Laboratories of the Centre of Excellence for applied physics in sustainable agriculture

AGROPHYSICS

Organization – equipment – research - applications

Bohdan Dobrzański Institute of Agrophysics Polish Academy of Sciences

Laboratories of the Centre of Excellence for applied physics in sustainable agriculture AGROPHYSICS were modernized and equipped in the years 2008-2010 in the project entitled Infrastructure development and laboratories refitting of the Centre Excellence AGROPHYSICS, executed in the Operational Programme – Development of Eastern Poland 2007-2013, co-financed by European Development Regional Fund

- Project value 26 371 086,00 PLN
- The support from European Development Regional Fund 21 527 147,60 PLN i.e. 81,63%
- National budget 1 266 302,40 PLN i.e. 4,80%
- the Ministry of Science and Higher Education 3 557 000,00 PLN i.e. 13,49%

ROZWÓJ POLSKI WSCHODNIEJ
NARODOWA STRATEGIA SPÓJNOŚCI

Instytut Agrofizyki im. B. Dobrzańskiego PAN Lublin

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

Address data
Instytut Agrofizyki im. Bohdana Dobrzańskiego Polskiej Akademii Nauk

Bohdan Dobrzanski Institute of Agrophysics Polish Academy of Sciences

ul. Doświadczalna 4
P.O. Box 201
20-290 Lublin 27
Poland

Phones:
81-744 50 61 - exchange IA PAS
81-743 85 58 - secretariat IA PAS
81-744 50 67 - fax
E-mail: sekretariat@ipan.lublin.pl

Dear Ladies and Gentlemen,

One of the expectations of a modern society is a high quality of life. This depends on our health, the quality of our environment of work and living, as well as the quality of food. The scientific knowledge required to meet these expectations is provided by life sciences: medicine, biology and agricultural sciences. Today, the agricultural sciences are one of the most interdisciplinary fields of knowledge. Biology, genetics, chemistry, mathematics, information technology, electronics, food engineering, automation, physics and much, much more are among the scientific branches which see an increasing use by the advanced and modern agriculture. The area of physics which is related to general agricultural science is called agricultural physics or simply „agrophysics". Agrophysics deals with the application of physics and physical chemistry to examine the properties of materials and processes which occur in the manufacture and processing of crops, with specific regard to the quality of raw materials and food products. Agrophysics is also used to provide solutions for complex problems of general environmental protection and the control of its quality or for alternative uses of agricultural raw materials, specifically with respect to renewable energy sources.

The chances for producing solutions pertinent to theoretical science and real-life applications are provided by the development and improvement of specialist agrophysical measurement methods used for the quality assessment of raw materials and food products in specific chains of the food production cycle (dielectric spectroscopy, microtomography, mechantronics, image analysis), process modelling, plant material damage identification, assessment of pigmentation, firmness, microstructure and texture of fruits and vegetables, as well as the performance control of safe food production, harvesting, transport and storage (full EM spectroscopy, from thermography to X-ray imaging and electrometric methods – potentiometry, amperometry, ionometry or acoustic emissions measurement).

The B. Dobrzański Institute of Agrophysics of the Polish Academy of Sciences in Lublin has been involved with agrophysics for over 40 years, also in cooperation with over 60 Polish and foreign scientific centres. The scientific research at the Institute has been highly acclaimed by the international circles; hence the Institute was awarded with the status of Centre of Excellence for „The Applied Physics in Sustainable Agriculture – AGROPHYSICS" in 2003, as a part of the EU Framework Programme 5. The Centre of Excellence status has bolstered the international position of our Institute. Since then, agrophysics has been enjoying a very high esteem in the international scientific society. The Institute has also got a huge opportunity of developing its research potential and modernizing the measurement methods by the funding awarded as a part of the project titled „Infrastructure development and laboratories refitting of the Centre of Excellence AGROPHYSICS". In the course of the Operational Programme – Development of Eastern Poland 2009 – 2013, 12 specialist scientific laboratories have been established and equipped with the most advanced scientific and research equipment. It is our great hope that their operation will significantly improve the scientific effectiveness of the Institute, cooperation with scientific bodies and, first of all, the inter-institute cooperation in the region for the implementation of innovative solutions at small and medium enterprises of the food and agricultural industry with respect to research and development.

You are welcome to read the folder which is intended as a review of the new research equipment and a guide for other scientific bodies into the current capacities of the Institute. Learn about our potential exemplified by the scope of research conducted in specific laboratories and their equipment and instruments. The enterprises which aim at improving the innovation of their production will be interested in the examples of practical applications presented in the folder. Note that this publication is an abridged source of information. Our intent behind it is to highlight the major topics of our operations. We are open to scientific cooperation, including interdisciplinary relations, and innovation. The presentation of every laboratory features the contact to individuals who will provide detailed information. Using our modern equipment and mutual experiences and achievements, together we can find new knowledge – to a mutual benefit. We welcome all proposals of cooperation (especially that the OP DEP 2007-2013 rules oblige us to cooperation for free!)

We invite all scientific institutions and businesses to cooperate in terms of general scientific, research, implementation and education areas. It is time for knowledge and innovation!

Józef Horabik
Director of the Institute of Agrophysics PAN

Laboratory of Natural Environment Monitoring
Department of Metrology and Modelling of Agrophysical Processes

Laboratory Supervisor: Prof. Bogusław Usowicz, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: b.usowicz@ipan.lublin.pl
http://zmmpa.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies the impact of moisture, soil water potential, temperature and salt level on the conditions of plant growth and development, as well as mass and energy exchange processes in soils. The laboratory performs measurements of hydrological and thermal properties of soils: water retention curves, water and thermal conductivity coefficients and thermal capacity. We also monitor the moisture, temperature, salinity and heat flux in soils in situ to describe and model of mass and energy transport processes in the soil-plant-atmosphere system.

Research profile:
- Development of methods for characterizing of porous media.
- Hydrological and thermal characteristics of porous media.
- Assessment of methods for soil environment studies.
- Monitoring of natural environment parameters.

Equipment

TDR soil moisture meter, manufacturer: IA PAN (2010)
- Measurement of porous media moisture within the range from 0 to complete saturation.
- Measurement of soil water potential from -800 hPa to 0.
- Measurement of electric conductivity from 0 to 1 S/m.

Examples of use:

- Measurement and monitoring of changes in soil moisture and soil water potential.
- Determination of the water retention curve and water conductivity with the instan taneous profile method.
- Monitoring of moisture, electric conductivity and temperature of soils and other po rous media.

Water retention hysteresis measuring set, manufacturer: SOILMOISTURE (2010)
- Determination of the retention curve hysteresis (wetting – drying cycle) in porous media

Examples of use:

- Dynamics of soil water potential – soil moisture dependence.
- Determination of characteristic points on water retention curve characterizing of soil water availability for plants.
- Dynamics of soil water potential – soil moisture dependence.
- Determination of characteristic points on water retention curve characterizing of soil water availability for plants.

Saturated zones water conductivity measuring set, manufacturer: Eijkelkamp (2000)
- Measurement of water conductivity in saturated zones of porous media.

Examples of use:

- Determination of water conductivity in saturated zones of porous structures.
- Determination of water conductivity of soils, filter beds, construction materials.

pF curve measuring set by Richards method, manufacturer: SOILMOISTURE (2010)
- Measurement of the water retention curve of porous media during drying process.

Examples of use:

- Determination of the main water retention curve branch of soils.
- Determination of amount of soil water useful for plants and characteristic points of soil water retention curve, e.g. field water capacity, permanent wilting point.

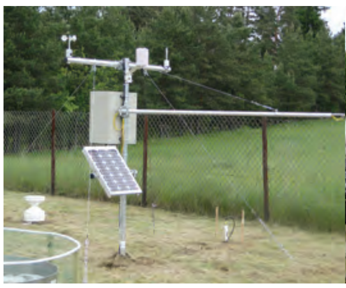
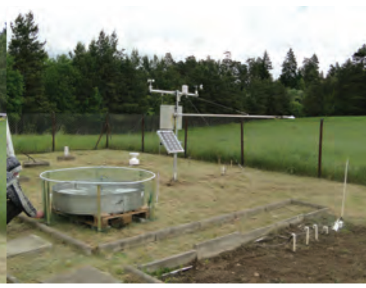
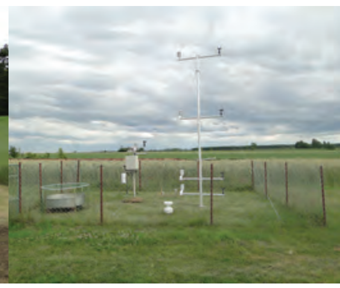
Agroclimatic parameters recording system, manufacturer: Delta-T (2010)

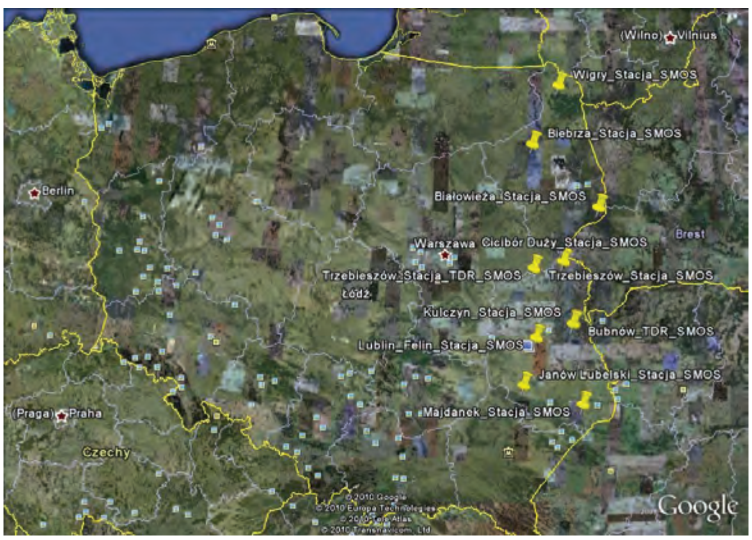
Measurement of:

- Radiation budget, PAR
- Potential evaporation of water
- Air humidity and temperature
- Wind speed and direction
- Soil moisture (from 0 to complete saturation)
- Soil temperature
- Soil water potential
- Soil electric conductivity from 0 to 1 S/m
- Precipitation

Examples of use:

- Studies of the thermal balance of active surface, modelling of mass and energy transport processes in the soil-plant-atmosphere system, modelling of thermal properties of soils. Studies of the spatial distribution of selected soil and air physical properties during drought or flood. Studies of moisture and temperature dynamics of soils and atmosphere, soil water potential, evaporation and radiation. Studies of impact of bogs on climate changes based on earth surface and satellite data.
- Monitoring of temperature and humidity of air and soil, soil water potential, water surface evaporation, wind speed and direction, precipitation, electrical conductivity, radiation (SW and LW) and photosynthetic active radiation (PAR).

Distribution of measurement stations in Poland

Laboratory of Thermography
Department of Metrology and Modelling of Agrophysical Processes

Laboratory Supervisor: Associate Prof. Piotr Baranowski, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: p.baranowski@ipan.lublin.pl
http://zmmpa.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies remote and contact-free assessment of surface temperature distribution and emitted infrared radiation distribution to diagnose disturbances in thermal conductance of soils, plant materials and other objects (e.g. in medicine or architecture), where the disturbances are exhibited by a heterogeneous distribution of surface temperature. Application of the NDT method of imaging spectroscopy (in UV, visible light and near IR ranges) enables the determination of absorption, dispersion and emission properties of examined objects.

Research profile:

- Use of imaging in near and medium infrared for:
- agrophysical research – modelling of mass and energy transport in the soil-plant-atmosphere system, determination of quality of crops and examination of renewable energy sources
- medical diagnostics
- industrial expertise: power engineering, building engineering, machine-building industry.

Equipment

SC7600 laboratory thermographic camera, manufacturer: FLIR Systems, Inc. (2010)

- Examination of the radiation temperature distribution (in the 3-5 µm range) of surfaces of any material.
- Temperature measurement range: 5-300oC; recording at 100 Hz in full reso lution (640x480 pixels), 335 Hz at the half of the resolution and 970 Hz at 1/4 of the IR detector resolution.
- Temperature measurements of objects of various sizes with the use of a 50 mm extender rings for macro imaging.
- The Altair software with various measurement functions: point, area (inclu ding automatic indication of extreme temperatures in the selected area), temperature difference, and isotherm.

Examples of use:

- Thermal properties of plant and animal tissues. Detection of mechanical damage and physiological changes in fruit and vegetable tissues. Detection of water and biotic stress in plants.
- Measurements of plant germination capacity. Detection of subsurface defects in all materials. Medical diagnostics: detection of inflammatory conditions, ischaemia, hyperhidrosis of palms and feet, examination of regeneration of surgical wounds.

SC620 portable thermographic camera, manufacturer: FLIR Systems, Inc. (2010)

- Examination of the radiation temperature distribution (in the 8-13 µm range) of surfaces of any material.
- Temperature measurement range: -40 - +500oC; recording at 30 Hz in full resolution (640x480 pixels).
- Simultaneous recording of thermal images and photographs, automatic association of visible and thermal images, fusion
  of thermal images and photographs.
- FLIR R&D software v1.2 with the option of analysing individual images and sequences of thermograms.

Examples of use:

- Determination of water conditions in arable fields – applied for the control of irrigation systems. Modelling of actual evapotranspiration. Examination of temperature conditions in greenhouses for optimal operation.
- Detection of plant areas attacked by diseases and pests. Diagnostics of mechanical equipment, electrical circuits and thermal insulation of buildings.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

Active thermography system, manufacturer: AT – Automation Technology GmbH (2010)

- Measurements with pulse thermography, lock-in thermography and pulsed-phase thermography.
- Controlling the operation of a halogen lamp array or triggering of flash lamp in synchrony with the recording of thermo graphic data (i.e. in cooperation with a thermal camera and a heatwave generator).
- Pulse thermal excitation of tested materials with single pulses (of various form) or a heatwave.
- Recording of internal temperatures of materials with the use of external contact surfaces in synchrony with thermogra phic measurements.
- The active thermography software and hardware enables examination with the use of the SC7600 laboratory camera or the SC620 portable camera.

Examples of use:

- Modelling of heat transfers in biomaterials. Development of procedures for thermographic detection of pathogenic le sions in plant and animal tissues using modern image analysis methods. Relation between the radiation temperature of surfaces of fruits and vegetables and their mechanical and chemical properties.
- Control and optimisation of storage conditions for fruits and vegetables. Classification and selection of crops. Detection of subsurface defects in various materials.

Hamamatsu C8800 UV spectrum camera with ImSpector UV4E imaging spectrograph, manufacturer: SPECIM (2010)

- Recording of UV images at the resolution of 1000 x 1000 pixels and acquisition of UV spectrum characteristics for any points of the image at a rated resolution of 2 nm.
- SpectralDAQ_UV software for data gathering and shutter control.

Examples of use:

- UV spectrum characteristics of various materials, including of biological origin. UV resistance of plant and animal tissues.
- Testing of UV light sources. Testing of sunblock creams. Examination of works of art.

VNIR (400-1000 nm) spectrum camera with ImSpector V10E imaging spectrograph, manufacturer: SPECIM (2010)

- Acquisition of spectral images at the resolution of 1344 x 1024 pixels for visible light and near infra-red (VNIR) and spectral characteristics for any points of the image at a resolution of 2.8 nm.
- Recording of VNIR images at an acquisition rate of 11 fps in full resolution.
- Spectral DAQ_VNIR software for data gathering and shutter control.

Examples of use:

- Relations between the colour and other qualitative parameters of food. Relation between spectral characteristics of soils and their granulometric composition and hydrological qualities. Physiological conditions of plants.
- Non-destructive analysis of the quality of fruits and vegetables during storage. Detection of diseases and damage of fruits and vegetables. Examination of the ripeness of fruits. Diagnostics of discolouration and pathological conditions of skin.

High-resolution SWIR spectral camera (1000 nm - 2.5 µm) N25E 2/3" imaging spectrometer, manufacturer: SPECIM (2010)

- Recording of SWIR images at the resolution of 320 x 256 pixels and acquisition of SWIR spectrum characteristics for any points of the image at a resolution of 10 nm.
- Recording of SWIR images at a frequency of 100 fps.
- SpectralDAQ_SWIR software for data gathering and shutter control.

Examples of use:

- Chemical compounds content and proportions of food ingredients/components. Early detection of viral and bacterial infections in leaves. Genetic testing of plants.
- Control of ripeness and quality of fruits and vegetables. Detection of surface and internal damage of tissue. Medical diagnostics.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Laboratory of Applied Optical Measurement Techniques

Department of Metrology and Modelling of Agrophysical Processes

Laboratory Supervisor: Associate Prof. Andrzej Bieganowski, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: a,bieganowski@ipan.lublin.pl
http://zmmpa.ipan.lublin.pl
http://www.ipan.lublin.pl

The shape, radii, size distribution and electrokinetic potential of particles are important to define properties of various substances, which is critical to many branches of industries as food industry, agriculture, environmental protection, chemical industry, ceramic industry, pharmacy, medicine, biology, biotechnology, cement industry. The measurement should be swift, easy, cost-effective and very precise. The samples for analysis should not be excessively large, while their method of preparation must be as low time and work-consuming as possible. The equipment operated in the Laboratory meet these requirements.

Research profile:

- Development of measurement methods for various materials (biological and other).
- Studies of sizes, size distribution and shapes of particles.
- Studies of the electrokinetic potential (zeta, ζ) of particles in water and non-water suspensions.

Equipment

Zetasizer Nano ZS, manufacturer: Malvern Instruments Ltd. (2004)

- Particle size measurements (0.6 nm – 6 µm) using PCS (Photo Correlation Spectroscopy).
- Examination of particles suspended in water and non-water media.
- Very small sample volume (approx. 1 ml) and short analysis time.
- Measurements in a wide temperature range (2-90oC)
- Measurement of zeta potential of dispersed particles of sizes from 3 nm to 10 µm using LDV (Laser Doppler Velocimetry), M3 (Mixed Mode Measure ment) and PALS (Phase Analysis Light Scattering).

Examples of use:

- Analysis of particle sizes, polydispersity and zeta potential of nanomaterials in various dispersion media. Analysis of sta bility of emulsions. Stability characteristics of colloid systems. Analysis of aggregation-dispersion processes in suspen sions of soils, minerals and biomaterials (e.g. bacteria, proteins), etc.
- Measurements of particle sizes and/or the zeta potential in potable water, filtered liquids (for filtering performance), emulsion of foods, cosmetics, pharmaceuticals, suspensions of powders, dusts, pigments, toners, and various deposits.

Mastersizer 2000, Manufacturer: Malvern Instruments Ltd. (2003)

- Determination of the particle size (granulometric) distribution in the range of 0.02 µm - 2 mm using laser diffraction methods.
- Low amounts of tested materials (from 0.5 to several grams).
- Application of inorganic and organic dispersion media.
- Short analysis time.

Examples of use:

- Stability of soil aggregates. Dynamics of dispersion processes in various media. Determination of granulometric composition of soils, sediments and thin deposits.
- Determination of the granulometric distribution of soils, deposits, microorganisms and small organisms (i.e. algae, yeast, protozoa), powders, dusts and pollutants in various dispersion media. Determination of the particle size distribution in foodstuffs (e.g. beverages, fruit juices, starch, chocolate) and other materials.

Morphologi G3, Manufacturer: Malvern Instruments Ltd. (2010)

- Measurement of particle sizes in the range from 0.5 μm to 2 mm using optical microscopy and image analysis.
- Determination of size distribution with precise determination of the number of analysed particles.
- Particle size distribution based on many pre-programmed parameters (e.g. elongation, circularity, convexity and others).
- Examination of dry powdered materials and their liquid suspensions.
- Colour microscopic photography of samples.

Examples of use:

- Analysis of the size and shape of particles in dry and dispersed forms. Examination of the size, shape and count of syn thetic or natural granular materials (powders, etc.), plant materials (e.g. seeds, plant roots, etc.), biomaterials and micro organisms.
- Measurements of the size, shape and count of particles – wide selection of materials (suspensions, deposits, filter conta minants, microorganisms, dusts, powders, microcapsules, granulates, etc.).

Auxiliary equipment for proper preparation and description of measurement samples.

ULTRAPYC 1200e helium pycnometer, manufacturer: Quantachrome Instruments (2010)

- Measurements of volume and density of solids, powders and suspensions.
- Sample volume range: 0.2-135 cm^3.

Calcimeter, manufacturer: Eijkelkamp Agrisearch Equipment BV (2010)

- Determination of the carbonate contents using the Scheibler method.
- Soil weight range: 1-10 g.

Shaker, complete with sieves, manufacturer: Fritsch GmbH (2010)

- Wet and dry segregation of particles.
- The sieve mesh depends on the analytical requirements.

Planetary-type mill, manufacturer: Fritsch GmbH (2010)

- Maximum initial grain size of materials: 10 mm.
- Ground grain size: below 1 μm.
- Grinding of soft and extremely hard materials.

Laboratory of Dielectric Spectroscopy

Department of Metrology and Modelling of Agrophysical Processes

Laboratory Supervisor: Associate Prof. Wojciech Skierucha, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: w.skierucha@ipan.lublin.pl
http://zmmpa.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies the dielectric properties of porous materials and develops prototype sensors for measuring physical and chemical properties of soils and plants (ion-selective, redox potential, moisture or oxidation sensors). The laboratory also studies moisture and salinity of materials using TDR (time domain reflectometry) and FDR (frequency domain reflectometry) methods.

Research profile:

- Dielectric properties of agricultural products and materials for the assessment of their quality.
- Development of sensors for measurements of complex dielectric permittivity of porous materials.
- Design and production of prototype electronic equipment for the measurement of physical properties of porous materials.

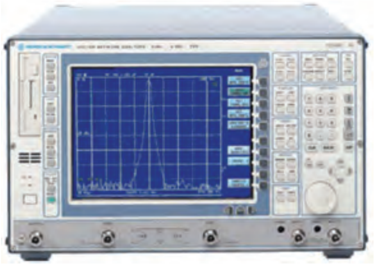
DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Equipment

ZVCE type vector network analyser, 20 kHz - 8 GHz, 3 channels, TDR, passive set of calibrators, N-type connectors, manufacturer: Rohde & Schwarz (2001)

Measured values: phase shift and amplitude attenuation of sinusoidal signals passing through or reflected by examined objects.

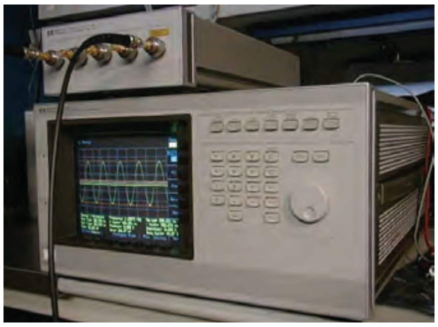


Examples of use:

- Examination of the dielectric properties of agricultural materials and products, determination of complex permittivity of porous materials, development of quality indexes for homogeneous materials, development of FDR and TDR die lectric sensors.
- Quality testing of agricultural materials and products.

HP 54120B wide-band sampling oscilloscope with a 4-channel sampling module and the HP 54121A pico-second pulse generator; DC frequency range: 21 GHz, SMA connectors, GPIB interface, manufacturer: Hewlett Packard (1995)

SAS-601B wide-band sampling oscilloscope; DC frequency range: 12.4 GHz, SMA connectors, manufacturer: Iwatsu (1994)



- Measured values: reflectometric and transmission analysis of delay and attenuation of pulses of tested objects.

Examples of use:

- Measurement of moisture content and salinity of porous materials using TDR (time domain reflectometry) and TDT (time domain transmission).
- Development of sensor for the measurement of moisture content and salinity of soils and other porous materials.

LCR E4980A precise meter, with optional measurement of permittivity of solids; operating range: 20 Hz - 3 MHz, manufacturer: Agilent (2009)

- Measured values: precise measurement of lumped R, L and C parameters of examined objects; complex impedance.

Examples of use:

- Electrical characteristics of solids and liquids, measurement of dielectric permittivity of porous materials, validation of sensor models of non-electrical quantities.
- Determination of quality indexes of agricultural and food products, calibration of measurement devices.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

DL9240 digital oscilloscope, 4 channels, freq. range: 1.5 GHz, 10 Gs/s sampling, manufacturer: Yokogawa (2007)

Measured values: time domain electrical signal waveforms.

Pendulum CNT-91 digital frequency meter, resolution: 50 ps, GPIB/USB interface, graphic display, 3.5 MB of built-in memory, precise frequency source, manufacturer: Pendulum (2009)

Measured values: frequencies of electrical signals.

Examples of use:

- Examination of selectivity and measurement accuracy of sensors for the measurement of physical and chemical quantities, testing of time and frequency characteristics of respective sensors.
- Development of physical and chemical sensors, calibration of developed sensors and measurement instruments.

SMU 2602 SourceMeter Instrument; operating range: 1μV - 200V, 1 pA - 10 A, 10μΩ - 200M Ω GPIB interface, RS-232 interface, 2 channels, manufacturer: Keithley (2009)

Measured values: sourcing and measurement DC voltage and current in potentiometric and amperometric measurements.

2100 series precision voltmeter, 6 ½ digit, GPIB, extensive firmware, manufacturer: Keithley (2009).

Measured values: internal resistance of biosensors, measurements of high-impedance sensors

Examples of use:

- Analysis of responses of physical and chemical sensors to forced voltages and currents.
- Development of physical and chemical sensors, e.g. soil redox potential, ion-selective, soil oxidation, testing their measurement selectivity and accuracy, calibration of developed sensors and measuring instruments.

WKL 100 climate chamber, temperature range: -20 - +120°C, relative humidity: 10-98%, capacity: 100 l, manufacturer: Weiss (2008)

Testing of soils and plants in variable climate conditions.
Testing of developed sensors and meters of electrical and non-electrical quantities at variable temperatures and humidity (tested factors: reliability, precision, short-term and long-term repeatability), temperature corrections.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Computer workstation with specialistic software

Design and programming of electronic modules and microcontrollers (Altium Designer, LabView v.5, Hi-Tech C Compiler, MPLAB C18 Compiler), development of mechanical elements (Autocad LT) for sensors agrophysical quantities, data analysis, processing and mathematical modelling (MatLab), document processing and archiving (Adobe Acrobat), development of user program interfaces (Borland Studio 2006, Visual Basic 6 Professional).

High-speed CNC engraving miller including servomechanisms, operating area: 400x 375x130 mm, manufacturer: Kimla Sp. z o.o. (2010)

Three ESD laboratory rooms (incl. 1 air-conditioned), complete with furniture, manufacturer: Treston (2010)

- Measurements with the use of ESD (electrostatic discharge)-sensitive instruments; development and production of electrical and mechanical elements of prototype measurement equipment.
- Volt-amperometric and high-frequency measurements with the use of ESD-sensitive instruments; production of precision mechanical details for sensors of non-electrical quantities.

Laboratory of Microscopy

Department of Microstructure and Mechanics of Biomaterials

Laboratory Supervisor: Associate Prof. Artur Zdunek, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: a.zdunek@ipan.lublin.pl
http://borz.ipan.lublin.pl/labs/mikro.html
http://www.ipan.lublin.pl

The laboratory studies structures of biological materials (biomaterials) from the nano scale to the macro scale. Classification of biomaterial microstructures requires using various microscopic techniques and special imaging procedures. Confocal microscopy enables high-quality imaging of cellular structures, which facilitates quantitative analysis. Characterizing the size and shape of cells requires relatively simple preparation, however, an instantaneous structure analysis requires special procedure for tissue fixation. Atomic force microscopy of suitably prepared samples enable characterising the structures in the nano scale. The primary activity of the laboratory is to search relations between the structure of materials, their mechanical properties and chemical composition, as determined with spectroscopic methods.

Research profile:

- Micro and macro structures of various materials.
- Micromechanical properties in reference to the topography of biomaterials.
- Spectroscopy-based analysis of chemical composition and structure of materials.
- Preparation of microscopic samples.

Equipment

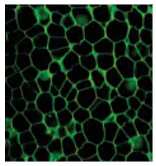
FluoView300 confocal laser microscope, manufacturer: OLYMPUS Corporation (2007)

- Analysis of the microstructure of materials.
- Contrast microscopic imaging of selected (stained) objects. 3-D analysis is possible.
- High-resolution microscopic photography of stained samples with He-Ne and Ar-ion lasers induced fluorescence.

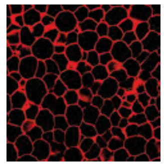
DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

Examples of use:

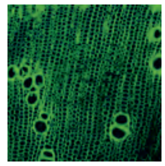
- Examination of structures of materials. Analyses of structure change processes.
- Histological examination and detection of defects in plant tissues.



Potato tissue



Potato tissue



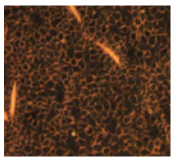
Horseradish tissue

Macroscope, manufacturer: IA PAN (2007)

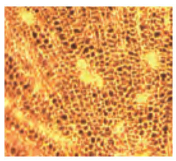
- Analysis of materials microstructure.
- Macroscopic observation and photography (approx. frame size: 8 x 6 mm) of samples in direct light.

Examples of use:

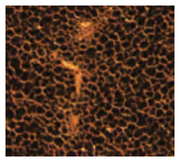
- Examination of materials structures. Analyses of structure changes of biomaterials during harvesting, transport, storage and processing.
- Detection of defects in plant tissues.



Apple tissue



Carrot tissue



Potato tissue

Damaged potato tissue

Stereoscopic microscope for examination in direct and reflected light with additional equipment, manufacturer: OLYMPUS Corporation (2009)

- Analysis of the microstructure of materials.
- Macroscopic observation and high-resolution photography of samples in direct and reflected light.

Examples of use:

- Examination of structures of materials. Analyses of structure behavior of biomaterials during harvesting, transport, sto rage and processing.
- Analysis of failures and damage in construction materials. Qualitative analyses of microbiological infections of food pro ducts.

Bioscope Catalyst II atomic force microscope, manufacturer: Veeco Instruments Inc. (2009)

- Analysis of the microstructure and mechanical properties of materials.
- Observation and microscopic photography of samples; analysis of mechanical properties in the nano scale.
- Topographic photography and analysis of mechanical properties of solid and biological materials in air and liquids.

Examples of use:

- Examination of structures of materials. Analysis of changes in the nano-structure and properties of food products caused by additives.
- Analysis of microporosity of construction materials, analysis of the matrix chemical bond strength of active substances in pharmaceuticals.

N-800N optical microscope, manufacturer: MBL (2006)

- Analysis of the microstructure of materials.
- Microscopic observation and high-resolution photography of samples in direct light.

Examples of use:

- Examination of structures of materials. Analyses of structure changes of biomaterials during harvesting, transport, sto rage and processing.
- Histological examination and detection of defects in plant tissues.

VT 1000S vibratome, manufacturer: Leica Microsystems GmbH (2007)

- Preparation of microscopic specimens: plant and animal tissues in natural condition of the thickness above 100 micro metres.

RM 2155 microtome, manufacturer: Leica Microsystems GmbH (2000)

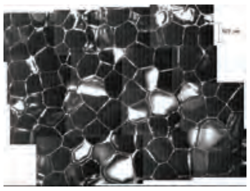
- Preparation of microscopic specimens of plant and animal tissues, including high hardness objects and preparates, of the thickness above 0.5 micrometres.

Aphelion Dev. 4.0 image analysis software, manufacturer: ADCIS (2009)

- Computer analysis of 2D and 3D images.
- 2D and 3D image transformation, and analyses, including colour, size and orientation of represented objects.

Examples of use:

- Dependence of mechanical properties of fruits and their microstructure. Visual analysis of fruits and vegetables damage during harvesting, transport and storage.
- Starch test. Analysis of fruits colour and its changes.



Fourier-transform infra-red spectroscopy (FTIR)/Raman spectroscopy system, manufacturer: Thermo Scientific (2010)

- The system includes Raman disperse spectrometer with 532 nm laser, Fourier-transform infra-red Raman spectrometer with 1064 nm laser, IR spectrometer and UV-VIS spectrometer.
- Structural identification and analysis of chemical compounds, mapping of chemical compound distribution in samples.

Examples of use:

- Analysis of multi-molecular compounds; analysis of cellulose crystallinity.
- Distribution of active substances in pharmaceutical tablets; chemometric polymer analysis.

Laboratory of Sensory Analysis and Mechanical Properties

Department of Microstructure and Mechanics of Biomaterials

Laboratory Supervisor: Associate Prof. Artur Zdunek, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: a.zdunek@ipan.lublin.pl
http://borz.ipan.lublin.pl/labs/sens.html
http://www.ipan.lublin.pl

Mechanical properties are critical to the quality assessment of biological materials (biomaterials), which are usually determined using appropriate testing method, including but not limited to compression, tensile and bending tests. Many mechanical properties of biomaterials are related to their susceptibility to destruction and the propagation of fractures inside them. The destruction processes can be analysed with the use of mechanical stress testing machines or the acoustic emission method (AE).

Fruits and vegetables are extremely susceptible to the conditions of harvest and storage. The quality of fruits and vegetables can also be analysed with non-destructive tests (NDTs). The laboratory currently develops instruments for NDTs. Among our capacities, we offer a new method based on the spatial-temporal speckle correlation (biospeckle). Our reference methods involve sensory tests. We also operate fully-equipped sensory panels employing a trained staff.

The laboratory performs mathematical modelling of various processes occurring in biomaterials with the use of specialistic software, which also enables prediction of physiological changes of plant materials based on the input experimental data.

Research profile:

- Testing and analysis of mechanical properties of biomaterials and fracture processes.
- Design of measuring instruments and development of biomaterial quality assessment methods.
- Modelling of mechanical processes in plant tissues.
- Sensory and instrumental testing of vegetable and fruit.

Equipment

Lloyd LRX universal testing machine, manufacturer: Lloyd Instruments Ltd, Hampshire (1997)

- Measurement of compression and tensile forces in any mechanical tests with the precision of 0.01%, speed range of 0.1-1000 mm min-1, force range of up to 2.5 kN and deformation dimensions of up to 750 mm.
- Testing of mechanical properties, including strength of any material.
- Mono-axial tensile strength and compression testing of any samples.

Examples of use:

- Analysis of the modulus of elasticity of plant and animal tissues. Fatigue analysis of bones. Flow and creep analyses of solid materials.
- Measurements of foodstuff textures. Adhesion measurements. Strength measurements of textiles.

Contact Acoustic Emission Detector (CAED), manufacturer: IA PAN (2009)

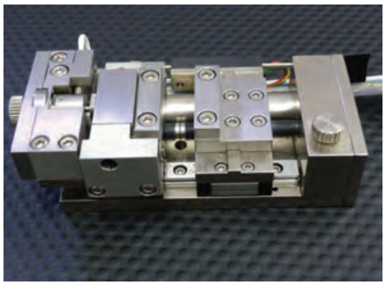
- Instrumental measurement of texture of apples (including crispness).
- Measurement of acoustic emission counts and firmness of apples in puncture test
- Quality control of fruits for processing and consumption fitness.

Examples of use:

- Analysis of the food additives impact on apple texture. Analysis of plant tissue fracture processes.
- Consumption quality control in specific stages of apple production and trade. Analysis of texture changes during storage. Optimisation of the harvesting date and storage me thods for apples.

MICROTEST 200N Tensile stage mechanical microtester for soft plant tissue, manufacturer: Deben LTD (2009)

- Strength of materials.
- Measurements of forces of up to 200 N and deformations of up to 20 mm in tensile strength and compression tests of thin samples with simultaneous video recording of microscopic image of deformed samples.



Examples of use:

- Microscopic analysis of deformation processes of soft plant tissues. Sample deformation process imaging. Modelling of deformation processes.
- Determination of material strength. Determination of material constant values.

AFS acoustic firmness sensor for fruit and vegetable, manufacturer: AWETA G&P (2010)

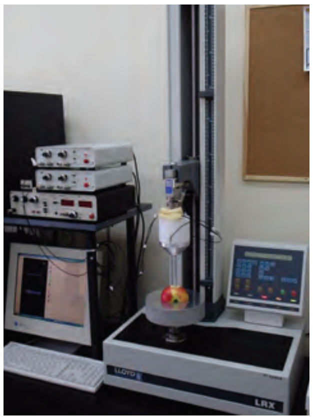
- Non-destructive quality assessment of fruits and vegetables, e.g. apples, tomatoes, pears, etc.
- Firmness index.
- Quality control of fruits and vegetables.

Examples of use:

- Monitoring of changes in biological materials during maturation.
- Non-destructive analysis of changes in the quality of fruits and vegetables during storage. Monitoring of disease and damage development. Optimisation of harvest dates.

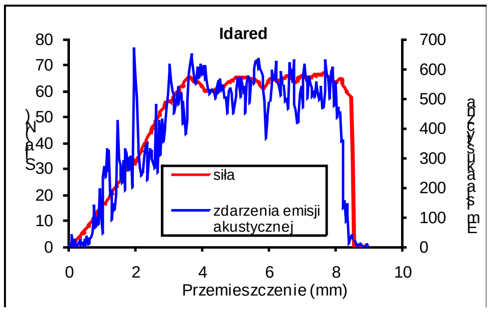
Laboratory acoustic emission (AE) recording station, manufacturer: IA PAN & IPPT (2008)

- Studies of fracture processes and strength analyses.
- Measurements of the acoustic signal during mechanical deformation of materials.
- Measurement of event counts, energy and average amplitude with spectral response characteristics in audible and ultrasound ranges of materials during their mechanical destruction.



Examples of use:

- Analysis of fracture processes of various materials, including biomaterials.
- Consumption quality control in specific stages of crops production and trade. Non-destructive analysis of changes in the texture of fruits and vegetables during storage. Optimisation of harvesting dates and storage methods.

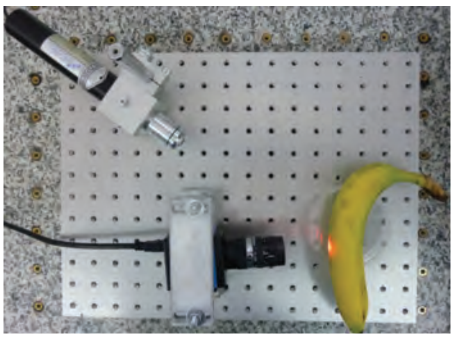


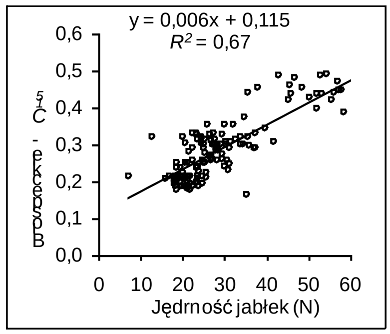
Spatial-temporal speckle correlation station (BIOSPECKLE), manufacturer: IA PAN (2007)

- Quality control of fruits, vegetables and other biological materials.
- Measurements of specular image dynamics of any material.
- Recording of specular image stills (max. resolution: 640 x 480 pixels) with the use of a He-Ne laser and CCD camera of up to 60 fps.

Examples of use:

- Monitoring of changes in biological materials during maturation.
- Non-destructive analysis of changes in the quality of fruits and vegetables during storage. Monitoring of disease and damage development. Optimisation of harvest dates.





R/S Plus rheometer, manufacturer: Brookfield Engineering Laboratories, Inc. (2009)

- Measurements of viscosity and determination of flow characteristics of liquids and soft solids in the viscosity range of 0.0015-124,000 Pa•s at a temperature range from -20 to +200°C.
- Can be applied to study fruit and vegetable products: jams, pomaces, oils, sauces and non-food materials, e.g. greases and oils.

Examples of use:

- Determination of the relation between coagulation rate and viscosity of biopolymer solutions; testing of rheological properties of starch.
- Determination of viscosity of fruit juices following the addition of various texturing agents, observation of changes in viscosity of technical lubricants at various temperatures.

Sensory analysis stations (4 items), manufacturer: IA PAN (2008)

- Quality control of food products.
- Sensory analysis of food products (QDA) in controlled conditions by trained stuff.

Examples of use:

- Impact of storage or additives on sensory characteristics of fruits and vegetables and other food products.
- Quality control of food products. Classification of food products.

ANSYS v11 FEM (finite-element method) modelling software, manufacturer: ANSYS, Inc. (2008)

- The software for FEM calculation and simulations of mechanical properties.
- Modelling.
- Strength calculations, linear and non-linear problems, flow.

Examples of use:

- Modelling of mechanical properties of materials, transport and flow processes.
- Estimation of structural elements strengths.

Laboratory of Surface and Structural Properties of Soil and Plants
Department of Physical Chemistry of Porous Materials

Laboratory Supervisor: Prof. Zofia Sokołowska, DSc
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: z.sokolowska@ipan.lublin.pl
http://zfmp.ipan.lublin.pl
http://www.ipan.lublin.pl

The phenomena and processes which occur on the solid-gas and solid-liquid interfaces differ from the phenomena in bulk phases by the fact that the former are subjected to surface forces. Knowledge on the nature of surface phenomena is necessary to understand the physicochemical processes occurring in soils and to control them in the macro scale. For example soil water transport processes observed in the field reflect surface free energy and wettability of the soil solid phase particles, microporosity, swelling-shrinking of clay minerals and organic matter, hydration of surface cations, charge and dissociation of surface functional groups, etc. It is also critical to know soil physical chemical and surface characteristics for the purposes of land improvement. It is worth noting that the so-called ‚agricultural' adsorbents like the soil, clay minerals or organic matter (humus) are of a complex nature, with respect to their chemical and mineral composition, size distribution and porous structure. The soil is a system which is multi-phase (liquid, solid and gas), multi-component (minerals, organic matter, organomineral compounds, living organisms), and polydispersive (from colloidal particles to macroscopic grains).
One of the most important characteristics of solid bodies is their porosity and specific surface area.
Depending on the method and type of a solid, the following types of specific surface areas are defined:

- total – determined with the use of polar adsorbates;
- external – determined with the use of apolar adsorbates;
- internal – calculated as the difference of the total and the external surface areas;
- interlamellar – surface within crystal lattice of swelling minerals, i.e. smectites and vermiculites.

The specific surface area can characterize the size and transformations of mineral and organic components in soil. Soil specific surface area is well correlated with the amount and type of clay fraction and soil humus, as well as with the physical and sorption properties of soils, such as microporosity, plant nonavailable water content, cation exchange capacity. This value has proved to be a sensitive indicator of soil-formation, structure destruction and erosion processes. The specific surface area can also be used to monitor soil degradation processes.

The solid phase porosity defines a general structure, which is due to the shape, size and mutual arrangement of particles and aggregates. The number of pores, their volume and sizes affect many soil phenomena as retention and transport of gases, water and nutrients, as well as the root penetration of the soil. The porosity and pore distribution are frequently applied not only in the studies of soil structure, but also in recognition and monitoring of mass transfer and soil degradation processes. Water is bound by the soil constituents via a number of intermolecular attraction forces, which cause adsorption, surface energetic, adhesion and capillary effects. The hydrophilic and hydrophobic properties of solids determine its wettability and hydro-physical properties. Spreading of liquids on a solid surface depends on the intermolecular forces of the solid and the liquid.

Hydrophobic or hydrophilic character of a solid surface can be expressed by a contact angle, interfacial energy free or the work of spreading. In the case of more complex materials like the soil specific qualitative parameters are also applied as height of capillary rise, absorption time of a drop placed on a solid surface or the free surface energy components.

Research profile:

- Interfacial processes in soil physicochemical medium.
- Surface properties as the indicators of changes in the soil and plant materials under environmental factors.
- Physical and chemical conditions affecting the formation and stability of soil structures.
- Description of soil wettability, intermolecular interactions and stability of aggregates using surface free energy.
- Acid-base equilibria in soils, soil particle charge, buffering capacity, cation exchange.
- Soil degradation: pollution acidification, alkalization, salinization, organic matter lost, structure destruction, hydrophobi city ; laboratory simulations of processes.
- Physicochemical methods for improvement and detoxification of degraded soils.

Equipment

MULTI N/C 2000, HT 1300 carbon and nitrogen analyser, manufacturer: Analytik Jena (2006)

- Analysis of total and organic carbon content in solids and solutions ranging from ppm to %.
- Analysis of the total nitrogen in solutions.
- Solid samples require no additional chemical processing; only grinding and sieving, solutions should be filtered.

AAS AA 300 heavy metal content analyser, manufacturer: Analytik Jena (2008)

- Fully automated system for the analysis of heavy metal contents in solutions.
- The only model on the market which automatically analyses of a few elements in a single sample.
- The automatic sample feeder enables continuous analysis of several dozens of samples.
- The apparatus measures metal concentrations from decimal parts of ppm, de pending on the element in question.
- Use: analysis of samples of soil, plant materials and foodstuffs.

UV VIS V-530 spectrometer, manufacturer: Jasco Inc. (2007)

- Measurement of radiation transmittance and absorption at defined wavelengths.
- Operating range: visible and UV range (200-1100 nm).
- Measures the entire absorbance spectrum or at a single wavelength.
- Used in biology, science, chemical industry and food industry.

Titrino 702 SM titrator, manufacturer: Metrohm AG (2006)

- Automatic device for quantitative potentiometric analysis in solutions.
- Direct titration – use of the direct reaction of the titrant and the titer.
- Indirect titration – the titrant reacts with the reaction product of the titer with other chemical compound.
- Reverse titration – determination of an excess of a titrant added to the examined solution.

Sorptomat Quadrasorb SI specific surface area analyser, manufacturer: Quantachrome Instruments (2009)

- Measures adsorption-desorption isotherms of the gaseous nitrogen in liquid ni trogen temperature.
- Additional applicable adsorbates: nitrogen, argon, carbon dioxide.
- The solid adsorbents should be degassed at high temperatures or in dry adsor bate flux.
- Determination of specific surface area of solids. Minimum measurable specific surface area: 0.05 m2 g-1.
- Determination of microporosity (pore sizes from nitrogen adsorption 5-200 nm).
- Measurements of soils, minerals, plant and food materials, chemical or construc tion materials.

Alpha 1-4 LSC lyophilizer, manufacturer: Martin Christ Gefriertrocknungsanlagen GmbH (2009)

- Used for thermolabile products.
- Lyophilization can be used to:
  - condense and dry various substances,
  - processing of food products, enzymes, proteins, etc.

FCF 12 SP muffle furnace, manufacturer: CZYLOK (2007)

- Ashing of biomaterials.
- Available fully automated heating with precise adjustment and sequences of temperature gradients.
- Maximum operating temperature: 1100 °C.
- Applications: preparation of samples for further analyses, strength testing of materials at high temperature.

Laboratory of Gas Chromatography
Department of Natural Environment Biogeochemistry

Laboratory Supervisor: Paweł Szarlip, PhD
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: p.szarlip@ipan.lublin.pl
http://chg.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies production and emission of greenhouse gases (carbon dioxide, methane, nitrogen(I)oxide) from soils and surface waters, activity of soil and water microorganisms, ability of soils to purify wastewater from nitrogen and phosphorus compounds, the impact of nitrogen fertilization on the emission of nitrogen(I)oxide and the response of plants on oxygen deficiency stress in the rhizosphere.

Research profile:

- Impact of environmental and anthropogenic factors on the biological activity and metabolism of microorganisms.
- Processes of greenhouse gases emission and absorption.
- Determination of components of gas mixtures.

Equipment

GC-2014 gas chromatograph with TCD, FID and ECD detectors, manufacturer: Shimadzu (2010)
Gas chromatographs: GC-14A with TCD detector; GC-14B with ECD and TCD detectors, manufacturer: Shimadzu (1991)

- Testing of gas mixture components (CO2, N2O, O2, CH4, C2H2, C2H4) in wide concentration ranges.

Examples of use:

- Determination of gas composition in various systems (atmosphere, soil, silos, stores).
- Testing of greenhouse gases emissions.
- Determination of respiratory activities (CO2 release and O2 absorption) of soils and biological materials.
- Monitoring of gas concentrations in closed systems.
- Monitoring of biological activity of soils.
- Testing of nitrogenase activity.
- Testing of methanotrophic, methanogenic, nitrification and denitrification activities.

DELTA V Advantage mass spectrometer, manufacturer: Thermo Fisher Scientific (2010)

- Testing of ratios of stable isotopes in gas samples.
- The integrated Pre-Con system enables practical assessment of trace gases (N_2O, CO_2 and CH_4) in the atmospheric air.

Analizy pierwiastków:
$^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$, $^{34}S/^{32}S$

Examples of use:

- Biochemical transformation cycles of nitrogen and carbon.
- Processes of production, emission and absorption of nitrogen oxide (I).
- Methane oxidation in anaerobic conditions.

Multiparametric meter for laboratory and field measurements, manufacturer: HACH LANGE (2010)

Analyses of concentration levels:

- oxygen - LDO oxygen probe, optical measurement of O2 in water solutions; automatic air pressure compensation; operating range: 0.00-20.0 mg dm-3 O2;
- sodium ions – ion selective electrode with integrated temperature sensor; operating range: from 0.023 mg dm-3 to 23 g dm-3;
- conductivity – platinum electrode; operating range: 0.01 µS cm-1 to 400 mS cm-1;
- redox potential – standard redox electrode with integrated temperature sensor; operating range: +/-1200 mV;
- pH – pH combined electrode; operating range: pH 0-14, applicable in water and soils;

Equipped with field versions of sodium, redox potential and pH electrodes with temperature sensors.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

pH and Eh analyser – titrating station, manufacturer: HACH LANGE (2010)

Measurements:
- redox potential – standard redox electrode with integrated temperature sensor; operating range: +/-1200 mV;
- pH – pH combined electrode; operating range: pH 0-14, applicable in water and soils;
- potentiometric titration.

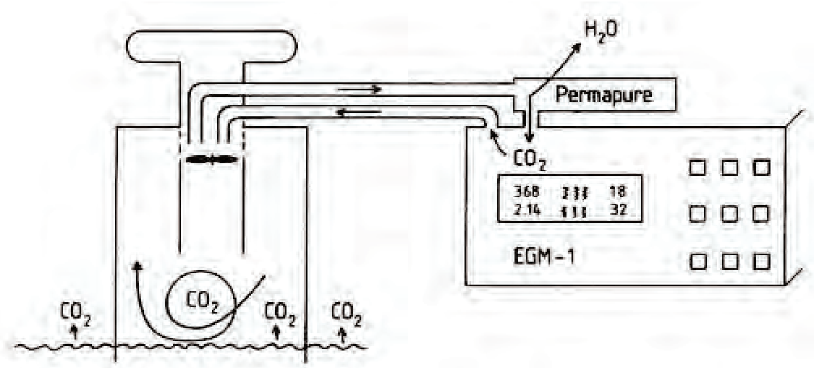
Examples of use:
- Oxygen status control, measurements of conductivity, redox potential and pH of surface waters and soil solutions;
- Impact of sodium, redox potential and pH on biological activity of soils and other biological systems;
- Determination of reduction resistance of soils;
- Determination of FOS/TAC values in biogas reactors.

EGM-4 – CO2 monitoring system in natural conditions, manufacturer: PP SYSTEMS (2010)

- IRGA infrared CO_2 analyser in natural environments, greenhouses, growth chambers, etc.
- Additional functions: temperature and soil moisture measurement.

Examples of use:

- Testing of respiratory activity of living ecosystem elements.
- Testing of CO_2 assimilation by plants.
- Testing of soil respiration depending on environmental conditions.
- In situ testing of CO_2 emissions



Measuring system Radiometer Copenhagen: PHM 82 STANDARD pH METER, PMM 64 RESEARCH pH METER, TTT 80 TITRATOR, manufacturer: Radiometer Copenhagen (1986)

Measurements: pH, redox potential, potentiometric titration.

FIAStar 5000 Analyzer of soluble nitrogen and phosphorus compounds, manufacturer: FOSS TECATOR (2000)

Measurement of nitrates (NO_{3-}), nitrites (NO_{2-}), ammonium (NH_{4+}) and phosphates (PO_{43-}) concentrations in potable water, groundwaters, surface waters and soil extracts.

Examples of use:
- Testing of pollution levels of water with soluble nitrogen and phosphorus compounds.
- Leaching of fertilizers by percolation waters.

Laboratory of Plant Root Systems
Department of Soil and Plant System

Laboratory Supervisor: Artur Nosalewicz, PhD
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: a.nosalewicz@ipan.lublin.pl
http://skr.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies total and compensatory water uptake by the parts of root systems depending on the type and physical properties of soils and the opening of the leaf stomata in various weather conditions. The research involves long-term water uptake mechanisms related to the growth of root system (rooting depth, structural changes of roots) and short-term mechanisms, which are related to the movement of water in roots through various pathways. The mechanical properties of soils, e.g. penetration resistance and strength of soil and soil aggregates are significant indicators of the quality of the root growth environment. Research in these areas is useful in the solving of problems related to stability of soil structures and prevention of compaction caused by farming machines.

Research profile:

- Impact of soil environment on the growth and functioning of plant shoots and roots.
- Impact of management practices on soil structure and physical properties.
- Image analysis of soil pore-size distribution and root structure.

Equipment

Image analysis system for the examination of plant roots and shoots

Software: WinRhizo PRO, REGENT INSTRUMENTS INC, (2007)
MATLAB packages, including Simulink, SimBiology, Image Processing Toolbox, Statistics Toolbox, The MathWorks (2010)
Epson XL10000 scanner with the transparent material adapter (2010)

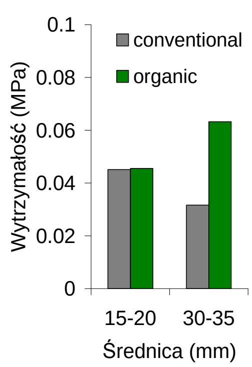
- Measurements of lengths and diameters of main and lateral roots; the number of nodes and branches of the root system located in a glass tray.
- Measurement of the surface area of leaves during vegetation.
- Analysis of leaves and roots colour.
- Maximum measurement precision and size of analysed surfaces: 4000 dpi, A3.

Examples of use:

- Impact of tillage, compaction and pollution of soils on the root and shoot growth.
- Resistance of plants to adverse soil conditions.

Zwicki Line 5kN (BT1-FR5.0TN.D30) static compression and tensile strength testing machine, manufacturer: Zwick GmbH&Co. KG (2007)

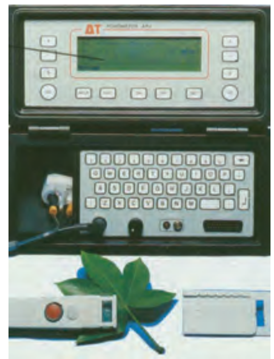
- Examination of mechanical properties of all materials applying forces up to 5000 N.
- Measured values:
  - force, range: 0-5000N; precision: 0.25%
  - probe position
- Heads: 100, 5000 N. Test space height: 1050 mm. Continuous deformation speed from 0.05 to 500 mm min-1. Compression and puncture test equipment. Fully configurable compression and tensile programs.
- Automatic determination of maximum force, strength, elastic modulus and other parameters.



Examples of use:

- Mechanical strength of soil structure elements.
- Elastic modulus of plant and animal tissues.
- Measurements of foodstuff textures.
- Measurement of the puncture strength of cardboard packaging.

AP-4 leaf stomatal resistance measurement instrument, manufacturer: Delta-T (2000)



- Measurements of the resistance (s cm-1) and conductance of leaves stomata (mmol m-2 s-1). Measurement error: < 2% Measurement time: 15-60 s
- Sensors: PAR illumination, temperature, pressure; installed on the measurement head.

Examples of use:

- Optimisation of plant growth conditions, e.g. temperature, substrate/soil moisture, fertilization.
- Stress resistance comparison of plant varieties.

Automated soil CO_2 emission measurement system, manufacturer: ACE (2009)

- CO_2 concentration measurements; range: 0-896 ppm, precision: 1 ppm. Open system (chamber capacity: 1.0 dm^3) – w/o pressure gradient; Closed system (chamber capacity: 2.6 l). Flow rate: 100-500 ml min^{-1}, precision: 2%.
- 40 Ah battery operating time: up to 28 days.
  - PAR: 0-3000 µmol m^{-2} s^{-1}.
  - soil temperature.

Examples of use:

- Continuous monitoring of soil environments, on-site measurements of soil respiratory activity.
- Impact of anthropogenic factors on the soil CO_2 emissions.

LAI 2200 portable leaf area meter, manufacturer: Li-Cor (2010)

- A device for quick and non-destructive measurement of the leaf area index (LAI) and other properties of plant areas, e.g. mean tip angle (MTA). The LAI measurements of grasses and trees can be performed in various weather conditions.
- The sensor operating range is 320-420 nm. Includes adapters for FOV limitation to 12.3°, 28.6°, 43.4°, 58.1° and 74.1°.

Examples of use:

- Monitoring of plant cover.
- Assessment of pesticides activity.

Helios Gamma spectrophotometer, manufacturer: Thermo Spectronic (2002)

- Single-beam optical system. Wavelength range: 190-1100 nm, aperture spectral width: 2 nm, wavelength precision: <1 nm. Wavelength repeatability: +/- 0.2 nm.
- Determination of spectral characteristics, ABS (absorbance) mode and %T (transmittance) mode. Determination of kinetic curves.

Examples of use:

- Enzyme activity in soils, sewage sludge and other materials.
- Enzyme activity of microorganisms.

Laboratory of Physical Properties of Fruits and Vegetables
Opiekun laboratorium: dr Dariusz Wiącek

Laboratory Supervisor: Dariusz Wiącek, PhD
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: d.wiacek@ipan.lublin.pl
http://wfow.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory concentrates on quality of fruits (apples, pears, strawberries, plums, currants, cherries, citrus fruits) and vegetables (carrots, leeks, celeries, beetroots, paprikas, tomatoes), their mechanical damage (contusions and squashes) during harvest, transport and storage, the influence of variety, temperature, storage time and ripeness on optical properties (colour, pigmentation intensity) of fruits and vegetables using colorimetric and spectrophotometric methods. Mechanical properties (firmness, damage resistance) are studied using compression and vibration tests, static and dynamic load tests, brittleness tests and fatigue tests in a wide range of temperature (cooling, freezing, heating).

Research profile:

- Development of physical methods for quality assessment of fruits and vegetables.
- Mechanical properties of plant materials under static and dynamic loads.
- Colouring of plant materials.

Equipment

INSTRON 6022 strength testing machine, manufacturer: Instron Ltd. (1987)

- Strength testing of materials under static loads.
- Axial testing: compression, stretching, bending, creeping and stress relaxation.
- Determination of forces, deformation, energy and elastic modulus of examined materials.
- Operating speed: 0-1000 mm/min, force range: up to 10 kN (0.1% of precision), operating space: up to 1635 mm (0.01 mm of precision).

Examples of use:

- Model research, strength assessment, analysis of flexibility, flowing and stress relaxation of plant, animal, dairy, construction and dental materials.
- Comparative assessment of mechanical properties of crops, determination of strength parameters of structural components used in agriculture and agricultural and food processing machines and equipment.

INSTRON 8872 strength testing machine, manufacturer: Instron Ltd. (2001)

- Strength testing of materials under static and dynamic loads.
- Axial testing: compression, stretching, breaking, creeping, flowing, fatigue and cyclic.
- Force range: up to 25 kN, operating pitch: 50 mm; frequency: up to 50 Hz.

Examples of use:

- Model and fatigue research, strength assessment, analysis of flexibility, flowing and creeping of any materials under static and dynamic loads.
- Comparative assessment of mechanical properties of apples, raspberries, and sprouts of flo wers and rape. Strength assessment of tennis string pulls.

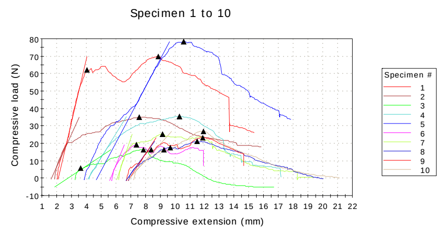
DEVELOPMENT
OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Lovibond CAM-System 500 imaging colorimeter, manufacturer: Tintometer Ltd (2008)

Source: http://www.globalspec.com

- Records objects image at a resolution of 752 x 582 pixels and saves each pixel in as RGB components.
- Measures sizes and shapes of objects.
- The time domain screen enables capturing an image sequence at defined intervals and as on-line playback.
- Assessment of heterogeneous or variable colour of the objects which cannot be measured with conventional spectrometers. Allows recording the entire or selected areas FOV image of the sample.
- Sample size: 240 x 280 x 120 mm.
- Measurement time: 1-2 s.
- The contact-free system ensures that the consistency and texture of objects do not affect the measurement results.

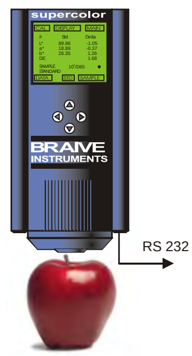


Examples of use:

- Examination, analysis and assessment of colours of any material.
- Quality testing of various products, including fruits and vegetables. Quantitative assessment of colour and appearance – a quality control system which enables the user to decide if tested products meet the required criteria of colour and appearance.

Supercolor Braive 6016 colorimeter, manufacturer: Braive Instruments (1995)

- Instrumental measurement of colours in the visible range of reflected light using the L*a*b* colour system by CIE in laboratory or field tests.
- Measurement field diameter: 11 mm.



Examples of use:

- Examination of the impact of agricultural technology, harvest, transport, storage and shelf-live of fruits and vegetables on behavior of optical properties of product surface.
- Qualitative assessment and classification of fresh and processed fruits and vegetables.

Laboratory of Assessment of Grain and Oil Materials Quality
Department of Physical Properties of Plant Materials

Laboratory Supervisor: Agnieszka Nawrocka, PhD
Tel. +48 81 744 50 61
Fax +48 81 744 50 67
e-mail: a.nawrocka@ipan.lublin.pl
http://ojszo.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies physical and chemical properties of seeds and stalks of cultivated plants, particularly new rape varieties and hybrids for the lipid industry and generation of oils as alternative energy sources. Mechanical properties of plants determining their hardness and damage resistance, as well as the relation between plants and moisture of materials are studied, as well. X-ray imaging is used to detect internal endosperm damage, which contribute to quantitative losses and lowered processing value of grain, and the presence of pests feeding inside kernels. Determination of the stages of pest development in X-ray images enables to trace the history of grain transport – from producers to stores. The laboratory studies physical properties of wet gluten: the content of bound and free water, which are sensitive tools for monitoring physiological and technological effects on flour processing, and the expansion capability of gluten membranes as a function of temperature, which enables the determination of parameters for forming good quality pastry crumbs.

Research profile:

- Studies of physical properties of plant raw materials (plants, seeds, fruits and vegetables) and physical processes during harvest, transport, storage and processing of crops.
- Development of methods for determination of physical properties of plant materials.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

Equipment

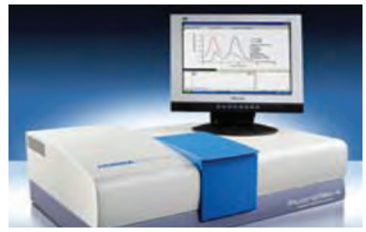
ACQUITY UPLC SYSTEM liquid chromatograph, manufacturer: Waters (2010)

- Qualitative and quantitative analysis of complex mixtures.
- Identification of separated compounds based on the retention times.
- Determination of concentration levels of various chemical compounds in samples.

Examples of use:

- Determination of composition of complex mixtures.
- Analysis of natural products and extracts

FLUOROMAX-4P spectrofluorometer, manufacturer: Horiba Jobin Yvon (2010)



- Measurement of fluorescence life times of over 100 ps.
- Measurements of molecules dynamics in solutions, micellar systems, etc. (anisotropic measurements).
- Recording of emission and excitation spectra (fluorescent molecules, nanoparticles, etc.).

Examples of use:

- Detection and determination of all fluorescent substances.
- Detection of trace components in food products (amino acids, vitamins, proteins, toxins), detection and determination of traces of enzymes, coenzymes, lipids, proteins, chlorophyll.

ICP OES - iCAP 6500Duo spectrometer, manufacturer: Thermo Scientific (2010)

- Analysis of elements contents in food, water and soils.
- Quick and simultaneous analysis of multiple prime and trace elements.
- Determination of high excitation potential elements (e.g. W, Cl, Br, I, S, U)

Examples of use:

- Examination of elements composition of organic and inorganic samples.
- Examination of elements composition, detection of pollution with heavy metals.

Cary 300/Biomelt spectrophotometer, manufacturer: Varian Pty (2010)

- Recording of light absorption and transmittance spectra in relation to the light wavelength.
- Qualitative and quantitative analysis of compounds based on recorded absorption spectra.

Examples of use:

- Analysis of compounds absorbing visible light and UV.
- Determination of organic substances (e.g. aromatic hydrocarbons, aldehydes, ketones, amines) and inorganic substances (i.e. rare earth elements, ozone, SO_2) which exhibit absorption in the UV range; determination of visible light radiation absorbing compounds, including dyes and colour metal salts (e.g. $KMnO_4$, $CuSO_4$).

Nicolet 6700 FT-IR spectrometer, manufacturer: Thermo Scientific (2010)

- Analysis of environmental pollution.
- Analysis of pollution of waters and soils, e.g. with aliphatic or aromatic hy drocarbons.
- Examination of biological materials.

Examples of use:

- Qualitative analysis of organic compounds, testing of time-dependent variations in concentration.
- Determination of physical and chemical properties (structure of compounds), analysis of chemical functional groups.

ASE 350 fast sample extractor, manufacturer: Dionex Corporation (2010)

- Testing of food, fodder, soils; environmental monitoring.
- Extraction of compounds soluble in food products.

Examples of use:

- Analysis of substances soluble in food products, fodder and water.
- Determination of residues of pesticides, antibiotics, contaminants, etc.

HG63 dry mass determination set, manufacturer: Mettler-Toledo (2010)

- Extraction of dry mass from plant biomasses.
- Determination of the dry mass content in samples and their preparation for further research.

Speed Four mineraliser, manufacturer: Berghoff Products + Instruments GmbH (2010)

- Preparation of samples for further studies.
- Mineralization of organic compounds in fodder, plants, soils and water.

Laboratory X-ray system for the determination of plant material structures – Elektronika 25 (2000), Faxitron MX-20 (2010)

- Two devices for generation of X-ray images of biological material on X-ray films.
- Imaging of biological material defects, e.g. transverse fractures of the grain endosperm, infestation level of insect pests.
- A databank of X-ray images of agricultural materials (available at the IA PAN website).
- Can be used to create a system for detection of internal damage of cultivated fruits and plant sprouts, caused by insect pests.

Extensograph E, manufacturer: Brabender (2009)

- Determination of rheological properties of dough during controlled stretching.
- Measurement of the dough energy, stretchability and stretching resistance in accordance with international standards: ICC 114/1, AACC 54-10 and ISO 5530-2.
- Assessment of usability of flours and doughs.

Farinograph E, manufacturer: Brabender (2009)

- Determination of rheological properties of wheat doughs in the kneading process.
- Measurement of functional properties of flours and doughs in accordance with ICC 115/1, AACC 54-21 and ISO 5530-1.
- Assessment of usability of flours and doughs.
- Measurement of water absorption of flours, dough rise times, dough consistency and its softening.

Examples of use:

- Assessment of baking properties of flours.
- Control of the influence of processing additives (e.g. proteolytic enzymes, emul sifiers, pro-health additives) on the quality of dough.
- Examination of the influence of processing (e.g. kneading time and intensity, seasoning time) on rheological properties of doughs.

SKCS 4100 equipment for determination of physical properties of grain, manufacturer: Perten Instruments (2009)

- Measurement of mass (12-80 mg), conventional diameter, humidity (9-19%) and hardness of wheat grain.
- Examination of the processing hardness of wheat, triticale and barley grain of dif ferent varieties.

Glucomatic 2200 gluten quality and quantity determination system, manufacturer: Perten Instruments (2010)

- Leaching of gluten from whole-grain grinding mill feeds and flours.
- Determination of wet gluten quality according to ICC 155.
- Determination of wet gluten quantity and gluten index.

Examples of use:

- Impact of heat treatment on gluten expansion capability.
- Impact of wetting and drying of grain on gluten quality and quantity.
- Effect of grain grinding effectiveness on gluten quality.

Falling Number 1800 α-amylase determination apparatus, manufacturer: Perten Instruments (2010)

- Determination of the activity of α-amylase in grain using Hagberg-Perten method, in accordance with ICC 107, AACC 56-81B and ISO 3093.
- Measurement of the falling number.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Examples of use:

- Impact of weather conditions before harvest on wheat grain quality.
- Wetting effects on grain amylolytic activity.

Stress-Tech rotation-oscillation rheometer, manufacturer: Perten Instruments (2009)
- Measurement configurations: plate-plate, plate-cone.
- Directly measured values: normal stress, shearing stress, oscillation frequency and angular deformation.
- Determination of dynamic storage and loss moduli, phase shift angles and viscosity.

Examples of use:

- Effects of pro-health additives on rheological properties of doughs.
- Effects of chemical composition (e.g. gluten proteins fractions) on rheological properties of doughs.

Zeleny test machine with software, manufacturer: Brabender (2010)
- Determination of protein quality in flours.
- Measurement of sedimentation ratio.

Grain sorting machine, manufacturer: Sadkiewicz Instruments (2010)
- Studied are sets of 5 sieves with apertures: 1.6, 2.0, 2.2, 2.5 and 2.8 mm.
- Determination of cereal grain accuracy and uniformity according to BN-699131-02.

Passage grain mill, manufacturer: Brabender (2010)
- Grinding of grain to flour in accordance with ICC 115/1, AACC 54-21 and ISO 5530-1.
- Grinding time per 100 g of grain: 90 ± 10 s.

Laboratory of Mechanics of Granular Materials
Department of Physical Properties of Plant Materials

Laboratory Supervisor: Mateusz Stasiak, PhD Eng.
Tel. +48 81 744 50 61
Fax. +48 81 744 50 67
e-mail: m.stasiak@ipan.lublin.pl
http://lgm.ipan.lublin.pl
http://www.ipan.lublin.pl

The laboratory studies properties of granular materials, and performs computer modelling and simulations of technological operations (storage, handling and processing) using such materials, mainly in the agricultural and food industry.

Research profile:
- Physical properties of granular raw materials and food products important in processes of storage and handling.
- Modelling of physical processes occurring in granular materials during storage, handling and processing.
- Pressure distribution in thin wall grain silo models. Factors responsible for air flow resistance of granular materials.

Equipment

Uniaxial compression device with cylindrical chamber, manufacturer: IA PAN (2000)
- Measurement of horizontal pressure; device diameter: 210 mm, maximum vertical pressure: 100 kPa, force measurement precision: 1 N.
- Determination of the stress-deformation relations of granular materials with simultaneous measurement of the average pressure on walls.
- Determination of pressure ratio, elastic modulus, Poisson's ratio, compressibility.

DEVELOPMENT OF EASTERN POLAND
NATIONAL COHESION STRATEGY

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO

Examples of use:

- Analysis of the elastic modulus, pressure ratio, Poisson's ratio and compressibility of plant granular solids and their beha vior at various moistures.
- Determination of the pressure exerted by granular materials on silo walls.

Uniaxial compression device „Joanna" with cubic chamber, manufacturer: IA PAN (2007)
- Mechanical testing of granular materials. Measurement of material pressure distribution on container walls.
- Wall-to-wall distance: 8-95 mm, height: 120 mm, maximum vertical pressure: 100 kPa.

Examples of use:

- Impact of deposit formation methods on states of stress.
- Testing of the stress distribution in cubic sections of deposits.

Tri-axial compression device, manufacturer: GEOTEKO (2004)
- Mechanical parameters of granular materials.
- Tangential acoustic wave speeds in granular materials.
- Measurement: stiffness modulus, elastic modulus.
- Hydrostatic pressure (10-90 kPa); frequency range: 1-10 kHz; sample sizes: h = 150 mm, d = 70 mm.

Examples of use:

- Determination of the stiffness modulus of granular materials.
- Determination of the elastic modulus of granular materials.
- Deposit response to mechanical loads.

1.7 m wide model silo for the testing of temperature and humidity distributions in grain deposits, manufacturer: IA PAN (2010)
- A laboratory scale silo with an array of probes.
- Measurement of distribution of relative humidity and temperatures in inter-granular spaces. Volume: 3.85 m3, capacity: 2.5-3 tons.
- Monitoring of self heating of grains.
- Monitoring of moisture migration and temperature propagation in grain deposits.

Examples of use:

- Testing the dynamics of temperature and moisture distribution in grain deposits.
- On-line monitoring of grain deposits parameters during storage.

Direct shearing devices (Jenike's devices) – 3 items for different granule sizes, manufacturer: IA PAN (2000)
- Direct measurement of the tangent force with high precision (0.05 N).
- Diameters of devices: 60, 120, 210mm, pressure range: 2-100 kPa, deformation speed: 2 mm/min, 4 mm/min.

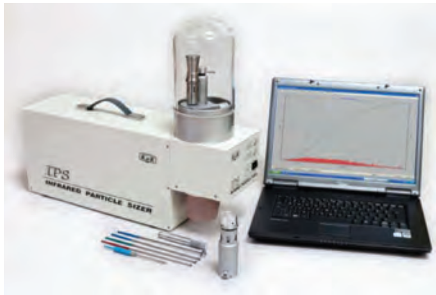
Examples of use:

- Determination of flowability of food powders.
- Resistance of granular materials.
- Determination of the geometry of outflow from silos.
- Determination of processing parameters for design of storage containers.

IPS UA ANALYZER, equipment for determination of granulation of solids in air, manufacturer: Kamika (2009)

Examples of use:

- Measurement of sizes of wet and adhering particles, 0.5-1000 mm.
- Measurement of sizes of non-adhering particles, 2-1000 mm.
- Measurement of average particle size and shape coefficients.
- Determination of specific surface areas of tested substances of known grain porosity.



RST-01 Ring Shear Tester device, manufacturer: Schulze (2010)

- Determination of quality of powders, determination of mechanical parameters of powders; determination of strength and flowability of powders, friction on structural materials, deposit densities.
- Measurement of the shearing force.
- Two measurement chambers: 1 – shearing surface 235 cm2, volume 900 cm3; 2 – shearing surface 85 cm2, volume 200 cm3.
- Maximum measurable shearing force: 400 N; maximum measurable consolidation force: 500 N; shearing speed range: 0.05-30 mm/min.

Examples of use:

- Determination of flowability of food powders.
- Resistance of granular materials.
- Determination of the geometry of outflow from silos.
- Determination of parameters for the design of processing.

Hosokawa Powders Tester, manufacturer: Hosokawa (2010)

- Measurements: angle of repose, angle of fall, angle of difference, aerated bulk density, compacted bulk density, compressibility, cohesion, uniformity, angle of spatula, dispersibility.
- Vibrator frequency: 50 Hz, amplitude: 0-3 mm; time adjustment range: 1-999 s, angular measurement precision: 0.1 deg, compaction amplitude: 18/10 mm.

Examples of use:

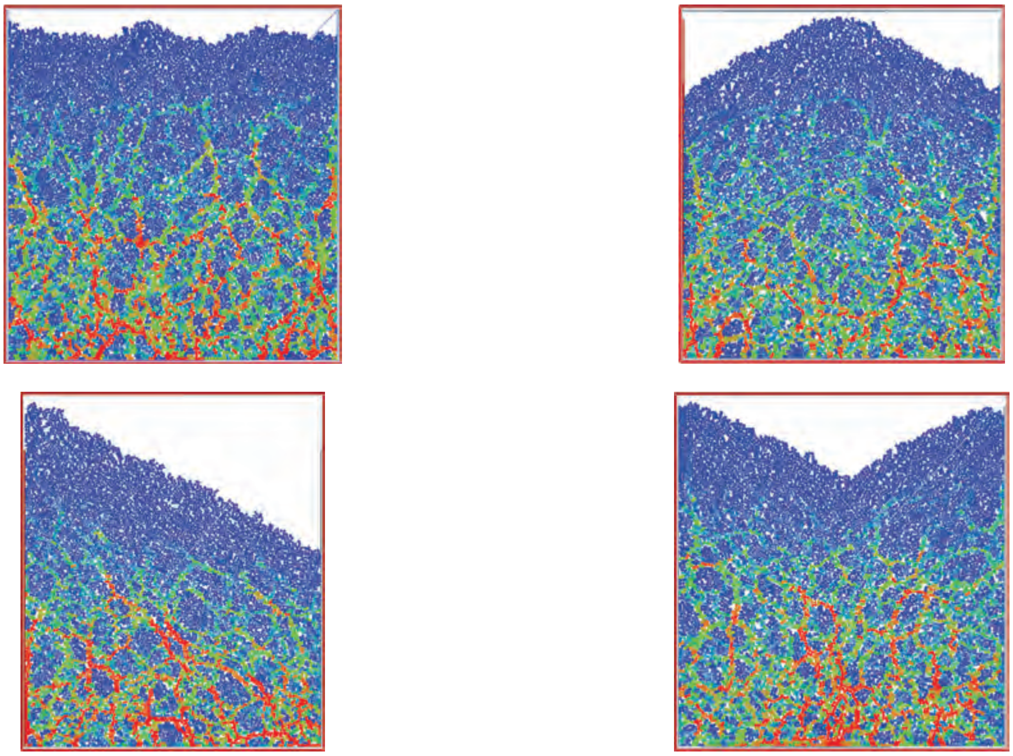
- Quality testing of powders.
- Determination of parameters for the design of processing.

DEM modelling software suite, v2.2.1, manufacturer: DEM Solutions (2010)

- Modelling of mechanical processes in 3D for various materials.
- Measurement of energy and velocity of modelled objects, including forces acting on system elements.

Examples of use:

- Analysis of interactions in granular materials on microstructural level.
- Impact of particles shape and size on technological processes.
- Modelling of technological processes for different geometry and material of constructions to improve the effectiveness of industrial equipment.
- Modelling of filling and emptying processes in storage equipment to prevent damage.



Distribution of compression forces in wheat-grain deposits generated using four filling methods:
a – dispersed stream,
b – centric,
c – extremely accentric,
d – circumferential.

Sieves for the determination of grain-size distribution of powders, manufacturer: Multiserw Morek (2005, 2009)

- Mesh size: 0.025-5.0.
- -SO DIN 3310-1 compliant.

Examples of use:

- Grain size analyses of powders.
- Determination of dust content in biomasses.