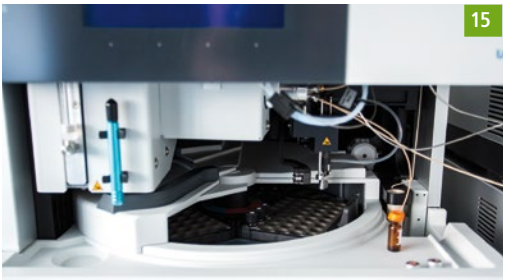
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NMR Spectrometry Labs

The labs feature the fully-integrated high-performance NMR spectrometers which can be used in a series of research applications such as structural biology, small molecule identification and material science.

The NMR laboratory is equipped with 3 spectrometers and offers routine and more complex, customized NMR services.

Bruker Ascend™ 600 MHz [16] equipped with a 24 position SampleCase sample changer, sample cooling down to –50°C and CryoPlatform™ Prodigy probe.
Other available probes allow NMR measurements in the range ^{19}F and ^{31}P-^{15}N, ^{1}H decoupling/observe, increased sensitivity for ^{1}H (tunable to ^{19}F) and ^{13}C Broadband Probe, 5 mm, 'BBFO SMART probe' with ATM with the operating range ^{19}F and ^{31}P-^{15}N, ^{1}H decoupling/observe, observation ^{19}F with ^{1}H decoupling and vice-versa, two-dimensional ^{1}H/^{19}F spectroscopy with superior quality VTN CP/MAS Probehead, rotor size 2,5 mm, range ^{15}N-^{31}P/^{1}H.

Bruker Ascend™ 400 MHz NANOBAY [17] equipped with a 16 position SampleXpress Lite sample changer and BCU-II; sample cooling to –50°C.

Broadband Probe, 5 mm, 'BBFO' with ATM observation/irradiation ^{31}P-^{15}N.

Allows observation ^{19}F with ^{1}H decoupling and vice-versa, two-dimensional ^{1}H/^{19}F spectroscopy with superior quality.

Bruker UltraShield 300 MHz [18]. The basic spectrometer based on Fourier 300 platform, equipped with DUL EasyProbe (5 mm ^{1}H and ^{13}C).

Thermal Analysis Lab

DSC 8500 Hyper-enabled Double-Furnace Differential Scanning Calorimeter (PerkinElmer). It permits studies of various physical and chemical changes (melting, crystallization, glassy transition, evaporation, sublimation, polymorphism, dehydration, thermal decomposition.

TYPICAL APPLICATIONS FOR THE SYSTEM: characterization of pharmaceutical materials, polymorph characterization in pharmaceuticals, process simulation in plastics.

STA 6000 Simultaneous Thermal Analyzer/FTIR Frontier (PerkinElmer). STA is a simultaneous technique that determines the weight changes of the sample (TG) and measures changes in temperature between the sample and the reference as a function of temperature and/or time (DTA). Coupling STA 6000 to an FT-IR spectrometer is ideal for applications where it is important to identify the species evolved from a material upon heating. These include investigation of decomposition mechanisms, identification of residual solvents in drug preparations, and safety and thermal stability of polymers and new materials.

TGA 4000 Thermogravimetric Analyzer (PerkinElmer). TGA 4000 allows measurements of changes in sample mass in a strictly defined atmosphere, provides detection of exo- and endothermic effects.

TYPICAL TGA 4000 APPLICATIONS: measurements of sample volatility, moisture content, oxidation stability, decomposition temperatures, carbon black content, performance of stabilizers, ash content.

PYRIS TGA 1/GC/MS Clarus 680 SQ8 (PerkinElmer). TGA1-GC/MS allows separation and identification of organic gas components emitted from the sample analyzed in the thermobalance. Because of its ability to detect very low levels of material in complex mixtures, the TG-GC/MS is a powerful tool for quality control, safety, and product development.

KEY APPLICATIONS OF THE HYPHENATED TECHNIQUES: molecular structure analysis, identification of decomposition products for safety applications, determination of trace contaminates and residual solvents, enhanced separation of overlapping evolved gases.

Flash 2000 Automatic Elemental Analyzer (Thermo Scientific) [19]. Modern and compact analyzer designed for unattended and full determination of CHNS and oxygen in any type of sample from solid to liquid. The analyzer allows a variety of configurations tailored to the application they serve: organic/inorganic chemistry and pharmaceuticals, environmental analysis, petrochemistry and energy, agronomy and marine science, human and animal samples, isotope analysis.


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Infra-Red Spectroscopy Lab

The Laboratory of Infra-Red Spectroscopy is equipped with the latest generation **FVS-6000 VCD Spectrometer** (Vibrational Circular Dichroism) with the spectral range 4000 – 850 cm^{-1} and the new stand-alone Jasco **4000 FTIR spectrometer**. Both systems are capable of measuring conventional IR absorption along with Vibrational CD and are controlled from the same Spectra Manager II spectroscopy software suite. Our services include measurements of VCD and IR spectra in solution and solid-phase in the spectral range 4000 – 850 cm^{-1} (VCD) and 7800 – 350 cm^{-1} (FTIR), temperature-dependent measurements in solution and assistance in solving specific problems of stereochemistry.

X-Ray Lab

X-Ray Lab is equipped with two **single crystal diffractometers** [20, 21] (Xcalibur S2, Agilent) with four-circle goniometer and a CCD detector. The systems feature a standard molybdenum X-ray tube as well as the unique silver enhance X-ray source. The silver lamp can be used e.g. to measure complexes with heavy metals such as lanthanides and actinides. It is typically problematic to solve such structures because of to their strong absorption of incident light. The diffractometers are adapted to hold high-pressure and low-temperature measurements. The lowest temperature that it can obtain is 100 K.
It can be used for identification of the crystal structure elements: unit-cell size, positions of the atoms within the lattice, bond lengths and angles. X-ray diffraction is also used for determination of electron distribution within the atoms, orientation of single crystals and absolute configuration.


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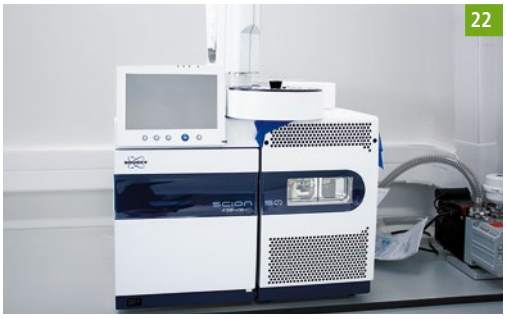
Chromatography

The laboratory for chromatographic studies is equipped with a complete and complementary set of instruments for separation and analysis of chemical substances.

Chromatograph SCION GC-MS Bruker [22] with a mass detector for mass range 1 – 1200 Da and scan rate up to 14000 Da/s.

Gas chromatograph Bruker SCION-456 [23] with FID and TCD detectors and autosampler.

Liquid chromatograph (HPLC) WATERS 2695 [24] with a UV/Visible and refractometric detectors.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Preparative **chromatograph BUCHI Labotechnik AG SEPACORE X10** [25] with a UV detector and fraction collector. Sepacore flash chromatography system X10 addresses most requirements for purification of organic compounds. The system offers optimal performance and scale-up capability of purification of crude synthesis mixtures and plant extracts.


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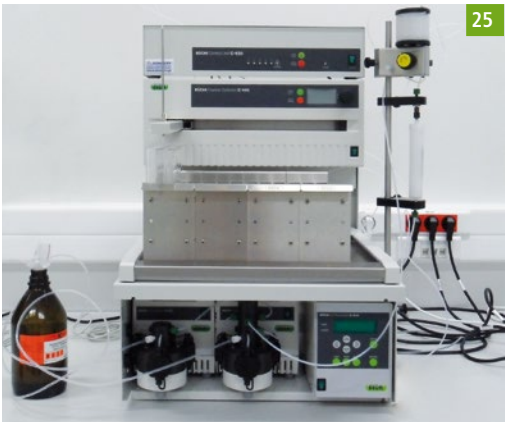
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CHEMICAL TECHNOLOGIES AND NANOTECHNOLOGIES

Special Condition Syntheses

The laboratory for special condition syntheses is equipped with a series of Anton Parr reactors permitting running processes under high pressure and in high temperatures. They offer a possibility to perform processes in solvents in supercritical state. The instrument unique in the country is a laboratory fluidal reactor permitting investigation and optimisation of processes in the fluid phase, under high pressure and in high temperatures, with the use of nitrogen, carbon oxide or hydrogen. The laboratory also has a glove box in which up to four persons can work simultaneously in controlled atmosphere.

Glovebox AMB-200 MOD (1800/1200) NAC, M. Braun Intergas-System [26]. MB-200B modular platform is designed with the capability of adding further box tops onto the original workstations. MB-200B can also connect directly to your choice of any standard MBRAUN gas purification system. Like pieces of a puzzle the MB-200B glovebox system can be "pieced together" to form the solution for countless applications and system configurations. Systems incorporating MB-200B modules typically feature additional equipment ranging from laboratory instruments and deposition systems to fully automated processing lines.

Fluid Bed Reactor System [27]. Three reactant feed lines are included. Each has a shut-off valve, filter, bypass valve, electronic mass flow controller (MFC), and a reverse-flow check valve. The MFC's are calibrated for 0 – 20000 sccm flow of H_2, CO, and N_2, respectively. Reactor is made of T316SS, is rated for use to 500 psi at 350°C and has a 1" ID and 36" inner length that expands to 2.5" ID in the uppermost 2" segment. The software provides for control and monitoring of three temperature zones, pressure, and the gas flow rates as well as displaying, monitoring, and data logging of all gas flows, temperatures, and pressure readings.

High-pressure and high temperature reactor [28] made of HC Alloy C-276; can work under pressures up to 345 bar and in temperatures up to 500°C, its capacity is 1000 mL and it is equipped with a stirrer and automatic control unit.

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Reaction setup for processes in supercritical CO_2 [29]. It can work with pressures up to 350 bar and temperatures up to 350°C, its capacity is 100 mL and it is fully automated. The setup permits running of flow-through and cyclic processes. Thanks to the use of sapphire windows the processes can be controlled by spectroscopic methods. The setup includes a pump for carbon dioxide and a pump for dosing reagents under high pressure.

Our **process development and scale up laboratories** offers You an access to the most advanced and precise equipment allowing for full insight to the wide range of chemical processes by measuring heat profiles, enthalpies, chemical conversion and heat transfer under process-like conditions and their optimization. Possessed automated lab reactors (Mettler Toledo EasyMax [30] and OptiMax synthesis workstations [31]) provide a simple platform for organic synthesis in chemical and process development that ensure high level of measurements repeatability and accuracy in laboratory scale (from 25 mL to 1 L). Our synthesis workstations can be equipped with heat flow calorimetry (HFCal) and in-situ FT-IR (ReactIR 15) modules to offer simultaneous benefits of an easy-to-work-with synthesis workstation, reaction calorimeter collecting heat data for scale-up and safety studies and IR data for kinetic analysis.

The RC1e reaction calorimeter [32] provides information, such as heat profiles, chemical conversion, and heat transfer, under process-like conditions using either heat flow or real-time calorimetry supported by iC Safety which converts the information into safety relevant information for process carried out in much bigger scale (up to 15 L).

Data obtained from mentioned above reactors can be easily verified in scale up laboratory (technology hall) where **pilot plant Normag reactors** [33] and rectification unit are placed.


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The laboratory offers analytical services in the scope of **FT-IR and UV-Vis** [34] **spectroscopy and particle size analysis.** FT-IR spectrometer (Nicolet iS 50) equipped with built-in diamond ATR module, DRIFT module, automated beamsplitter exchanger with two beamsplitters and DLaTGS detector enable measurements of solid and liquid samples in the range of 12 000 – 350 cm^{-1} with a 0.09 cm^{-1} resolution. The analysis is supported by advanced software options and the library containing over 10000 spectra. The laboratory has a portable in-situ FT-IR spectrometer [35] (Mettler Toledo ReactIR 15) of spectral range 4000 – 650 cm^{-1} equipped with 1.5 m DiComp ATR fibre probe and MCT detector for in-situ measurements.

[36] For samples analysis in a UV-Vis range (190-1100 nm) a Nicolet Evolution 220 PC can be used. This compact, simple in use, double-beam geometry with 1 nm spectral bandwidth, spectrophotometer offers a possibility of precise measurements in 4 basic modes: spectral analysis, fixed wavelength analysis and quantum or kinetic analysis supported by advanced INSIGHT software options.

Dispersive properties of the materials can be characterised by **laser diffraction technique with Mastersizer 3000 (Malvern Instruments Ltd.)** [37]. The laser diffraction method is based on two physical phenomena: diffraction and interference of light waves. The results are obtained as a relation between the volume (in %) and the diameter of particles, in fact of a fraction of particles. The instrument measures particles of the sizes from 0.2 to 2000 μm. Particle diameters in the range of 0.6 – 10000 nm can be analyzed employing the **method of dynamic light scattering (DLS) with NanoPlus-3 (Micromeritics Instruments Co.)** [38]. Dynamic light scattering is a non-invasive, well-established technique for measuring the size and size distribution of molecules and particles, with the latest technology even those of sizes lower than 1 nm. Typical applications of DLS are the characterisation of particles dispersed or dissolved in a liquid. It is also possible to measure electrophoretic mobility (zeta potential) in the range from –200 to 200 mV.

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Thermal Analysis

Laboratories belonging to this thematic block are equipped with apparatuses and instruments for investigation of phase transitions in the temperature programmed conditions. The equipment in this block of building B can measure thermal effects and mass loss taking place upon heating or cooling of samples. Moreover, they offer a possibility of taking mass spectra of the gases wrapping the sample so a possibility of determination of its composition.

Thermobalance TG 209 F1 Libra Netzh [39]. It permits heating of a sample at a rate up to 200 K/min and to the maximum temperature of 1100°C. Measurements can be performed in a neutral or oxidising atmosphere. Permits recording thermal effects providing more detail information on the transitions observed. In contrast with other thermobalances, no time-consuming baseline determinations need normally to be carried out with the TG 209 F1 Libra® prior to a measurement. The unique BeFlat® function of the Libra automatically compensates for any external factors influencing the measurement.

TYPICAL APPLICATIONS:

- Dolomite – Thermal Decomposition,
- Rubber Compound for Tires – Decomposition,
- Rubber Compound – Evaporation of Plasticizer.

Differential Scanning Calorimeter, DSC 204 F1 Phoenix Netzsch [40]. The DSC measuring cell consists of a cylindrical high-conductivity silver block with an embedded heating coil for broad thermal symmetry (3D symmetry) in the sample chamber, the cooling ports for liquid nitrogen or compressed air cooling and a cooling ring for connection of the intracooler (also with simultaneous liquid nitrogen cooling). The gas-tight construction and integrated mass flow controllers for the purge and protective gases allow coupling to an FTIR or MS for gas analysis. Temperature range: –85°C ... 600°C, heating rate: 0.001 K/min ... 200 K/min, cooling rate: max. 200 K/min.

TYPICAL APPLICATIONS:

- EVA Film Sample,
- Metal Alloys – Melting Peaks,
- Polymers – Polyethylene terephthalate (PET),
- Polymers – Polystyrene with narrow molar mass distribution,
- Silicon wafer – Thermophysical Properties,
- Sorbitol – Glass Transition,
- UV curing.

Another thermogravimetric analyzer [41] (Mettler Toledo TGA 1) for analysis of evolved gas, equipped with TGA-MS interface and mass detector (Pfeiffer Vacuum ThermoStar GSD 320 T2 [42]). This combination of analytical techniques (TG-MS) allows analysis of the decomposition products to get additional information about the sample and enables measurement curves interpretation with greater certainty. Temperature range of analysis is RT to 1100°C with a heating range from 0.02 to 250 K/min and precision of 0.4 K. Analyzed mass range is 1 to 200 amu with a resolution of 0.5 to 2.5 amu.

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Electrochemistry, Thermal and Mechanical Processing

This block of laboratories offers the equipment for construction and characterisation of electrode systems and chemical sources of current, apparatuses for refinement, disintegration, sifting and fractionation of solid state samples. High-temperature furnaces permit thermal treatment in controlled atmosphere.

The VMP3 is a research-grade multi-channel potentiostat. With its modular chassis design, 16 independent potentiostat channels can be used. The VMP3 is equipped with additional capabilities, including low current measurement, impedance and high current via plug-in modules.

APPLICATIONS:

GENERAL ELECTROCHEMISTRY, SENSORS, CORROSION, ENERGY STORAGE [43,44]:

- 16 independent channels ,
- Compliance: 20 V range adjustable from [–20; 0] V to [0; +20] V,
- Current ranging from 10 μA up to 400 mA,
- Current resolution: 760 pA,
- Low current: 4 ranges 1 μA to 1 nA with a resolution of 76 fA,
- Control voltage: 20 V adjustable,
- Resolution: 5 μV,
- EIS measurement from 10 μHz to 1 MHz,
- Acquisition time: 20 μs.

THE LINE FOR CONSTRUCTION OF ELECTRODE SYSTEMS INCLUDES [45,46]:

- Pouch Cell Case/Cup Forming Machine for Aluminium-Laminated Films – MSK-120,
- Compact Vacuum Sealer for Preparing Pouch Cell – MSK-115A,
- Compact Tape Casting Film Coater with Dryer, Vacuum Chuck & Adjustable Film Applicator – MSK-AFA-III.

Horizontal Tube Furnace Nabertherm RHTC 80-710/15 [47,48] with Silicon Carbide Rod Heating and integrated control systems have an easy-to-replace working tube and high-quality fibre insulation for fast heating and cooling rates. The silicon carbide heating rods installed parallel to the working tube ensure excellent temperature distribution and temperatures to 1500°C.

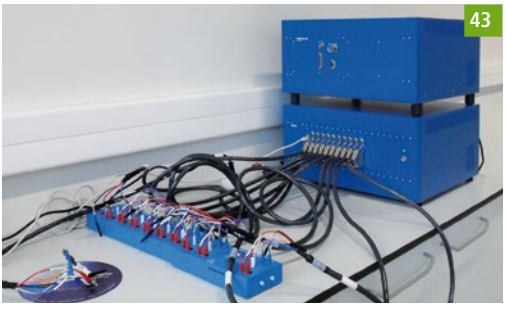
These furnaces are suitable for a wide range of laboratory tests in medical, dental, hygienic, ceramic and glass labs, and also in other industries. They are used for testing in which a very precise distribution of temperature at DIN 17052-1 is needed and also when quick heating to a desired temperature is required. Applications include fritting tests, calcinations, softening or material sintering point setting and the firing of samples. The design includes a manual door opening upwards, composite refractory muffle, S thermocouple, HT40 controller, and heating spirals wound onto the muffle. Graphic temperature recorder, RS interface, exhaust fan, temperature cycle recording software, INDUSTRY controller and inlet of protective atmosphere.

Analytical sieve shaker AS 200 RETSCH [49] is used in research & development, quality control of raw materials, interim and finished products as well as in production monitoring. The controllable electromagnetic drive offers an optimal adaption for every product. Sharp fractions are obtained even after short sieving times.

APPLICATION EXAMPLES: cement clinker, chemicals, coffee, construction materials, fertilizers, fillers, flours, grains, metals powders, minerals, nuts, plastics, sand, seeds, soils, washing powder...

Planetary Ball Mill RETSCH PM 200 [50] is used wherever the highest degree of fineness is required. Apart from the classical mixing and size reduction processes, the mills also meet all the technical requirements for colloidal grinding and have the energy input necessary for mechanical alloying processes. The extremely high centrifugal forces of the Planetary Ball Mills result in very high pulverization energy and therefore short grinding times.

APPLICATION EXAMPLES: alloys, bentonite, bones, carbon fibres, catalysts, cellulose, cement clinker, ceramics, charcoal, chemical products, clay minerals, coal, coke, compost, concrete, electronic scrap, fibres, glass, gypsum, hair, hydroxyapatite, iron ore, kaolin, limestone, metal oxides, minerals, ores, paints and lacquers, paper, pigments, plant materials, polymers, quartz, seeds...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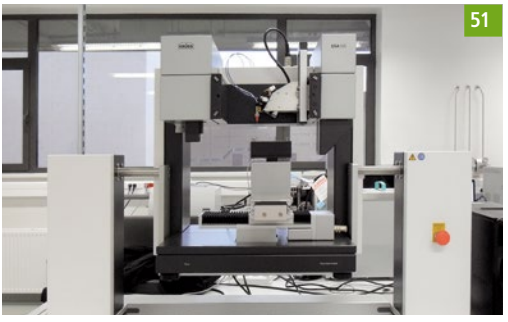
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Drop Shape Analyzer – DSA100E [51] enables measurements of the surface tension of a liquid without changing **over** the instrument. This can be carried out manually or even incorporated into an automatic measuring sequence. Joint interpretation of data for liquid and solid state enables a comprehensive characterization of the component compatibility. For example, it is possible to determine the intensity of adhesion and long-term stability of a coating.

Mortar Grinder RM 200 [52] can mix and homogenize powders, suspensions and pastes even of high viscosity. RM 200 is suitable for the proper and reproducible sample preparation to analytical fineness. It substitutes cumbersome hand mortars by a high performance drive

with electronic control. The grinding set can be cooled and heated and is very easy to clean. Grinding sets of various material qualities are available which can be exchanged easily for optimum adaptation to various grinding tasks.

APPLICATION EXAMPLES: ashes, cement clinker, chemical products, coal, cocoa nibs, coke, drugs, food, homeopathic materials, nuts, oil seeds, pharmaceutical materials, plant materials, salts, silicates, slag, soils, spices, tiles, yeast cells.

FIELD OF APPLICATION: agriculture, biology, chemistry/plastics, construction materials, food, geology/metallurgy, glass/ceramics, medicine/pharmaceuticals.

Dynamic Vapour Sorption (DVS) [53] is the gravimetric technique for studying water and organic sorption/adsorption on particulate materials. The instrument **Advantage** uses a dry carrier gas, usually nitrogen, and the user can select one of any two vapour sources. Precise control of the ratio of saturated and dry carrier gas flows is enabled with mass flow control combined with the use of unique real time vapour concentration monitoring for both water and organics. A known concentration of the selected vapour then flows over a sample suspended from a recording ultra-microbalance, which measures the weight change caused by sorption or desorption of the vapour molecule. These dynamic flow conditions enable the sorption/desorption process to be rapidly studied. It can be used for many applications:

- Moisture uptake behaviour of food and natural materials.
- Stability and caking of food ingredients.
- Moisture diffusion into blister packaging systems.
- Moisture sorption of hydrophobic pharmaceutical materials.
- Surface energies and surface areas of powders using organic vapour probes.
- Determination of deliquescence points.
- Moisture-induced glass transition in an amorphous material.
- Determination of amorphous contents.
- Pharmaceutical stability, drying and thermal degradation.
- Adsorption of porous materials.

Special Equipment

In this Block we can analyze chemical and biological samples using innovative techniques. The laboratories of this block offer the unique equipment presented below.

Nano Spray Dryer B-90 (Büchi Labortechnik AG) [54]. Spray drying is the process of choice for particle formation and drying and it entirely depends on the composition of the material. It is a fast and gentle method for obtaining substances in powder form. Possible area of it application: spray drying from solution, spray crystallization, encapsulation, coating and structure modifications. It is the preferred method of drying of many thermally sensitive materials in for example, food and pharmaceutical industries.

Chemical Inkjet Printer CHIP-1000 (Shimadzu) [55]. Chemical Inkjet Printer CHIP-1000, a unique device for delivering reagents on a micro-scale. CHIP 1000 Printer is based on piezoelectric technology and can be applied for development of target surface chemistry. The key benefit of this technology is the possibility of true micro-scale applications in tissue analysis by mass spectrometry, antibody delivery for mass spectrometry or nanomaterial construction.

Centrifuge 5810 R (Eppendorf) [56]. Centrifuge 5810 R is a workhorse for medium to high-throughput laboratories. It combines extraordinary versatility and capacity for both tubes and plates with an extraordinary compact footprint. Centrifuge 5810 R allows spinning of many tubes at a time or centrifugation of large volume vessels at high-speed, this multipurpose centrifuge with a variety of rotors and adapters covers virtually any application in tubes, bottles, flasks and microplates. The instrument is literally a combination of three centrifuges in one: a high-capacity centrifuge for

cell culture and clinical applications; a high-speed centrifuge for separating cell lysates; and a microcentrifuge for nucleic acid purification.

NS LAB-M (Elmarco) [57]. NS LAB-M machine employs Nanospider Technology for electrospinning of polymer melts into nanofibres. This innovative product is a special laboratory device designed for research and development of new nanofibre materials in the environmentally friendly approach for a number of application such as filtration, hygiene, medicine, sound absorption, etc. The main advantages of this technology are mechanical simplicity, no need of nozzles and ease of operation. Nanofibre layer can be of any desired basis weight with various surface masses and volume densities. A wide spectrum of polymers can be used as substrates.

H-4-PEP Synthesizer (K&A Laborgeraete) [58]. The nucleic acids and polypeptides synthesizer is a modern instrument that could be used to synthesize, according to projected sequence, biologically active molecules like proteins or DNA and RNA. Long oligos of highest purity produced with this devices are superior compared to market competitors. Wobbles, modifications and automated synthesis of S-oligos belong to the standard package. Individual process of synthesis can be started and ceased at any stage. Furthermore, the online trityl monitor enables monitoring of the quality of the running synthesis at all times.


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Plastics Processing

A laboratory mixer (Remi Plast) [59] for materials in a form of powder or granules with temperature controlled (20 – 95°C), volume of 60 l and rotation speed ranging from 60 to 500 rpm.

Laboratory hydraulic press (Remi Plast) [60]. A hydraulic press for plastics with table size of about 400×400 mm (both tables heated to 300°C) and press power of 400 kN.

Injection molding machine – e-victory 170/80 (Engel) [61]. A tie-bar-less hybrid injection molding machine with electric injection unit and closing force equal to 800 kN with plasticizing system adapted to operate at temperatures up to 350°C for processing thermoplastics with fiber content up to 30 wt%. A dual-socket mold with removable inserts fits any research (according to the requirements of PN-EN ISO 294-2:2002). A 2-slot injection mold allows for testing the characteristics of tensile strength (PN-EN ISO 527-2 – dumbbell shape type 1A), bending and Charpy impact strength (ISO 179-1) and flammability of plastics (UL 94 test as per EN 60695-11-10-1999 – bar shape with thickness of 3 mm).

Extrusion, mixing and production lines – HAAKE PolyLab OS (Thermo Scientific) [62]. Modular processability – measuring system for extrusion which consists of a twin-screw extruder, single-screw extruder and numerous dies: horizontal rod die, sheet, tape & ribbon die, pipe & tubing die and blown film die.


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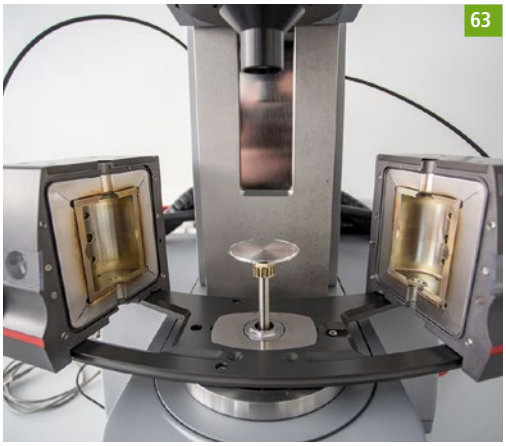
Rheological Properties

Rotational rheometer – MCR 302 (Anton Paar) [63]. A rheometer consists of a modular platform to perform DMTA analysis on solids as well as liquids in torsion and extension mode. It is equipped with a convection temperature control device for cone/plate and parallel plate measuring geometries (temperature range: –130 to 450°C). It also has measuring tools such as: solid torsion bar fixture for rectangular bars up to 12 mm, universal extensional fixture, lower measuring plate (D=52 mm), measuring plate (D=25 mm) and cone measuring plate (D=25, angle 1°).

Capillary rheometer – CEAST SR10 (Instron) [64]. A rheometer with maximum force of 10 kN. It is equipped with double piston/cylinder with diameter of 9,55 mm and maximum working length of 160 mm. The device allows testing at temperatures up to 400°C. The rheometer enables to obtain flow curves at a fixed nozzle geometry (L=5, 20 and 30 mm, D=1 mm) as well as run tests with Bagley correction.

Melt Flow Testers – CEAST MF20 (Instron) [65]. A melt flow tester is a single weight system that can perform consistent tests on commodity and also special grade materials that are sensitive to moisture and temperature. The system is suitable for conducting tests as per ISO 1133 and ASTM D1238 Procedures A, B, C and complies with ISO 1133-2 specifications.

Viscometer – Bohlin Visco 88 (Malvern Instruments Ltd.) [66]. A viscometer is an easy to use device which provides accurate shear viscosity measurements at single or multiple shear rates. Technical parameters are the following: rotational speed 0 – 1000 rpm, shear rate ranging from 0 to 2×10^4 s^{-1}, torque ranging from 0 to 10 mNm, shear stress between $0 – 10^4$ Pa, viscosity between $5 – 10^7$ mPas and temperature ranging from –35 to 150°C.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Mechanical Properties

Dual Column Tabletop Universal Testing Systems 50 kN – Instron 5969 [67]. Dual column systems are multi-purpose instruments that are commonly used for plastics, metals, rubber materials, automotive components and composites. Its speed is ranging from 0,001 to 3000 mm/min. The machine is used to perform stretching and bending tests at ambient temperature as well as with a use of temperature chamber.

HDT Vicat – CEAST HV3 (Instron) [68]. An apparatus for measuring plastic deformation of stressed (HDT) and softening (Vicat) temperatures. Technical parameters are the following: three testing stations, temperature ranging from 20 to 300°C and a heating method that uses silicone oil.

Impact Pendulum Machine – CEAST 9050 (Instron) [69]. An impact pendulum is designed for determining the resilience of thermoplastic materials to impact (Charpy, ISO 179) with a maximum energy of 25 J.

Environmental Stress Chamber – ARS-0220 (Espec) [70]. Achieving reliability requires a system that delivers results quickly and reflects environmental conditions. The environmental stress chamber can withstand heat loads generated by the specimen and achieve improved change rate in an expanded temperature and humidity range. The chamber is also equipped with a specimen temperature control function. Technical parameters are: temperature control ranging from –75 to +180°C with humidity control (10 to 98% rh).

UVTest Fluorescent/UV Instrument – ATLAS [71]. A chamber for aging tests includes a raining system and closed water circulation. It is equipped with research programs for the most popular standards and enables to accept user programs. Fluorescent UV lamps: (8) – 40 W.


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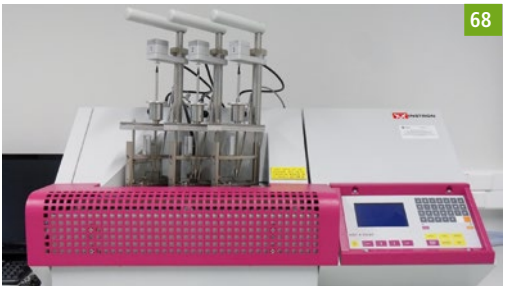
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BIOTECHNOLOGY

Biomedical Biotechnology

Biomedical biotechnology field of WCAT is divided into three main parts: (i) Molecular Biology Block, (ii) Cell Biology Block and (iii) Animal Facility. All of them are organized to perform all main areas of biomedical research starting from the molecular and cellular aspects of pathomechanism and therapeutical strategies of human diseases to in vivo studies with use of different animal models in pre-clinical trials.

Molecular Biology Laboratories

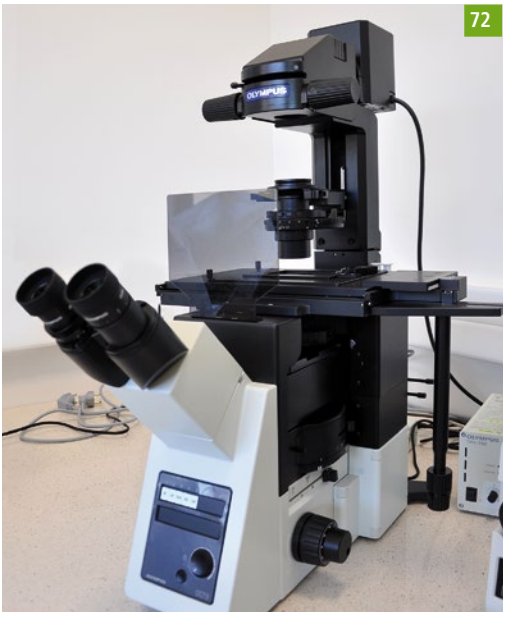
The laboratories of Molecular Biology Block are dedicated to perform biochemical and molecular biology research in order to investigate the network of chemical reactions taking place in the cells and living organisms. The mission is to identify and understand the structure, function, interactions and metabolism of nucleic acids, proteins, carbohydrates and lipids as well as understand how the interactions between cellular molecules are regulated. The knowledge about the biological processes at the molecular level in physiological and pathological conditions, is expected to contribute to the development of novel molecular therapeutics and new therapies.

The Molecular Biology Laboratory provides access to specialized equipments used in molecular biology and biological chemistry to fulfill its mission. It maintains a large array of instrumentation for cloning, gene expression, purification and characterization of biomacromolecules. It includes research-quality, general-use laboratory equipment like homogenizers, shakers, mixers, thermomixers, ovens, water baths, centrifuges, pH meters, balances, micropipets, agarose gel electrophoresis systems, MilliQ water-purification system and ice flaker. The nucleic acids can be amplified and analyzed by using standard and 96 – well real – time thermocycler (QuantStudio 6K Flex, Applied Biosystems). Digital imaging system (G BOX Chemi XR 5, Syngene) is available for visualization and data processing. Bacteria and different kinds of cells can be modified using electroporators (Gene Pulser XcellTM Total System, Bio-Rad) and gene guns (Helios Gene Gun Systems, Bio-Rad; PDS – 1000/HeTM and HEPTATM System, Bio-Rad). The Laboratory possess the incubators and shakers for growing bacteria and cells. The biomacromolecules and biochemical reactions can be analyzed using visible and UV spectrophotometer and microplate reader (Infinite M200 Pro, Tecan) for detection of absorbance, fluorescence and luminescence. The separate autoclave systems allow sterilization of buffers, media, glass, plasticware and wastes. Sources of vacuum, nitrogen, air, O_2 and CO_2 are accessible. Corrosive and flammable liquid storage cabinets as well as fume hoods are available for working with hazardous substances. Moreover, a separate part of the laboratory is dedicated for material storage and banking. In addition to the cold room, the storage rooms possess refrigerators, freezers, deep freezer, and the automatic system for a storage of biological samples in the vapors of liquid nitrogen.

Cell Biology Laboratories

The mission of the Cell Biology Laboratories is to provide state of the art research environment for both understanding biological processes at the cellular level and to stimulate the development of cell biology technologies including new therapies and cell based products. The research interests of Cell Biology Laboratories includes neuroscience, genetic neurological diseases, stem cell research, therapies of neurological disorders, cancer therapies and cancer cellular models.

The Laboratories contain high quality animal and human cell grow equipment including CO_2 incubators, sterile hoods, fluorescent upright and inverted microscopes, dissecting microscopes [72]. A true highlight



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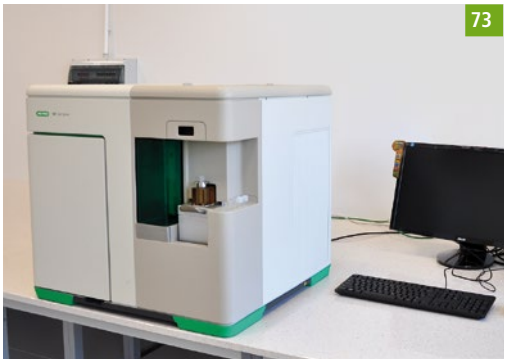
of our facilities is a cluster of cleanrooms containing eukaryotic cell bioreactors for producing clinical grade cell biology products. The laboratories is able to conducted research in variety of cellular models such as tumor cell lines, human and animal primary cells, neuronal cells, stem cells and induced pluripotent stem cells. The neighboring animal facility is able to provide tissues to isolate desired primary cell cultures. Pure populations of cells can be isolated and analyzed using fluorescence-activated cell sorting (S3TM Cell Sorter, Bio-Rad [73]). The laboratories contains cell bio-banking facility to store cells and tissues in liquid nitrogen. The laboratories are equipped to analyze cell populations by immunofluorescence, histology and molecular methods using FACS technology and microplate reader with different applications (luminescence, fluorescence and absorbance). The laboratories have access to confocal and electron microscopy facility.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Animal Facility

Animal house is designed to perform experiments in conditions of GLP (Good Laboratory Practice). Animal house consists of two main parts: experimental laboratories and an area were animals are breaded. Additionally there are some technical areas e.g. quarantine rooms, repositories, and social rooms. The clean part on animal house is protected by highly specialized systems of autoclaves, air showers and windows allowing safe transfers on animals, cages and food between particular areas. In animal house about five thousands of mice in IVC system and about six thousands of mice in conventional cages, rats (about three thousands in IVC system) and rabbits may be kept at the same time including very sensitive immunodeficient strains of these animals commonly used in some specialized studies including transplantation and cancer research [74, 75].

In experimental part well equipped surgery rooms are available. In this area several advanced instruments are localized. They include the computer tomography [76] (Argus CT, Sedecal), in vivo visualization system (either fluorescence or luminescence readout – PhotonImager Optima Basic, Biospace Lab), X-ray machine (RS 2000 X-Ray Biological Irradiator, RadSource) and equipment for behavioral experiments (IntelliCage by New Behavior and ActiMot2 System, TSE Systems). In other part of animal house there are three specialized laboratories. First is hematological and biochemical laboratory in which basic analyses of blood and urine components could be carried out. It is equipped also with two modern chromatographs working in both gas (GC – 2010 Plus, Shimadzu) and high performance liquid chromatography formats (HPLC Prominence, Shimadzu). Further, the histological laboratory equipped with several advanced machines allowing automatic processing of histological samples is located. Here the high quality microscope is installed as well. Third laboratory is equipped with the cell culture instrumentation including the CO_2 incubator, sterile hood and inverted microscope. All analytical fields of animal house may be supported by very well equipped laboratories localized in biotechnology wing of WCAT. Animal house is designed to perform experiments in conditions of GLP (Good Laboratory Practice). Animal house consists of two main parts: experimental laboratories and an area were animals are breaded. Additionally there are some technical areas e.g. quarantine rooms, repositories, and social rooms. The clean part on animal house is protected by highly specialized systems of autoclaves, air showers and windows allowing safe transfers on animals, cages and food between particular areas. In animal house about five thousands of mice in IVC system and about six thousands of mice in conventional cages, rats (about three thousands in IVC system) and rabbits may be kept at the same time including very sensitive immunodeficient strains of these animals commonly used in some specialized studies including transplantation and cancer research.


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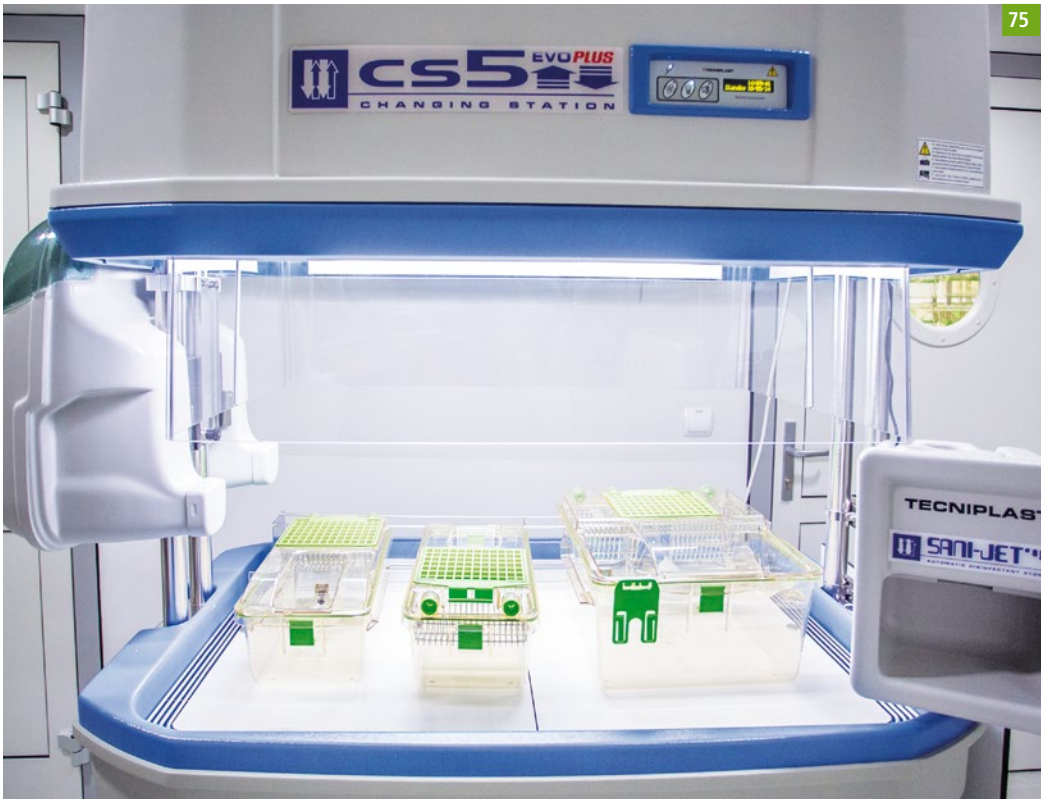

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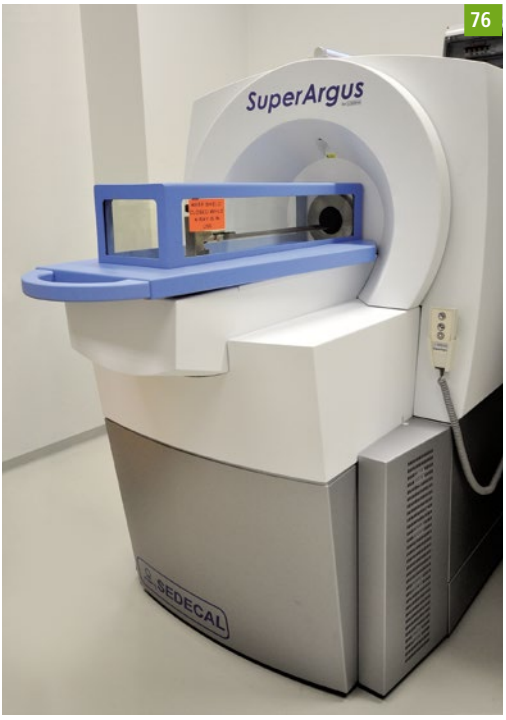

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Plant Biotechnology

Plant Biotechnology Facility is devided into three parts: (i) Block of in vitro cultures, (ii) Block of phytotrons and (iii) Greenhouse. All blocks make an integrated platform which provides all devices to conveniently and consecutively perform, from in vitro manipulations to greenhouse cultivation, projects focused on utilitarian aspects biotechnology and joined basic sciences such as genetics, physiology, phytopathology, etc.

Block of *in vitro* cultures

The block provides all devices to conveniently perform every step of various in vitro cultures, including bacteria, fungi and plants. The block starts from preparation laboratories, where culture media for all types of in vitro cultures as well as substrates for plants cultivated in growth chambers can be composed. Beside common small equipment, there is a double door autoclave (PS/RSC/EH450 – Prioclave) to separate clean and biohazard zones and transportation carts. Preparation laboratory is joined to a room for glass washing and a common store.

The next part of the block is group of laboratories for transplantations and other manipulations with biological materials, joined with rooms for cultures in sterile conditions. This sub-block is divided into part for bacteria, fungi and plants. This division is only nominal, when necessary any equipment in any room can be easily used. The 'bacterial' and 'fungal' parts are practically identical. They are appropriately supplied with laminar chambers with vertical air flow, of the first (FlowFAST V12P – Faster) and the second biosafety classes (SafeFAST Classic 218 – Faster) as well as equipment for microbial cultures as incubators, both growth chambers (IN110, IN55, IPP55 Plus – Memmert) and shakers (Excella E24(R) and E25(R) – New Brunswick [77], Innova 42R – Eppendorf) of different capacities and both with heating or heating/cooling functions, etc. The 'plant' part includes a set of laminar chambers with horizontal air flow (FlowFAST 15H – Faster) and three rooms with specialist (light, air flow) shelves (POLON) adapted for plant in vitro cultures. Apart from mentioned typical outfitting, this block is equipped also in microscopic sets and apparatus for gene transfection. The microscopic equipment includes stereoscopic microscopes (SZX7, Olympus) for macroscopic observations and preparation manipulations and an optical microscope for observations of tissue slices and single cells in bright field and contrast phase at magnification 100 – 1000× (BX43, Olympus) conjugated with a digital camera and imaging system (CellSens). Gene transfection can be performed via electroporation and microprojectile method, using an equipment provided by Bio-Rad company. Electroporation sets include items for gene transfer into bacteria and yeast cells (MicroPulser Electroporator) and an universal electroporator for all cell types (Gene Pulser Xcell Total System [78]). Microprojectile bombardment can be performed both stationary, e.g. in sterile conditions, for in vitro, in vivo and ex vivo experiments (PDS-1000/He System with HEPTA Adaptor [79]) and using a mobile gene gun (Helios Gene Gun System), which enables gene transfection in any conditions, in situ, in vitro, ex vitro, in vivo and ex vivo. The last part of the block is a subunit for utilisation of wastes (PS/RSC/EH230 – Priorclave) from in vitro cultures and phytotrons.

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Block of phytotrons

Phytotrons [80] enable to conduct experiments in strictly defined growth conditions: temperature, humidity, light intensity and spectrum, etc. The block consists of two parts: 12 walk-in phytotrons customised by Greendrop Co and four growth chambers (Snijders).

The set of walk-in phytotrons is divided into three subunits: 'normal', 'pathogenic' and 'GMO', for proper plants, respectively. Phytotrons for normal plants include 1 item adapted for experiments at low temperatures (up –20°C) and 2 items for experiments at cool (from 0 to 15°C). Remained 'normal' and 'pathogenic' and 'GMO' items are designed for experiments at standard conditions. All walk-in phytotrons have module construction, i.e. their internal equipage is optional. Phytotrons can be set with flood tables or shelves with regulated height, both mobile and easy connectable to electrical and watering systems. Tables and most of shelves are equipped with metalohalogenic 2 – 5 lamps emitting full visible spectrum light. These lamps can be composed at will to adjust light intensity. Some shelves have sets of LED lamps with fully adjustable light intensity and regulated spectrum. Watering and fertilisation of cultivated plants is automatic and all climate parameters: thermo- and photoperiod, humidity etc. in phytotrons are controlled by the computer system MulitiMa, specially designed for this purpose.

The second part of this block includes three typical growth chambers (Economic Lux, model ECD01E) and one chamber for experiments in special conditions (Microclima MC1000E), both digitally controlled. The first ones offer standard conditions for plant growth, i.e. capacity 400 l, temp. –5°C to +50°C, humidity 70 – 95%, light intensity 240 μmol•m^{-2}•s^{-2}. The latter offers wider range of parameters: capacity 1000 l, temp. –15°C to +50°C, humidity 40 – 95%, light intensity 100 – 1000 μmol•m^{-2}•s^{-2}. Cultivation surface of each type of chamber can increased by shelves connectable to climate systems.


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Greenhouse [81]
The greenhouse is customised to WCAT needs and constructed analogously to the set of walk-in phytotrons (Greendrop Co). There are identical zones: 'normal' comprising 5 standard boxes and 1 with an option of dark-room, and 'pathogenic' and 'GMO' each comprising 4 boxes. These latter zones are separated by lock chambers and include their own utilisation stations and rooms for personnel dressage. Also, construction of whole greenhouse is designed in such a way in order to limit contamination transfer among zones and conform requirements of biological safety. Accordingly, pots etc. with a substrate can be transported only in one way – from preparation room, through growth boxes to utilisation devices. Similarly, entries and communication courses for 'normal', pathogen-infected and GM plants are separated. The greenhouse is connected by a corridor with other blocks of plant biotechnology facility, so plants can be directly transported from those blocks to the greenhouse, without contacting outer environment. In the greenhouse plants are cultivated on flood tables, 3 items in each box. The total table cultivation area is approx. 50 m^2 for normal plants and 25 m^2 for 'GMO' and 'pathogen-infected' ones. Plant growth conditions are controlled by the same MultiMa computer and watering together with fertilisation is also automatic.

Industrial Biotechnology

The industrial biotechnology block is oriented towards research concerning biocatalytic processes involving mostly bacteria and fungi. Novel processes targeted at utilization of various industrial by-products, production of value-added metabolites and obtaining enzymes with applicative potential are some of its main interests. The laboratories are currently well equipped for performing different scientific tasks.

Isolation and characterisation of microorganisms
The microbiological laboratory is equipped for isolation and cultivation of microbes from environmental samples of different origin. Sterility of the laboratories is assured by the use of proper laminar flow cabinets of the first and second biosafety class (FlowFAST, SafeFAST; Faster) and one-direction flow of materials assured by sections of different volume autoclaves (Priorclave). Our facilities allow cultures in controlled conditions, such as temperature or gas composition (classic and CO_2 incubators). Furthermore, work involving psychrophilic organisms is possible, as incubators supporting sub-ambient temperatures are available on site (IPP55 Plus, Memmert). With the advanced analytical equipment present at WCAT, characterization of the obtained isolates can be performed by a broad range of techniques.

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Genetic manipulation of microbes
When conventional methods of bioprocess development provide insufficient results, possibilities for further improvement often exist at the molecular level. Both directed and non-directed methods can be exploited. The microbiological laboratory has means of obtaining competent cells, performing transformation and analysing the outcome of the complete procedure. The effects of such molecular manipulations can be observed at genetic level, or reveal themselves as new qualities in processes carried out using the modified organism.

Development and optimisation of microbiologically or enzymatically catalysed processes [82]
Process development is a logical consequence of obtaining an interesting biocatalyst, be it a bacterium, fungus or an enzyme isolated from one. Our laboratories are equipped with a system of small scale bioreactors perfectly suited for performing such tasks with high throughput (BioFlo 115, New Brunswick Scientific). These devices allow researchers to minimize the influence of external parameters and focus on process variables. Performing simultaneous runs in strictly controlled environment enables screening for significant factors, both of physical and chemical nature, which are to be further optimized. A properly performed optimization has often proved to be the key on the way to applicative viability of a bioprocess. With cutting-edge analytical equipment available at WCAT, various responses to changes in process variables can be considered.

Small scale microbial cultivation for preparatory needs [83]
A 5 litre bench-top bioreactor (BioFlo 115, New Brunswick Scientific) and a high throughput super-speed centrifuge (Sorval LYNX6000, ThermoScientific) present on site make it possible to obtain biomass of bacteria, yeast or moulds for further characterisation, or for obtaining intracellular biomolecules of scientific interest. The equipment present in the laboratories and two preparative chromatography systems allow further isolation and purification of these compounds.

Isolation, separation and purification of biomolecules [84]
After biomass has been obtained, it is often necessary to disrupt the cells and extract compounds such as proteins or other biopolymers. Various homogenisation techniques are used that require different equipment which is available in the Industrial Microbiology Laboratories (Sonopuls mini 20, Bandelin). Furthermore, many techniques of characterisation only allow analysis of biomolecules purified to a certain degree. Thus, there are two preparative chromatography systems coupled with automated fraction collectors (Akta Pure 25, GE Healthcare) that allow molecules of interest to be separated from the bulk of cellular constituents.


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