



Bohdan Dobrzański  
Institute of Agrophysics  
Polish Academy of Sciences

Research, Departments and Laboratories



## MAIN ATIVCITY

Fundamental and applied research on application of physics to environmental management and protection, sustainable agriculture, and agricultural-food industries.

### PHYSICS AND BIOLOGY OF THE ENVIRONMENT

Physical, chemical, physico-chemical and biological properties of soils and their relation with mass and energy transport in the soil-plant-atmosphere system. Data bases and systems of control of the hydrophysical and thermophysical properties of soil. Time and space variability within the soil environment. Phenomena and processes determining the physical quality of soil. Soil aeration status. Emission of greenhouse gases from soils to the atmosphere. Environmental quality.

### PHYSICS OF PLANT MATERIALS

Physical properties of plants and agricultural crops. Physical processes in harvesting, transport, storage and processing of raw plant materials. Microstructure of plant materials. Identification of damage to agricultural crops and quality estimation of agricultural materials and products. Technologies enhancing the quality of food materials, products and fibers.



### AGROPHYSICAL METROLOGY

Development and improvement of physical methods and equipment for measurement, monitoring and analysis of physical parameters of soil and atmospheric conditions important to environmental and agricultural processes.

### MONITORING AND MODELLING

Development of methodology and measuring devices for monitoring of physical and physicochemical processes in the environment related to plant growth. Predictive models for optimisation of food safety based on new technologies and the influence of the environment. Computer simulation of physical and physico-chemical processes due to environmental effects and processing of agricultural products.

## PhD STUDIES

Four year PhD postgraduate studies prepare students of natural sciences for writing a PhD thesis in agricultural sciences with specialization in agronomy-agrophysics via research and coursework. Some of the courses are coordinated with the University of Life Sciences in Lublin.

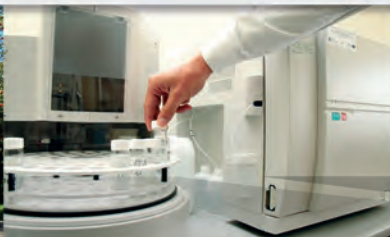
### The students:

- perform research work within the basic scientific activity of the Institute, participate in lectures, lab presentations, seminars, and English course, scientific conferences and workshops
- improve their qualifications through additional courses and trainings
- may apply for international and national scholarships, projects for young researchers, participate in research teams in large programmes
- undertake popularising and education initiatives as presentations in Science Picnics, Festivals of Science, and school lessons.

<http://doktoranci.ipan.lublin.pl>

## KNOWLEDGE TRANSFER

- Modern gauges for measurement of moisture of soils and porous materials by time-domain reflectometry (TDR).
- Internet accessible system of data acquisition with a TDR meter of moisture, salinity and temperature of porous materials.
- Data bases and maps of hydrophysical and physicochemical properties of Polish soils in arable and sub-arable horizons, and in the subsoil (water retention at various moisture levels, water conductivity coefficients, specific surface area, redox potential).
- Monitoring of benzo(a)pyrene and mycotoxin content in rapeseed in most Polish drying plants and storage facilities of oil-producing industry
- Biodegradable vegetable oil for chainsaw lubrication produced from by-product oil at mustard production.
- New rapeseed harvest technology that guarantees limitation of quantitative and qualitative losses of yield.
- Contact Acoustic Emission Detector for fruits quality assessment.





# DEPARTMENT OF METROLOGY AND MODELLING OF AGROPHYSICAL PROCESSES

Assoc. Prof. Cezary Sławiński  
c.slawinski@ipan.lublin.pl

- Agrophysical metrology
- Modelling of water, salt and energy exchange in soil-plant-atmosphere system
- Water, air and thermal properties of soils-plant-atmosphere system and their temporal and spatial variability
- Interpretation of thermal images
- Computer data bases and mapping

## 1 Laboratorium Monitoringu Środowiska Przyrodniczego

**Prof. Bogusław Usowicz**  
b.usowicz@ipan.lublin.pl

### Research profile:

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

### Analysis:

- Determination of water and thermal characteristics of porous media
- Studies of thermal balance of active surface, modelling of mass and energy transport processes

## 2 Laboratory of Thermography

**Assoc. Prof. Piotr Baranowski**  
p.baranowski@ipan.lublin.pl

### 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
- medical diagnostics
- industrial expertise: power engineering, building engineering, machine-building indust

### Analysis:

- Determination of water conditions in arablefields
- Detection of plant areas attacked by diseases and pests
- Determination of quality of crops
- Examination of renewable energy

## 3 Laboratory of Dielectric Spectroscopy

**Assoc. Prof. Wojciech Skierucha**  
w.skierucha@ipan.lublin.pl

### 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

### Analysis:

- Quality testing of agricultural materials and products
- Testing of soils and plants in variable climate conditions

## 4 Laboratory of Evaluation, Treatment and Utilization of Post Fermentation Sludge / Research Lab of Physical Characteristics of Modified Soils\*

**Assoc. Prof. Cezary Sławiński**  
c.slawinski@ipan.lublin.pl

### Research profile:

- Monitoring of environmental parameters
- Development of measurement methods and performance characteristics of porous media, in particular soils
- Measurement of water and thermal characteristics of porous media
- Development of methods for evaluating the parameters of the soil medium

### Analysis:

- Determining the course of the hysteresis curve of the retention in porous bodies
- Investigations of dependency between moisture and water potential of porous media
- Determination of water contents useful for plants and characteristic points of the water retention curve in the processes of sorption and desorption

\*Research Lab of Physical Characteristics of Modified Soils is an integral part of Laboratory of Evaluation, Treatment and Utilization of Post Fermentation Sludge, being in turn an element of Regional Laboratory of Renewable Energy (RLRE). The whole structure of RLRE is presented on the last page.





# DEPARTMENT OF NATURAL ENVIRONMENT BIOGEOCHEMISTRY

Assoc. Prof. Andrzej Bieganski  
a.bieganski@ipan.lublin.pl

## 1. Laboratory of Gas Chromatography

**Paweł Szarlip, PhD**  
p.szarlip@ipan.lublin.pl

### Research profile:

- Emission and sorption of greenhouse gases (CH<sub>4</sub>, N<sub>2</sub>O, CO<sub>2</sub>) from soil and surface waters
  - Microbial activity in soil and aquatic environments
  - Capacity of soil to eliminate biogenic compounds from waste waters
  - Responses of plants to stress resulting from oxygen deficit and other in the root zone
- ### Analysis:
- Determination of gas composition in various systems (atmosphere, soil, silos, stores)
  - Testing of greenhouse gases emissions
  - Monitoring of biological activity of soil

## Laboratory of Biogas Analysis

**Paweł Szarlip, PhD**  
p.szarlip@ipan.lublin.pl

### Research profile:

- Quality of biogas as a product of methane fermentation
  - Estimation of the possibility of soil fertilisation with post-fermentation wastes
- ### Analysis:
- Measurements of gas concentration: methane, carbon dioxide, hydrogen sulfide, hydrogen, oxygen
  - Analysis of total nitrogen
  - Analysis of total organic and inorganic carbon



- Processes of emission and absorption of greenhouse gases (methane, nitrous oxide, carbon dioxide) in soil and aquatic environment
- Monitoring of the emission of gases to the atmosphere (waste dumps, mining overlays etc.)
- Diffusion of gases, oxygen concentration and redox potential in soil profile in relation to such soil properties as compaction, aggregation, air-water-conditions etc.
- Effect of the status of soil oxygen status on biochemical processes – transformations of nitrogen and carbon, redox processes and enzymatic activity of soil
- Effect of unfavourable soil conditions (e.g. oxygen deficit, contamination with heavy metals and other) on biomass production, availability of nutrients and defensive mechanisms of plants (biochemical indicators of antioxidative stress)
- Shape and size of particles, cells and other agrophysical objects in relation to the processes to which those objects were/are subjected
- The initial phase of water erosion – so-called splash

## 3 Laboratory of Applied Optical Measurement Techniques

**Assoc. Prof. Andrzej Bieganski**  
a.bieganski@ipan.lublin.pl

### Research profile:

- The initial phase of water erosion-so-called splash
  - Size, size distribution and shape of particles of various objects of natural, agricultural and anthropogenic origin
  - Electrokinetic potential (zeta) of particles in water and non-water suspensions
  - Development of measurement methods for various materials (biological and nonbiological) with relation to optical measurement techniques
- ### Analysis:
- Stability characteristics of colloid systems
  - Dynamics of dispersion processes in various media
  - Determination of granulometric

composition of soil, sediments and thin deposits

- Analysis of the size and shape of particles in dry and dispersed forms





### DEPARTMENT OF MICROSTRUCTURE AND MECHANICS OF BIOMATERIALS

Assoc. Prof. Artur Zdunek  
a.zdunek@ipan.lublin.pl

#### 1 Laboratory of Microscopy

**Assoc. Prof. Artur Zdunek**  
a.zdunek@ipan.lublin.pl

##### Research profile:

- Investigation of nano, micro and macro structures of biomaterials
- Spectroscopy-based analysis of chemical composition and structure of biomaterials

##### Analysis:

- Quantitative analysis of geometrical parameters of biomaterials microstructure
- Analysis of micromechanical properties of biomaterials
- Spatial analysis of biochemical composition of biomaterials



#### 2 Laboratory of Sensory Analysis and Mechanical Properties

**Assoc. Prof. Artur Zdunek**  
a.zdunek@ipan.lublin.pl

##### New devices:

- Contact acoustic emission detector (CAED) for apple texture evaluation
- Device for biospeckle activity evaluation of fruits, have been developed. The laboratory provides also professional sensory evaluation which is used for food testing and as the reference method for developing instrumental methods.

##### Research profile:

- Investigation of mechanical properties of biomaterials and fracture processes
- Instrumentation for quality evaluation of fruits and vegetables
- Modelling of mechanical processes in biomaterials

##### Analysis:

- Sensory and instrumental testing of fruits and vegetables
- Model-based prediction of fruits and vegetables quality
- Rheological properties of food

- Structure of biomaterials
- Image analysis
- Mechanical properties and texture of fruits and vegetables
- Instrumentation for quality evaluation of fruits and vegetables
- Modelling of granular and cellular structures

#### 3 Laboratory of Biochemistry

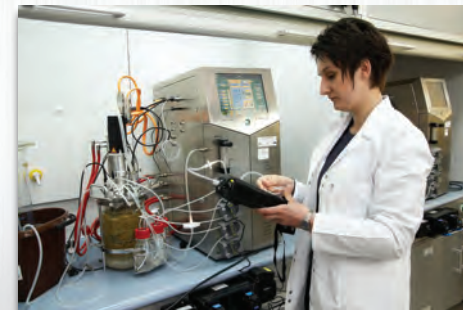
**Justyna Cybulska, PhD Eng.**  
j.cybulska@ipan.lublin.pl

##### Research profile:

- Biochemical analysis of plant materials, especially cell walls
- Evaluation of physiological state of fruits and vegetables based on the key compounds
- Investigation of quality of food-plant products and semi-products
- Modelling of plant cell walls using physical analogues of plant cell walls

##### Analysis:

- Quantitative analysis of pectin, calcium and nitrogen in biological samples, mainly in plant tissue
- Quantitative analysis of starch by means of polarimetric and enzymatic methods, and quantitative marking by the starch index method
- Quantitative analysis of polysaccharides of plant cell walls by sequential extraction
- Sample preparation for biochemical analysis by accelerated solvent extraction
- Determination of total soluble solids, total titratable acidity, dry mass and water activity in plant tissues and food products





# DEPARTMENT OF PHYSICAL CHEMISTRY OF POROUS MATERIALS

Prof. Zofia Sokołowska  
z.sokolowska@ipan.lublin.pl

- Research, Departments and Laboratories
- Physicochemical characteristics of soil and plants
  - Surface properties of the soil solid phase
  - Formation and stability of soil structure
  - Soil wettability
  - Acid-alkaline equilibrium in soil
  - Soil degradation
  - Physicochemical methods of amelioration and detoxification of contaminated, saline and acidic soils
  - Simulation of adsorption processes

## Laboratory of Surface and Structural Properties of Soils and Plants

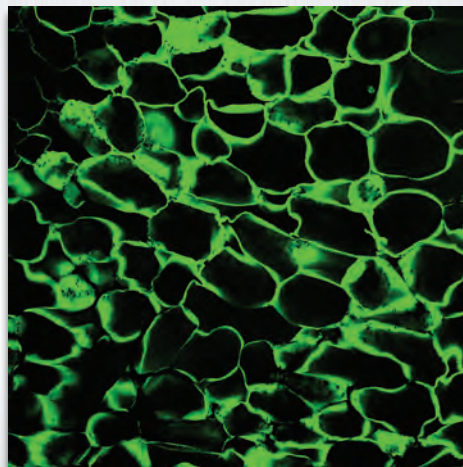
**Prof. Zofia Sokołowska**  
z.sokolowska@ipan.lublin.pl

### Research profile:

- Interfacial processes in soil physicochemical medium
- Surface properties as the indicators of changes in the soil and plant materials under environmental factors
- Physicochemical 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 soil, soil particle charge, buffering capacity, cation exchange capacity
- Soil degradation: pollution acidification, alkalization, salinization, organic matter lost, structure destruction, hydrophobicity laboratory simulation of processes
- Physicochemical methods for improvement and detoxification of degraded soils

### Analysis:

- Organic carbon in solids and solutions
- Heavy metals content in solutions
- Potentiometric acid-base titration
- Adsorption-desorption isotherms of nitrogen and water vapor
- Contact angle
- Quantity and qualitative studies of humic acids
- Porosimetry



## 2 Research Lab of Chemical and Physicochemical Characteristic of Sludge\*

**Patrycja Boguta, MSc**  
p.warchulska@ipan.lublin.pl

### Research profile:

- Study of physicochemical properties of plant and animal materials used as batch in to the methane fermentation process
  - Study of physicochemical properties of sediments after methane fermentation
  - Study of physicochemical properties of sludge to be recycled
- ### Analysis:
- Basic physicochemical characteristic: pH, mass, carbon content, moisture, ash
  - Heavy metal content
  - Microwave mineralization
  - Particle size analysis

\* Research Lab of Chemical and Physicochemical Characteristic of Sludge and Research Lab of Recycling and Utilization of Sludge Solid Phase are an integral part of Laboratory of Evaluation, Treatment and Utilization of Post Fermentation Sludge, being in turn an element of Regional Laboratory of Renewable Energy (RLRE). The whole structure of RLRE is presented on the last page.

## 3 Research Lab of Recycling and Utilization of Sludge Solid Phase\*

**Assoc. Prof. Alicja Szatanik-Kloc**  
a.kloc@ipan.lublin.pl

### Research profile:

- Study of possibility use of sediments after fermentation in agriculture
  - Influence of post-fermentation sludge addition on physicochemical and structural properties of soils
  - Research sludge (modification) in order to improve its recycling properties
  - Laboratory simulations of physicochemical processes accompanying the use of sludge in agriculture (impact on soils and plants)
  - Studying physicochemical processes occurring in the environment after the use of sludge
- ### Analysis:
- Microscopic analysis of the biological materials
  - Adsorption properties
  - Ion-exchange properties
  - Separation of solid and liquid phase



- Physical properties of soil and plant response
- Water erosion
- Soil compaction
- Activity of micro-organisms and earthworms in soil

### 1 Laboratory of Plant Root System

**Artur Nosalewicz, PhD**  
a.nosalewicz@ipan.lublin.pl

#### Research profile:

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

#### Analysis:

- Mechanisms of long- and short-term water uptake
- Mechanical properties of soils
- Stability of soil structures and prevention of compaction caused by farming machines
- Investigation of the effect of soil physical conditions on the growth, function, morphology and topology of the root system



### 2 Research Lab of Plant Growth\*

**Artur Nosalewicz, PhD**  
a.nosalewicz@ipan.lublin.pl

#### Research profile:

- Studies on the effect of water and nutrients accessibility on leaf spectral characteristics
- Researches related to the impact of soil conditions, light intensity, CO<sub>2</sub> concentration on plant photosynthetic activity, function of photosystems I and II in leaves and suspensions
- Measurements of the water flow within the soil – plant – atmosphere system

#### Analysis:

- Measurements of the absorption and reflection of light by biological substances in the range of wavelength covering visible and Near Infra-Red (NIR) light
- Chemical detection or monitoring of N, sugar and water in leaves
- Measurements of plant sap flow using noninvasive methods in 2-7 mm stems
- Impact of growth condition on the rate of photosynthesis and chlorophyll fluorescence

### 3 Research Lab of Soil Improvement\*

**Artur Nosalewicz, PhD**  
a.nosalewicz@ipan.lublin.pl

#### Research profile:

Evaluation of the use of organic amendments applied in soil remediation, with a particular emphasis on surface quality and drainage outflow. Studies are carried out in the laboratory equipped with a rainfall simulator and perforated flume floors. During a rainfall simulation performed on flumes containing soil and various amendments, samples of surface and drainage water and sediment are collected. The quality of water is determined with the use of a photometric analyser.

#### Analysis:

- Quantity of sediment, surface runoff and drainage water
- Quality of water, wastewater, saline, process water, effluents and soil/sludge digests (Aluminium, Ammonia, Nitrite, Calcium, Chloride, Copper, Ferrous iron, Fluoride, Magnesium, Cyanide, Chromium, Manganese, Molybdenum, Reactive P, Silica, Sulphate, Thiocyanate, Total Phenols, Zinc, Alkalinity, Hardness)
- Water stability of soil aggregates in high energy test with the use of a rainfall simulator

### 4 Laboratory of Molecular and Environmental Microbiology

**Magdalena Frać, PhD**  
m.frac@ipan.lublin.pl

#### Research profile:

- Study of soil microbial and enzymatic activity
- Evaluation of microbiological state and microbial diversity of soil, organic waste, sewage sludge, air and water

■ Microbial diagnostics - identification of microorganisms using the BIOLOG system and modern techniques of molecular biology in environmental samples

- Mycological research and expertises

#### Analysis:

- Quantitative and qualitative investigation of microbial pollution
- Evaluation of bacteria total number
- Evaluation of total number of fungi and yeast
- Microbiological evaluation of the air
- Bacteria, yeast and fungi identification using DNA analysis
- Mycological analyses of soil and waste

\* Research Lab of Plant Growth and Research Lab of Soil Improvement are an integral part of Laboratory of Evaluation, Treatment and Utilization of Post Fermentation Sludge, being in turn an element of Regional Laboratory of Renewable Energy (RLRE). The whole structure of RLRE is presented on the last page.



# DEPARTMENT OF PHYSICAL PROPERTIES OF PLANT MATERIALS

Prof. Marek Molenda  
m.molenda@ipan.lublin.pl

## 1 Laboratory of Physical Properties of Fruits and Vegetables

**Dariusz Wiącek, PhD**  
d.wiacek@ipan.lublin.pl

### 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

### Analysis:

- Comparative assessment of mechanical properties of crops, determination of strength parameters of materials important for agriculture and food processing
- Comparative assessment of mechanical properties of fruits, vegetables, grains, and sprouts of flowers
- Examination, analysis and assessment of colours of materials
- Examination of the impact of agricultural technology, harvest, transport, storage and shelf-life of fruits and vegetables on optical properties of product surface

## 2 Laboratory of Mechanics of Granular Materials

**Mateusz Stasiak, PhD Eng.**  
m.stasiak@ipan.lublin.pl

### Research profile:

- Physical properties of granular 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

### Analysis:

- Determination of mechanical parameters: pressure ratio, elastic modulus, Poisson's ratio, compressibility
- On-line monitoring of grain parameters during storage
- Determination of flowability of food powders
- Determination of parameters for the design of processing

## Research, Departments and Laboratories

- Physical and biological changes during harvest, transport, storage and processing of agricultural crops
- Physical properties of plant materials
- Optimisation of harvest and development of new agricultural technologies

## 3 Laboratory of Assessment of Grain and Oil Materials Quality

**Agnieszka Nawrocka, PhD**  
a.nawrocka@ipan.lublin.pl

### Research profile:

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

### Analysis:

- Analysis of elements contents in food, water and soil
- Qualitative and quantitative analysis of compounds based on recorded absorption spectra
- Examination of biological materials

## 4 Laboratory of Methane Fermentation

**Prof. Jerzy Tys**  
j.tys@ipan.lublin.pl

### Research profile:

- Studies of the process of digestion of selected agricultural wastes
- Determination of the optimal charge to obtain the maximum biogas efficiency

### Analysis:

- Methane digestion
- Determination of biogas quality
- Determination of biogas efficiency
- Determination of the quality and capacity of used charge for biogas production

## 5 Laboratory of New Technologies of Renewable Energy and Biomass Acquiring

**Prof. Jerzy Tys**  
j.tys@ipan.lublin.pl

### Research profile:

- The potential use of algal biomass in renewable energy production
- Determination of the optimal parameters to evaluate the potential of algae species for economical and ecological production of renewable energy
- Study of molecular level processes

### Analysis:

- Qualitative and quantitative analysis of bioproducts used for energy production
- Qualitative and quantitative studies of biomass content
- Analysis of the content and composition of lipids, products of combustion reactions and technological by-products of biomass production





## THE STRUCTURE OF REGIONAL LABORATORY OF REVENABLE ENERGY

### Regional Laboratory of Revenable Energy

#### Laboratory / Research Lab

- **Laboratory of New Technologies of Renewable Energy and Biomass Acquiring**
- **Laboratory of Methane Fermentation**
- **Laboratory of Biogas Analysis**
- **Laboratory of Evaluation, Treatment and Utilization of Post Fermentation Sludge**
  - Research Lab of Physical Characteristics of Modified Soils
  - Research Lab of Chemical and Physicochemical Characteristic of Sludge
  - Research Lab of Recycling and Utilization of Sludge Solid Phase
  - Plant Growth Lab
  - Soil Modification Lab
- **Laboratory of Molecular and Environmental Microbiology**
- **Biochemical Laboratory**

#### Department

- Department of Physical Properties of Plant Materials
- Department of Physical Properties of Plant Materials
- Department of Natural Environment Biogeochemistry
- Department of Metrology and Modelling of Agrophysical Processes
- Department of Metrology and Modelling of Agrophysical Processes
- Department of Physical Chemistry of Porous Materials
- Department of Physical Chemistry of Porous Materials
- Department of Soil and Plant System
- Department of Soil and Plant System
- Department of Soil and Plant System
- Department of Microstructure and Mechanics of Biomaterials

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