



MINISTRY  
of RESEARCH and  
INNOVATION



National Institute  
for Research and Development  
in Electrical Engineering  
ICPE-CA Bucharest  
ROMANIA

# Offer of products and services

## INCDIE ICPE-CA



This publication can be found on-line :  
<http://www.icpe-ca.ro/eng/products>

Thanks to all heads of departments / labs / services / offices, colleagues from ICPE-CA who brought their contribution to this catalog.

## **EDITORIAL NOTES**

### **Publisher:**

INCDIE ICPE-CA  
313 Splaiul Unirii, sector 3  
Bucharest - 030138, ROMANIA  
Phone: +40-21-346.72.31  
Fax: +40-21-346.82.99  
e-mail: [office@icpe-ca.ro](mailto:office@icpe-ca.ro); [marketing@icpe-ca.ro](mailto:marketing@icpe-ca.ro)  
<http://www.icpe-ca.ro>

### **COORDINATORS**

Prof. Dr. Wilhelm Kappel, Scientific Manager of  
INCDIE ICPE-CA Bucharest, Romania  
Dr. Eng. Elena Enescu, Technical Manager  
INCDIE ICPE-CA Bucharest, Romania

### **EDITORIAL STAFF**

Gabriela Obreja  
Matilda Gheorghiu

### **LAYOUT**

Gabriela Obreja

### **PHOTOS**

Ciprian Onica

### **TRANSLATION CORRECTED by**

Carmen Mateescu

### **PRINTING OFFICE**

INCDIE ICPE-CA

## FOREWORD

### *ICPE-CA, the most important supplier of solutions in electrical engineering*



Wilhelm Kappel,  
Scientific Manager of INCDIE ICPE-CA,  
Bucharest, Romania

Dear Partners,

Faithful to the motto under which it operates - advanced research and technological development for the benefit of the society - INCDIE ICPE-CA has a close collaboration with the economic environment in Romania, trying to develop technologies and to deliver opportunities and solutions for positioning the companies on the new market niches.

As a research-development-innovation institute in electrical engineering, INCDIE ICPE-CA is involved and wishes to be still active in the field of high technology and innovation on the energy market, contributing to identify the innovative solutions for energy efficiency and security in energy supply.

In this respect, the institute has promoted a series of investment and research projects intended to increase the institute competitiveness in areas which include high technology, a vision which is in full agreement with the European targets.

For the partners who know us, the ICPE-CA personality is defined as: fundamental and applied research in the electrical engineering sector. Basing on a rich portfolio of applications in electrical engineering, as well as a full range of services in designing, characterization and testing of materials and products, we wish to become the most important supplier of solutions in the field of electrical engineering.

With a high technical endowment and highly qualified personnel, the laboratories for research, testing and experimentation, accredited in accordance with the EU standards and directives, allow checking the scientific and technical consistency of some ideas, solutions, equipments and new products, thus ensuring a research and education environment of a high technical and scientific level.

The catalogue contains the wide range of products that we designed, developed and which we distribute, such as: equipments, components and materials for energy, electrical engineering, special applications and/or for the environment. Moreover, we provide technologies and services for designing, characterization and testing of materials and products, but also technical assistance and consultancy in the field of electrical engineering.

This catalogue reflects only a part of the institute research potential and annually presents our new achievements to the partners, in the hope to inspire them for innovative research and development products that can be achieved in collaboration with us.

We are confident that everything we provide is helping you to increase continuously your activities effectiveness.

Bucharest, 2018



# CONTENT

Foreword	3
Products	
Equipment	7
Components	47
Materials	81
Services	111



# EQUIPMENT

## CONTENT

Transducer for measuring the dynamic viscosity in continuous flow	9
Piezoelectric transducer for measuring mechanical vibrations (Accelerometer)	10
Capacitive water desalination module	11
Plant for superconducting coil active protection at superconductive motors	12
Apparatus for <i>in situ</i> concrete resistivity measuring of reinforced concrete structures	13
Household biogas unit for rural areas	14
High magnetic field superconductive generator	15
Submersible generator for Small Hydro Power Plants (SHP)	16
Synchronous electric generator with permanent magnets (1.5 kW), for wind generator	17
Synchronous electric generator with permanent magnets (3 kW), for wind generator	18
Hallbach cylinder - Generator of rotational and homogenous magnetic field	19
Injector with piezoceramic microactuator	20
Submersible microhydrogenerator for powering a fluvial balise	21
Magnetostrictive sonic motor with electronics drive module	22
Linear magnetostrictive motor for outer space applications	23
Micro wind power plant	24
Boat with electrical propulsion system, having self-energy assured by renewable resources	25
Sextupole electromagnets for particle accelerators	26
Power supplies for sextupole electromagnets	27
Steerer electromagnets for particle accelerators	28
Brake pneumatic equipment	29
Automatic non-destructive testing system for railway components	30
Stand for computerized testing and diagnosis of railway dampers	31

## CONTENTS

Computerized stand for testing and control used in railway equipment	32
Dynamic balancing equipment for rotors with weight less than 2 kg	33
Electrosecurity and protection system of underground structures from concrete steel	34
System for monitoring and optimizing of the electrical consumption in the poultry farm	35
Electronic equipment for scanning of geometric profiles	36
Equipment for measuring and control of dynamic unbalancing for drive shafts MRC	37
Non-contact revolving angle micro-transducer	38
Electromagnetic pulse generation system, by the controlled exploitation, with current loop	39
Synchronous superconducting electrical motor	40
5kW cogeneration system based on fuel cells	41
Double excited electric machine	42
Wind power plant with rated power of 4 kW	43
Light rig for water wells drilling FA 100	44
Manometers with elastic element for special fluids	45



# Transducer for measuring the dynamic viscosity in continuous flow

## Description:

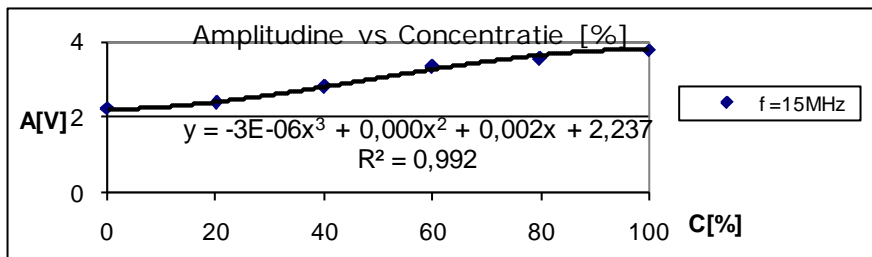
The transducer for measuring the dynamic viscosity in continuous flow uses two active elements made of piezoceramic material which are part of the solid solutions based on  $\text{Pb}(\text{Ti}, \text{Zr})\text{O}_3$  modified with  $\text{Nb}^{5+}$ . Each active piezoceramic element is disposed between two ceramic plates, forming a transmitter element respectively a receiver element. The transmitter element operates on the physical principle of piezoelectricity reverse and the receiver on the physical principle of direct piezoelectricity.



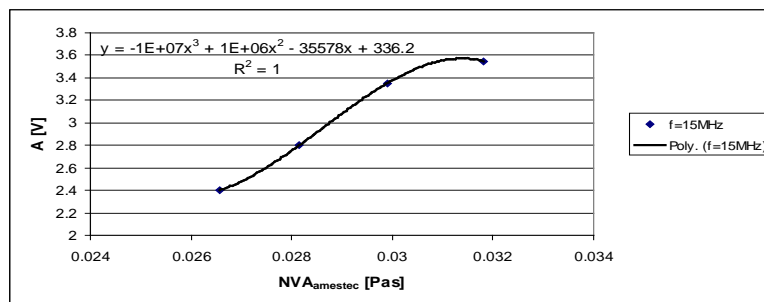
Transducer for measuring the dynamic viscosity in continuous flow using active piezoceramic elements

## Main technical characteristics

Measuring range  $\nu = [26 - 32] \text{ mPa} \cdot \text{s}$



The amplitude\* / concentration characteristic for glycerin-water solution to  $f=15 \text{ MHz}$  frequency



The amplitude / viscosity characteristic for glycerin-water to  $f=15 \text{ MHz}$  frequency

## Applications

- measurement of continuous flow dynamic viscosity of transformer oil used as cooling agent in high power transformers;
- measurement of continuous flow dynamic viscosity of liquid fuels used at combustion engines;
- measurement of continuous flow dynamic viscosity of laboratory testing solution.

\* peak to peak voltage measured to piezoceramic receiver element

# Piezoelectric transducer for measuring mechanical vibrations (Accelerometer)

## Performance:

- sensitivity: 1.01 mV/(m/s<sup>2</sup>);
- frequency range:
  - measured (±15%): 0.8 ÷ 10000 Hz;
  - measured (±10%): 10 ÷ 10000 Hz;
  - measured (±5%): 100 ÷ 10000 Hz;
- maximum amplitude of the acceleration:  $V_p = 3500 \text{ m/s}^2 \text{ pk}$ ;
- resolution: 0.03 m/s<sup>2</sup> rms.

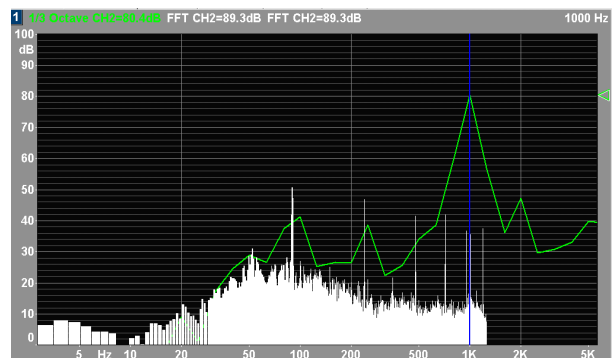
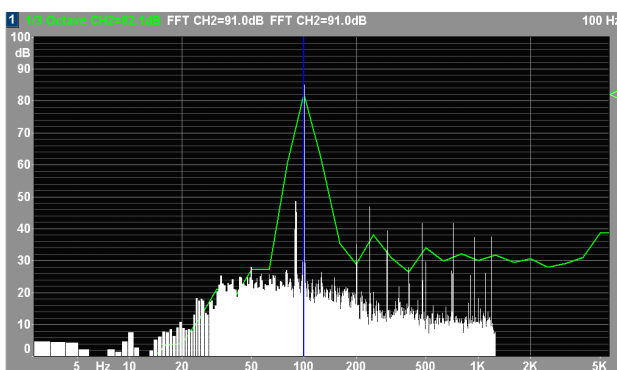


## Characteristics:

- diameter: 16 mm;
- height: 25 mm;
- weight: 42 g;
- active element: PZT;
- connector: BNC;
- box material: stainless steel.

## Applications

- measurement and analysis system of mechanical vibrations with piezoelectric transducers;
- piezoelectric transducers for measuring of bearings vibrations;
- measurement of absolute vibrations for bearings cage and ball bearings; diagnosis of ball bearings - BCU;
- dynamic balancing machines in 1,2,3 planes for rotors, cardans, turboblowers etc.;
- monitoring, protection and diagnostic of equipment.



# Capacitive water desalination module

Patent applications: A/00688/02.08.2010 and A/00787/04.08.2011

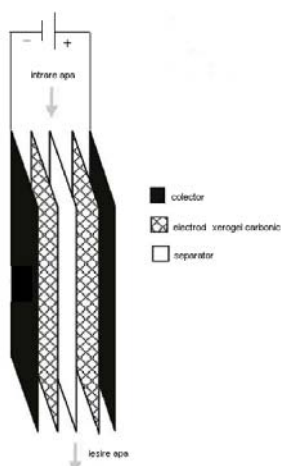
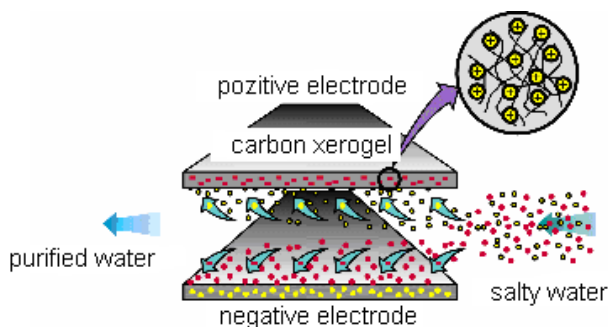
## Application

Removing of different ionic species from waste waters without acids/bases and without the generation of by-products.



## Working principle

1. Liquid effluent flows through 2 parallel and equidistantly carbon electrodes at approx. 1.5 V.
2. After polarization, non-reducible and nonoxidizable ions are removed from the electrolyte from the electrolyte by the imposed electric field held and in electric double layers formed at the surfaces of electrodes.



## Components:

- 44 pairs of electrodes based on carbon xerogels
- 23 collectoris
- 43 separators
- electrodes size: 200x200x2.5 mm

## Advantages:

- elimination of wastes from chemical regeneration;
- unlike membrane-based treatment technologies such as reverse osmosis and nanofiltration, capacitive desalination does not require high pressures; thus equipment such as housing, pipes, and pumps is less costly;
- capacitive desalination requires low voltages that normally do not exceed several volts. Therefore, safety issues are negligible;
- capacitive desalination is suitable for operation in remote areas since it can be operated on solar energy. In this respect, the technology may be considered environmentally clean;
- electrodes less sensitive to scaling;
- potential that capacitive desalination system to function „on-line” (ex: washing machine softener).

## PERFORMANCE for presented MODULE:

Electrosorption capacity (salt removal %):

87.33 – 99.09 %

$$\eta(\%) = (C_i - C_f) / C_i$$

where:  $C_p, C_f$  - initial and final concentration

## Total energy consumption - for presented module

Working voltage 1Vcc, absorbed current: 480mA.

$W = 1V \times 0.480A \times 1h = 0.480 Wh$  for 1 litre of desalting artificial sea water

## Current density:

$I = 480mA$ ,  $S = 0.04m^2/\text{electrode}$  (desalting module has 44 pairs of electrodes having size: (200x200x2.5)mm, working surface:  $44 \times 0.04 = 1.76 m^2$ )

$$J = 0.27 [A/m^2]$$

## Applications

- removing of different ionic species from waste waters without acids/bases consuming has a great importance in radionuclides removal (removal of anorganic radioactive materials);
- treatment of hot water from nuclear plants or hydropwers. Capacitive desalination could be applied on submarines were electrical energy and chemical consumption is limited;
- high purity water for semiconductor industry;
- water softening;
- water desalination for agriculture purposes;
- sea water desalination;
- analytical equipment which combine capacitive deionization principles with ion chromatography for adsorption on carbon xerogels beds.

# Plant for superconducting coil active protection at superconductive motors

## Description:

The plant solves the superconducting coil active protection at superconductive motors, in case of accidental exit from the superconducting state, i.e. in case of its normalization.

The plant is composed of:

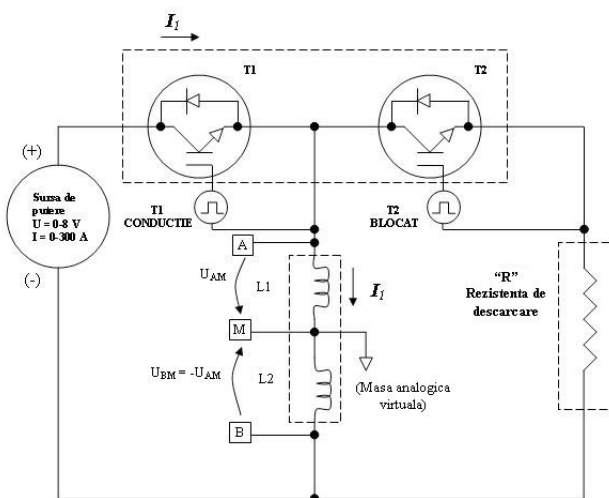
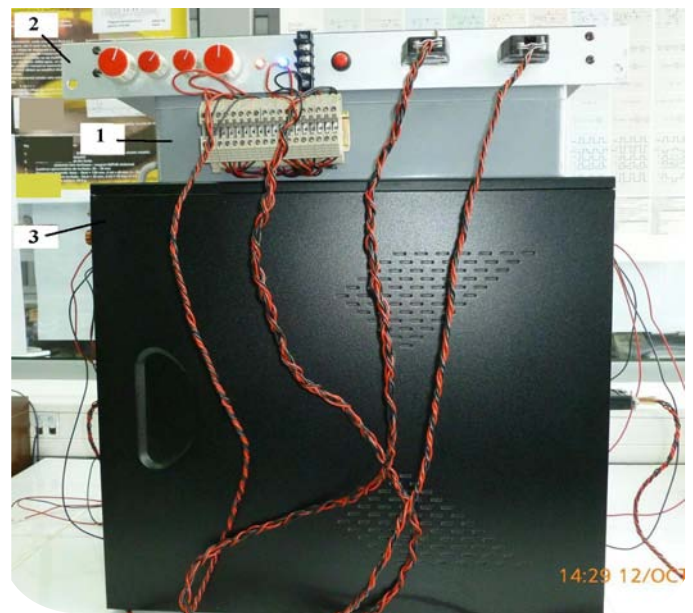
1. Stabilized voltage supply module;
2. Logical sequences programming module;
3. Power module.

## Principle of operation

If the voltage collected from the protected superconducting coil exceeds a preset threshold, this is interpreted as a quench. In this case, it triggers a sequence of two ultra-fast electronic switches controlled so that the superconducting coil to be disconnected from the power supply and then to be put in paralel with discharge resistance.

## Main technical characteristics:

- time of quench detection:  $\sim 1\mu\text{s}$ ;
- time of decoupling of the power supply:  $1-10\mu\text{s}$ ;
- discharge energy:  $1 - 10\text{kJ}$ ;
- characteristics of the voltage power supply of the superconducting coil are: adjustable DC voltage  $U = 0 - 8\text{V}$  and preset DC  $I = 0 - 150\text{ A}$ .



*Electronic scheme of plant for superconducting coil active protection*

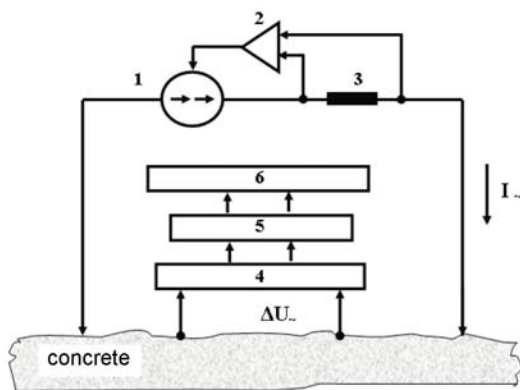
## Applications

- research regarding the magnetic properties of materials;
- superconductive motors and generators;
- calibration of magnetic field sensors;
- superconducting coil protection component of the electromagnets destined for particle accelerators;
- nuclear physics (RES, RMN, particle detectors).

# Apparatus for *in situ* concrete resistivity measuring of reinforced concrete structures

## Description:

The apparatus includes a measuring probe of special construction designed to ensure the parallelism of the four electrodes and equal / constant distance of them, as good and constant electrical contact between electrodes and the concrete surface to be measured (simultaneously and uniformly pressing - and for uneven surfaces up to 15mm).



*The block diagram of the electrical measuring circuit:*

- 1 – current constant generator - sinusoidal of  $500 \pm 5$  Hz;
- 2 – loop of maintaining a constant current measurement;
- 3 – shunt;
- 4 – band pass filter  $500 \pm 10$  Hz, with attenuation of minimum 40 dB at 150 Hz;
- 5 – voltage signal rectification (filtered);
- 6 – electronic digital voltmeter (3 1/2 digit).

## Applications

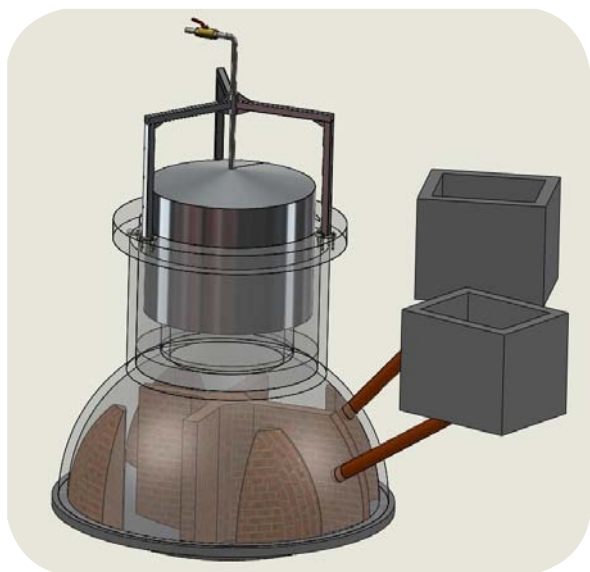
- the apparatus is destined for the *in situ* concrete resistivity measuring of reinforced concrete structures related to the civil and industrial construction;
- degradation state investigation of some concrete structures which were not provided with monitoring electrodes.



## Main technical characteristics

- resistivity measuring in the range of  $5 \Omega\text{m} \div 100 \Omega\text{m}$ ;
- optical indication of the values under  $5 \Omega\text{m}$  and those over  $100 \Omega\text{m}$ ;
- eliminates the measuring errors due to the polarization phenomena between the concrete surfaces (second stage conductive environment) and the contact probes (first stage);
- eliminates the measuring errors due to the eventual dispersion currents both in DC and in AC, low and high frequency, and of the disturbing signals respectively with the frequency under 350 Hz (the 7th harmonic of the electro-energetic system frequency) and of those over 1 kHz (industrial generators, radio-communications equipments etc.);
- measurement class of minimum 2.5;
- autonomous supply – functional autonomy of minimum 1 h;
- digital display of the measured value, with a display of 3 1/2 digits.

## Household biogas unit for rural areas



### Applications:

- supplying of combustible gas for domestic use in rural households and small farms;
- treating of biodegradable wastes such as animal dejections, crop residuals, domestic wastes, for lands hygienization and illness prevention;
- production of ecological soil conditioners to be used in agriculture.

### Feedstock type:

- Dairy farm and piggery waste slurries;
- Crop waste, silage, forestry green residuals;
- Household food waste with or without green waste.

### Technical and economic results:

This biogas unit ensures the treatment of organic waste while generating valuable products (biogas and soil conditioner), helping to reduce the consumption of conventional fuels (firewood, gas, oil) in rural communities. For a biogas unit having the inner volume of the fermenter of 4 m<sup>3</sup> and the useful volume of 2.8 m<sup>3</sup>, the following technical and economical performances can be obtained:

- treating a daily quantity of approx. 25 kg organic waste (manure, green waste, food scraps etc.);
- obtaining biogas in a volume of approx. 1-2 m<sup>3</sup> / day, with respecting the process parameters (pH, temperature, humidity). The energetic value of the biogas containing approx. 60% methane is 5000-6000 kcal / m<sup>3</sup>, a volume of 1 m<sup>3</sup> of biogas replacing ca. 0.5 liter fuel oil or ca. 5.5 kg wood;
- obtaining a daily quantity of approx. 20 kg liquid organic fertilizer which is free of pathogens, odorless and rich in the N, P, K basic nutrients.

### Advantages:

- production of natural fertilizers for agriculture, increasing competitiveness of agricultural products and thus increase the living standards of the rural population;
- reduction of organic waste deposited on the soil, reducing the soil acidity and eutrophication of groundwater and surface water, reducing the emissions of greenhouse gases;
- inactivating the pathogenic organisms from the natural biomass to prevent the risk of infection with different pathogens and parasites eggs;
- simplicity building and operation and a low specific consumption of materials which are easily available in rural areas;
- design flexibility, depending on the availability of raw materials and the energy needs of the family;
- the secondary product – digested biomass – has a high level of the organic compounds decomposition as a results of the controlled mass flow and a partial separation of the bioactivity areas.

*The household biogas unit for rural areas was built in Boteni village, Argeş county, Romania, in 2010, currently being functional.*

# High magnetic field superconductive generator



**Construction:** cryostat, two cooling stages cryocooler, winding made from high temperature superconductive tape (HTS).

## Technical characteristics of the high magnetic field generator:

- number of superconducting coils: 2;
- two cooling stages cryocooler: 4.2 K and 50 K;
- magnetic field optimal area:  $30 \times 30 \times 30 \text{ mm}^3$ , room temperature, which can be vacuumed for the easy access of the electrically charged particles for their deviation;
- generated magnetic field: 0 - 5 T;
- high field uniformity:  $\sim 10^{-3}$ ;
- stainless steel cryostat, vacuumed at  $10^{-5}$  mbar.

## Applications:

- laboratory applications (calibration of magnetic field sensors, study of semiconductors, study of physical phenomena etc.);
- applications of nuclear physics (particle accelerators, nuclear spectroscopy etc.);
- industrial applications that require high magnetic fields ( $>2\text{T}$ ).

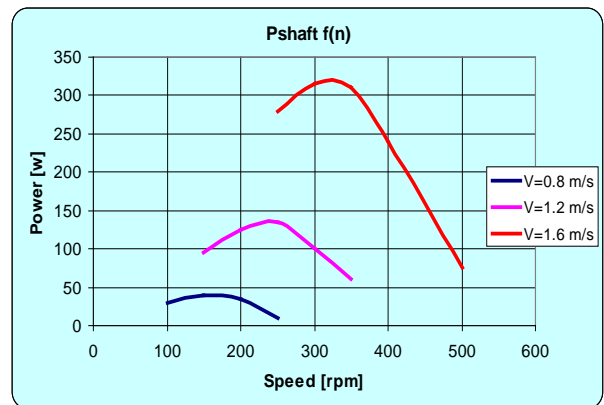
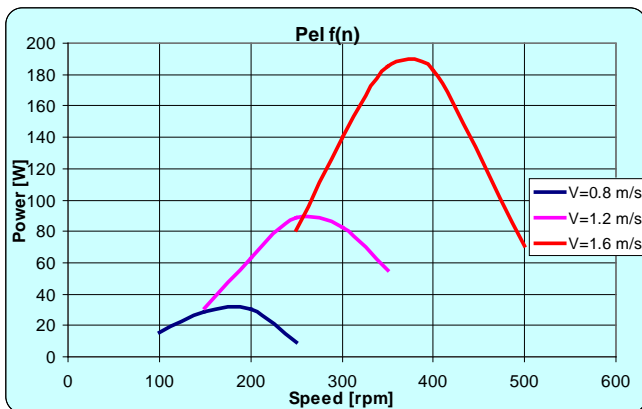
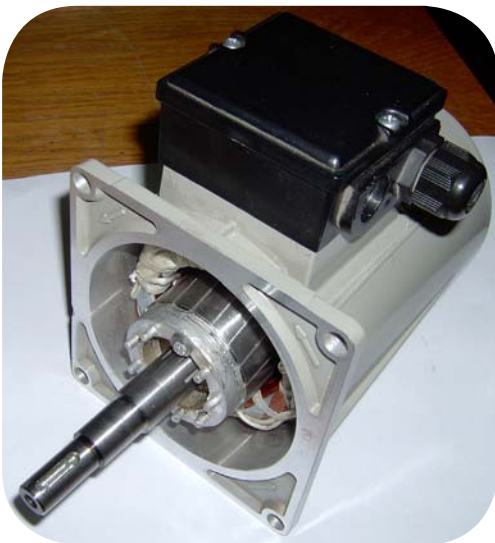
# Submersible generator for Small Hydro Power Plants (SHP)

## Main features:

- rated revolution  $n_n = 350 \text{ rot/min}$ ,
- rated voltage per phase  $U_{fn} = 11 \text{ V}$ , AC power,
- rated power  $P_{eln} = 200 \text{ W}$ .

The functional specificity of submersible electric generator meet a series of structural conditionality, as follows:

- sealed overall construction which is compatible with immersion operating;
- materials and protective coatings resistant to the corrosive effects of water, as environment;
- capacity to take over, at the end of the shaft, apart from the radial loads for operation of the hydraulic rotor with blades (fixed directly on it), and axial loads due to the effect of pushing the water stream on the blades, by integrating in construction of a radial-axial bearing with two rows of balls.



*Electrical and mechanical power characteristics*



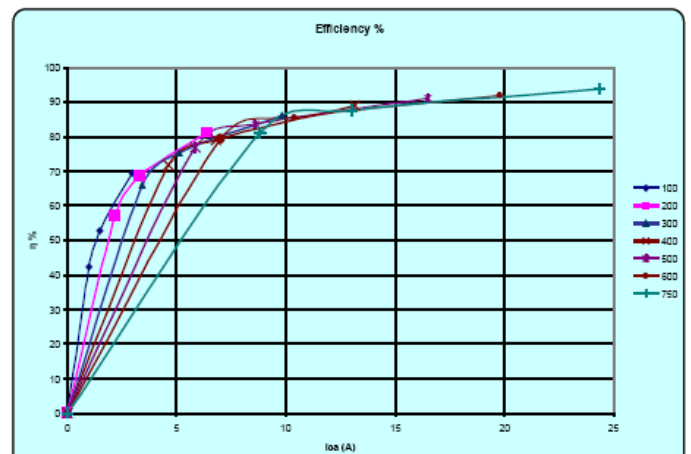
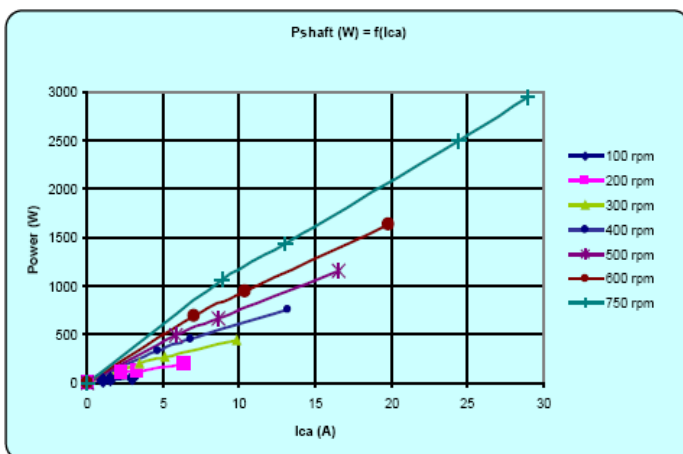
# Synchronous electric generator with permanent magnets (1.5 kW), for wind generator

## Main features:

- $V = 24$  V, AC voltage, three-phase;
- rated power: 1.5kW;
- rated speed: 750rpm;
- cogging torque: max. 0.8Nm.



The structural subassembly of the stator is taken from an asynchronous motor with the rotor in cage, of equivalent power.



*Power and efficiency variation  
depending on the phase current at fixed revolutions*

## Advantage:

Short cycle of assimilation in small-scale production.

## Applications:

Hydraulic or wind energy conversion for the micro power plants based on primary renewable energy.

# Synchronous electric generator with permanent magnets (3 kW), for wind generator

## Main features:

- $V = 48$  V, AC voltage, three-phase;
- rated power: 3 kW;
- rated speed: 750 rpm;
- cogging torque: max. 1.2 Nm.

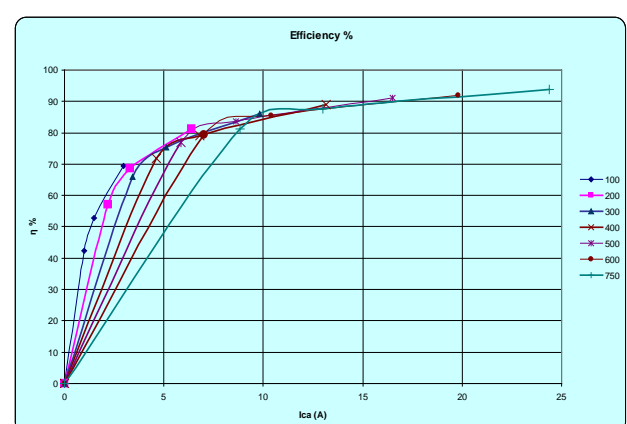
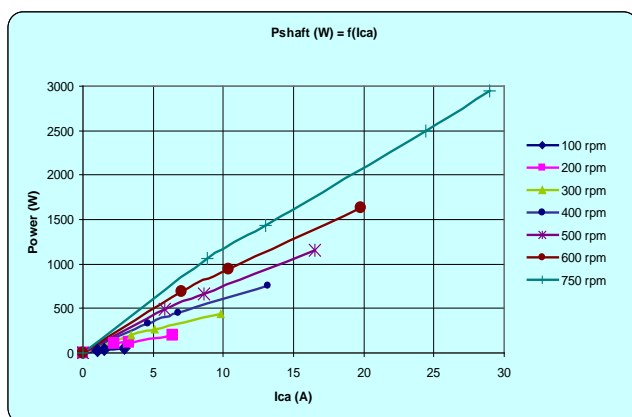
## Advantage:

- short cycle of assimilation in small-scale production;
- low cost.

## Applications:

Hydraulic or wind energy conversion for the micro power plants based on primary renewable energy.

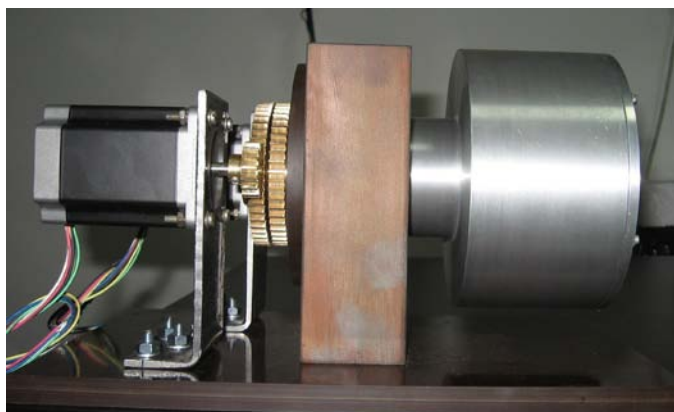
The structural subassembly of the stator is taken from an asynchronous motor with the rotor in cage, with equivalent power.



*Power and efficiency variation  
depending on the phase current at fixed revolutions*

# Hallbach cylinder

## Generator of rotational and homogenous magnetic field



### Description

Hallbach cylinder is a generator of rotational and homogenous magnetic field used at measurement system of the materials magnetic properties. The assemble has two cylinders A and B placed concentric with the permanent magnets 1 and 2. In order to homogenize the magnetic field with a variation lower than 5%, the cylinder A2 of a different section is designed as for rotating of the two cylinders A and B in different directions will be obtained values of magnetic field from 0.05 T up to 1 T with homogeneity of 96 % - 97 % in A2 inside cylinder.

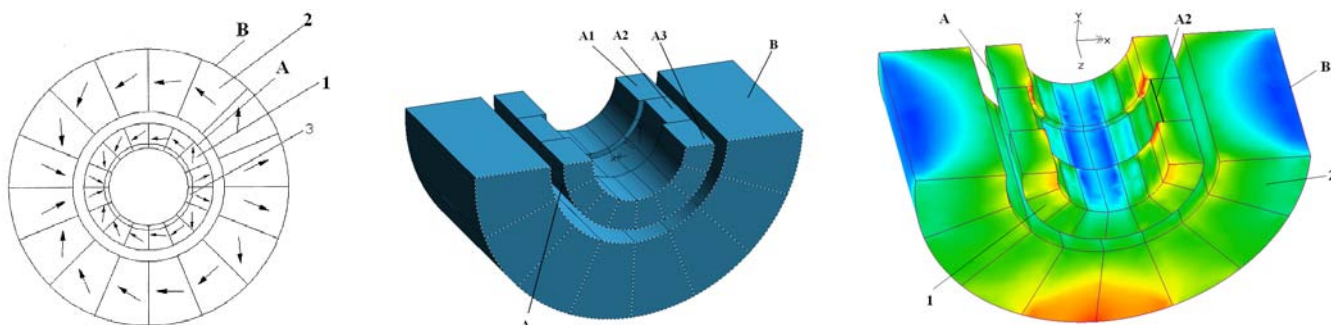


Fig.1. Hallbach cylinder

a) magnetization directions of permanent magnets, b) constructive structure in which is shown the A2 region which homogenize the magnetic field, c) 3D distribution of magnetic induction

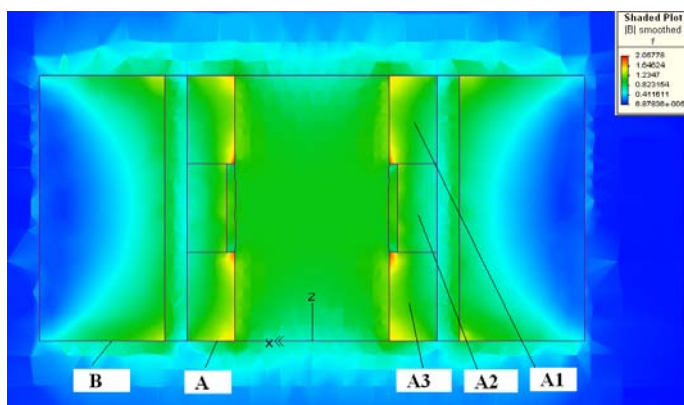


Fig. 2. Distribution of magnetic induction in section

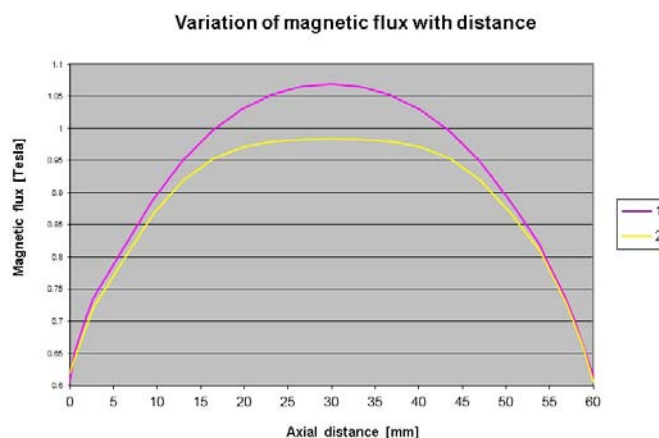


Fig. 3. Variation of magnetic induction on axial length

### Advantages:

- low manufacturing costs;
- reducing the energy consumption to produce the uniform magnetic fields.

# Injector with piezoceramic microactuator

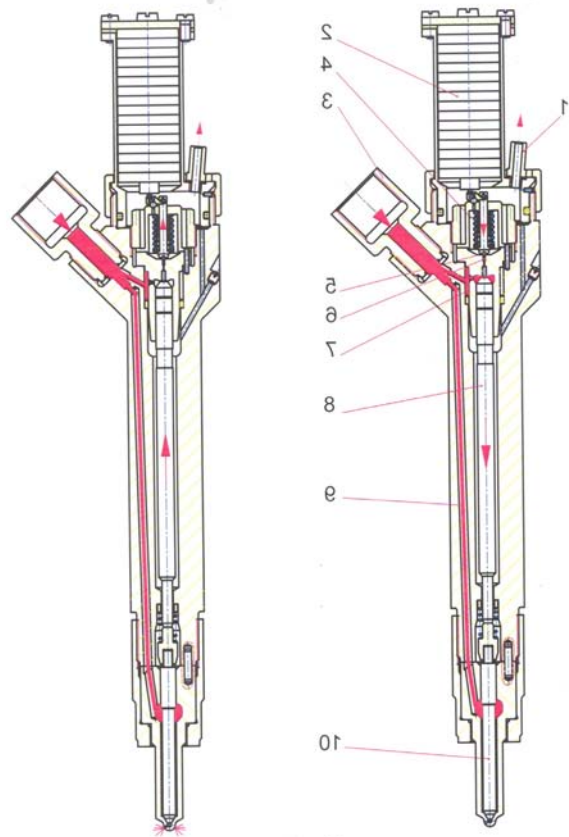
## Description:

The piezo injector with electronic command is the most important piece of the injection equipment, being the element which strictly measures the quantity of the fuel required by the thermal engine, assuring a very fine sputtering.

The injector permits to know precisely the injection start, as well as the fuel quantity passed through the atomizer. Due to the additional equipment, it can be very quickly noticed the appearance of post-injection, phenomenon which damages the burning process from thermal motor cylinder and leads to the high increasing of noxes content from burning gases.

## Technical characteristics of the microactuator:

- number of piezo elements: 10 – 30 with thickness of 0.2mm (material PZT5 or equivalent);
- overall size and weight:  $\Phi 12 \times 30(40)$ ,  $m_4 \approx 20\text{kg}$  (included injector body);
- range of supply voltage: DC 50 - 300V;
- maximum micro-moving: 20  $\mu\text{m}$ ;
- frequency in pulse regime: 1.5 kHz;
- estimated fuel flow of injector: 4  $\text{cm}^3/100$  pulsations;
- electrical resistance of column: > 200 M $\Omega$ ;
- electrical capacity: 70 - 100 nF.



*Closed injector  
(state of rest)*

*Open injector  
(injection phase)*

## Submersible microhydrogenerator for powering a fluvial balise

### Main features:

- rated speed  $n_n = 150$  rot/min,
- nominal voltage on phase  $U_{in} = 10$  V c.a.,
- nominal electric power  $P_{eln} = 20$  W.

The functional specificity of the submersible electric generator complies with a series of constructive conditionings, as follows:

- sealed construction which is compatible to the functioning in immersion;
- protective materials and coatings resistant to the corrosive action of the water flowing, as ambient environment;
- solid construction based on pressure bearing, able to takeover radial and axial loads.



# Magnetostrictive sonic motor with electronics drive module

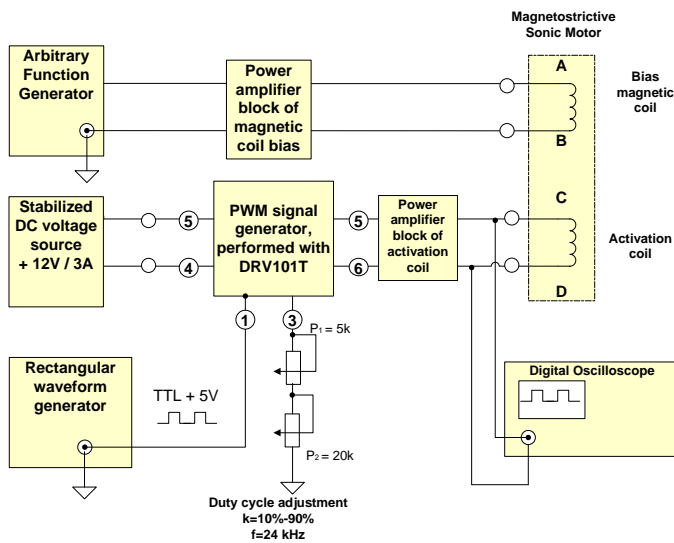
## Description:

The magnetostrictive sonic motor with electronics drive module is composed of three subassemblies:

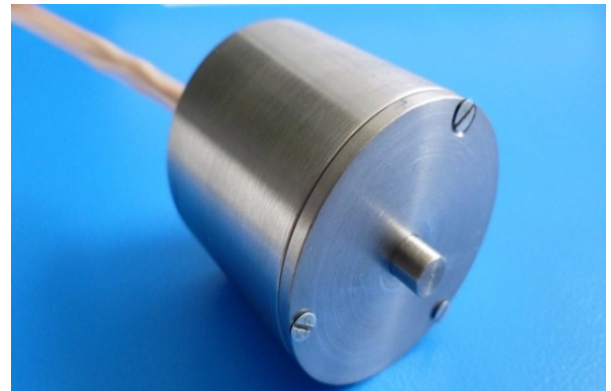
- a first subassembly consisting of a magnetic bias coil energized with a voltage  $U_2$ , shaped PWM2, by a power amplifier block of the bias magnetic coil,
- the second subassembly consisting of a coil energized activation voltage  $U_1$ , shaped PWM1 by the power amplifier coil of the activation block,
- the third sub-assembly consists of a cylindrical magnetostrictive active core secured to a upper pivot who take alternative linear movement from magnetostrictive active core, a lower fixing pivot, a pretensioner spring who ensure the mechanical bias and a permanent magnet of cylindrical shape, which makes the magnetic bias with magnetic coil bias.

The electronics drive module is composed of a control unit which supplies the voltage PWM U-shaped with a frequency in the range of  $f = 1 \text{ Hz} - 12 \text{ kHz}$  and the duty cycle in the range  $k = 10\% - 90\%$ .

A power amplifier block of coil activation ensure an 1A current (average value) by the activation coil corresponding to excitation voltage  $U_1$ , shaped PWM1 and a power amplifier block of the bias magnetic coil ensure a 3A current (average value) by bias magnetic coil corresponding to excitation voltage  $U_2$ , shaped PWM2.



Block diagram of the electronics drive module



Magnetostrictive sonic motor

## Main technical characteristics:

- activating coil works for a PWM voltage of 28V peak to peak amplitude in accordance with photovoltaic panels mounted on the satellite;
- higher forces ( $\approx 103\text{N}$ ) for small amplitudes ( $\approx 0.1\text{mm}$ );
- frequency of oscillation of mobile equipment can be set in the range  $f = 0.5\text{Hz} - 12\text{kHz}$ .

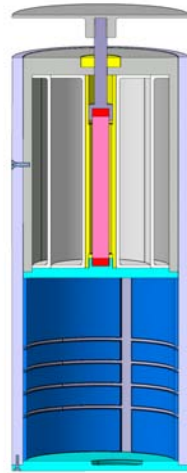
## Applications:

- in the space industry;
- in the field of sonics;
- for the auto industry in the field of fuel injection for high power heating engines;
- in the field of robotics;
- in the field of microdrives.

# Linear magnetostrictive motor for outer space applications

## Description:

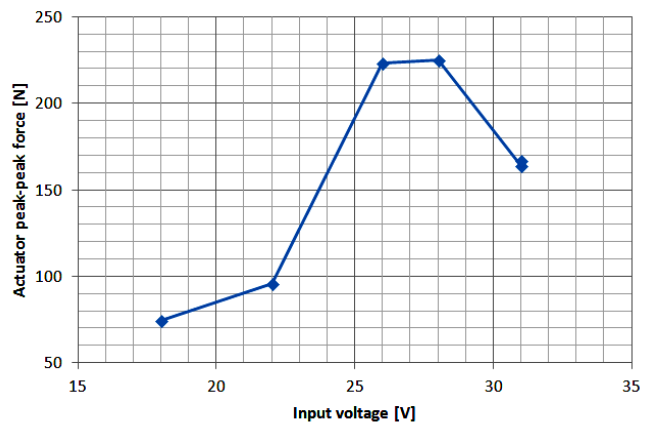
The linear magnetostrictive motor for outer space applications presents specific constructive characteristics. The magnetization magnetic field is produced by an auxiliary coil with two permanent magnets, which replaces the classic cylindrical permanent magnet. Activation voltage of premagnetization coil and activation coil is PWM having amplitude peak to peak correlated with the amplitude provided by solar panels of satellites. In space, in the absence of terrestrial gravitational field, the cooling assembly of the two coils and magnetostrictive active material is made of three Peltier elements, activated by a PWM modulator.



*Linear magnetostrictive motor for outer space applications*

## Main technical characteristics:

- an extended interval of voltage PWM frequency that activate coils (drive and bias): 0.5Hz-16kHz,
- an extended interval for voltage PWM duty cycle that activate coils: 20%-90%,
- a supply current for rated voltage 28Vcc between 1A-1.9A for the entire frequency range,
- within 0.5Hz - 100Hz forces up to 300N and amplitudes up to 30 $\mu$ m can be obtained,
- within 4kHz - 16kHz forces up to 100N and amplitudes up to 3 $\mu$ m can be obtained.



*The force variation relatively to supply voltage of linear magnetostrictive motor*

## Applications

- The target application is the manufacture of electrical drives specific in the field of space technology, such as:
- fuel injection modulation at spatial rocket based on very good operation frequency of linear magnetostrictive motor;
  - electrical drives that requires linear displacement to a frequency within the range of 0.5 Hz - 16kHz simultaneous to the high forces of up to 300 N.

# Micro wind power plant - CER 1.5

## Characteristics:

- rated power: 1.5 kW;
- maximum power: 1.7 kW;
- wind speed corresponding to rated power: 12m/s;
- starting wind speed: 3 – 3.5m/s;
- output DC voltage: 24V;
- output AC voltage: 230V.

## Wind turbine

- three blade rotor made of fiberglass reinforced polyester, with a diameter of 3.2 m.

## Electric generator (integrated by SC Electroprecizia Săcele, Romania):

- terminal voltage corresponding to rated power:  
3 x 27 V, AC voltage;
- rated speed: 750 rot/min.



## Electrical equipment of automation and power distribution

### *Controller (DC-DC converter)*

Input voltage: 15 – 40 V, DC voltage;

Output voltage: 28 V, DC voltage.

### *Inverter DC-AC*

Input voltage: 28 V, DC voltage;

Output voltage: 230 V (pure sinusoidal wave).

The cabinet can be fitted with 2/4 electrical accumulators of 12 V/150Ah, coupled in series or parallel circuit.



# Boat with electrical propulsion system, having self-energy assured by renewable resources

## Description

The boat has at the bow, in the section between two floating bodies of catamaran, a porter which support a sliding system with two positions, having an electric micro-hydro-generator.

The weight of boat together with energetic conversion systems (solar and hydraulic), electrical propulsion system, electrical energy storage system (two electrical battery), boat hand gear, together with related subassemblies is about 600 kg.

The propeller permits the boat to move with a maximum speed of 3 m/s, and cruising speed of 1.8 m/s, both for additional loading of maximum 500 kg.

For this application has been designed and obtained a boat of catamaran type, with a sun-blind on which was assembled three photovoltaic panels to assure an additional self-energy for the boat.

The boat body is catamaran type and has overall sizes: length 6 m, width 2.2 m, high 2.4 m.

Electrical energy storage system: 2 - 4 batteries, bonded in different connections (series / parallel), each battery being connected at voltage of 12 V and capacity of 75 Ah.

Electrical propulsion system consists of AC servomotor (brasless), body for movement transmission, pusher-type propeller, force electric driving for propeller (electronic converter - variable-speed drive, supplying from the battery). Electric motor voltage: 24 V. Maximum electric motor power: 3 kW.

Conversion system of solar energy in electrical energy (three photovoltaic panels of USP 150 type, bonded in parallel) having DC terminal voltage: 24 V and maximum power: 3 kW.

At the output the photovoltaic panels are connected to an electronic controller to stabilize a voltage of 24 V, necessary to load the batteries and electrical utilities of the boat.



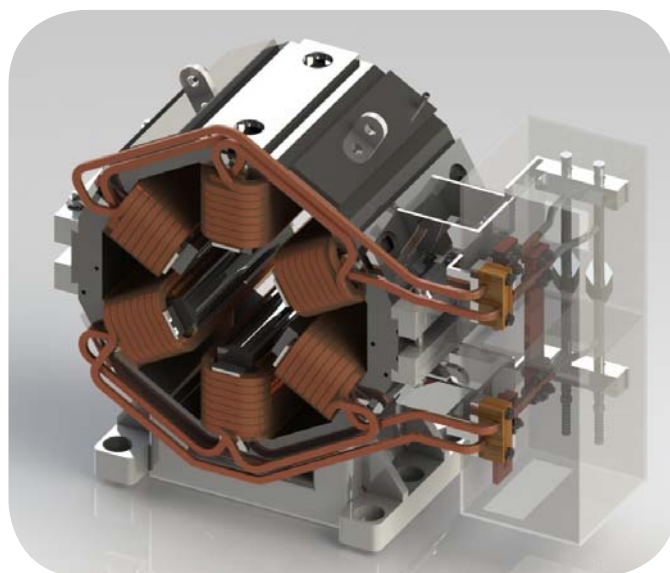
## Applications:

Ecological boat for Danube Delta Biosphere Reservation.

## Sextupole electromagnets for particle accelerators

FAIR - *Facility for Antiproton and Ion Research*, is an integrated system of particle accelerators which will provide high energy and high intensity beams of ions from antiprotons to uranium particle and will be set up in Darmstadt, Germany. FAIR will offer to scientists from Europe and around the world the opportunity to conduct research of very high level in terms of nuclei structure physics, antimatter physics, physics of nuclear matter under extreme conditions, plasma physics and related applications. Romania, as a foundation member of FAIR GmbH - company that will coordinate the activities in the project -, will support 1% from the FAIR project costs. A part of these costs represent in kind contribution, meaning equipment that will be installed in the accelerator facilities. Within this in kind contribution, INCDIE ICPE-CA Bucharest, Romania, will contribute to realize of 120 sextupole electromagnets and 83 power supplies for these electromagnets. These equipments will be installed in the HESR - High Energy Storage Ring, part of the FAIR project.

Parameter	Sextupole
$d^2B/dx^2$	max. 45 T/m <sup>2</sup>
Aperture	140 mm
Magnetic length	300 mm
Iron yoke length	270 mm
Iron yoke width	450 mm
Iron yoke height	450 mm
Mass of iron (magnetic circuit)	~160 kg
Number of coils	6
Windings / coil	15
Layers / coil	2
Windings / layer	7.5
Conductor dimensions	10.6 x 7 mm <sup>2</sup>
Cooling bore	4 mm
Copper crossection	60.77 mm <sup>2</sup>
Length of conductor / coil	~ 12 m
Copper mass / coil	~ 6.5 kg
Current	290 A
Current density	4.77 A/mm <sup>2</sup>
Total mass	~ 220 kg
Voltage (DC)	6.12 V
Resistance	21.12 mΩ
Inductivity	3.4 mH
Power (DC)	1.8 kW
Water flowrate	~0.86 l/min.
Pressure drop	~ 1.14 bar



## Power supplies for sextupole electromagnets

Parameters of the Power Supply:

- input: 400 V, three phases, 50 Hz;
- output voltage: +/-45 V;
- output current: 0...350 A;
- current slew rate: 20 A/s;
- statically and dynamical accuracy: 0.0001;
- environment: 18...28°C and maximum 70% humidity;
- cooling demineralised water with:
  - conductivity < 10  $\mu\text{S}/\text{cm}$ ;
  - flow temperature  $25\pm 1^\circ\text{C}$ .

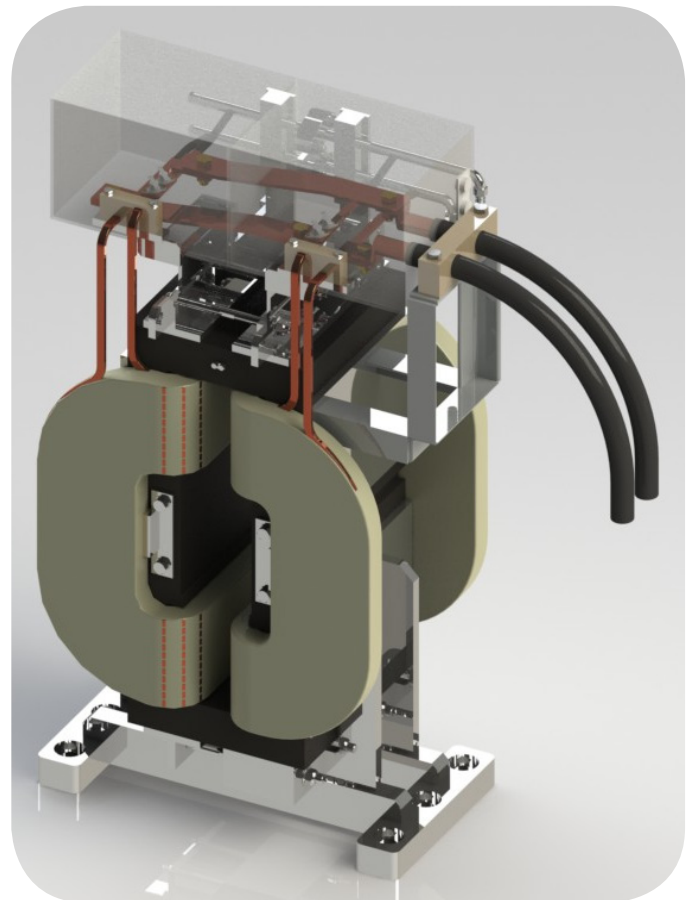


## Steerer electromagnets for particle accelerators

On October 4, 2010, nine countries, including Romania, signed the documents of setting up of FAIR GmbH, a company which will coordinate the activities of FAIR project - *Facility for Antiproton and Ion Research*. This project aims to achieve an integrated system of particle accelerators which will provide high energy and high intensity beams of ions from antiprotons to uranium particle and will be set up in Darmstadt, Germany.

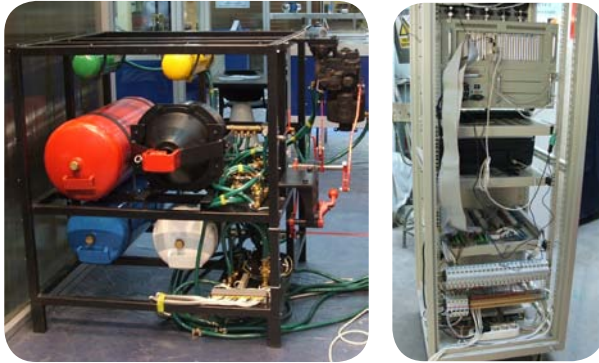
Steerer electromagnet is one of the five types of electromagnets which INCDIE ICPE-CA will deliver within FAIR project and has the following **main characteristics**:

Max deflection angle:	2 mrad
Aperture (diameter):	100 mm
Iron yoke length:	270 mm
Iron yoke width:	580 mm
Iron yoke height:	450 mm
Mass of iron (magnetic circuit):	~160 kg
Number of coils:	2
Windings / coil:	44
Layers / coil:	4
Windings / layer:	11
Conductor dimensions:	10.6 x7 mm <sup>2</sup>
Cooling bore:	4 mm
Copper crosssection:	60.77 mm <sup>2</sup>
Current (DC):	304.1 A
Current density:	5 A/mm <sup>2</sup>
Voltage (DC):	12.84 V
Inductivity:	0.28 mH
Power (DC):	3.9 kW
Total weight:	~350 kg



# Brake pneumatic equipment

This computerized system provides acquisition, graphic processing and operating diagram reproducing, as well as definition of possible errors components for tested brake pneumatic equipment subassemblies.



## Construction technical characteristics:

- supplying voltage (DC): 230V; 50 Hz;
- cue voltage (DC): 24 V;
- effective pressure: 10 Bar;
- consumed power: max 2.5 kW;
- overall dimensions:
  - electronic command unit: 600 x 600 x 1650 mm;
  - electro-pneumatic unit: 1300 x 1500 x 1350 mm.

## Novelty:

- automation of all testing process of air distributors;
- conception of a pneumatic command unit with KD2 valve functions;
- obtaining of software for testing and diagnosis.

Operating diagrams are testing with a computer system equipped with software and there are compared with calibration diagrams assessed by operator and memorized by computer.

Computation programme assures the testing of all parameters which characterize the functioning of air distributor, without the interfering of human operator.

Information regarding the evolution of pressures in different pneumatic chambers is taking up by pressure sensors with digital displays.

Automation of the testing process for the air distributors is making by replacement of KD2 valve functions with a pneumatic control unit made by electronic electro valves.

The main components of the stand: compressed air storage unit, industrial computer, printer, data acquisition unit, DC sources for supplying and command, electro-pneumatic execution unit, digital measurement device, transducers.



## Advantages:

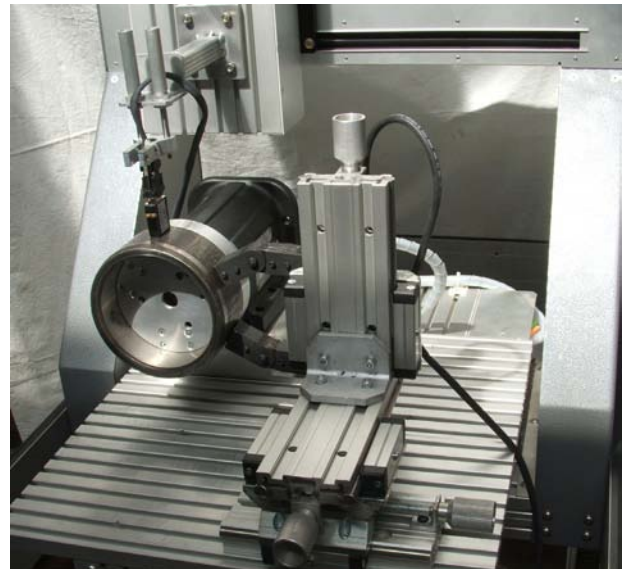
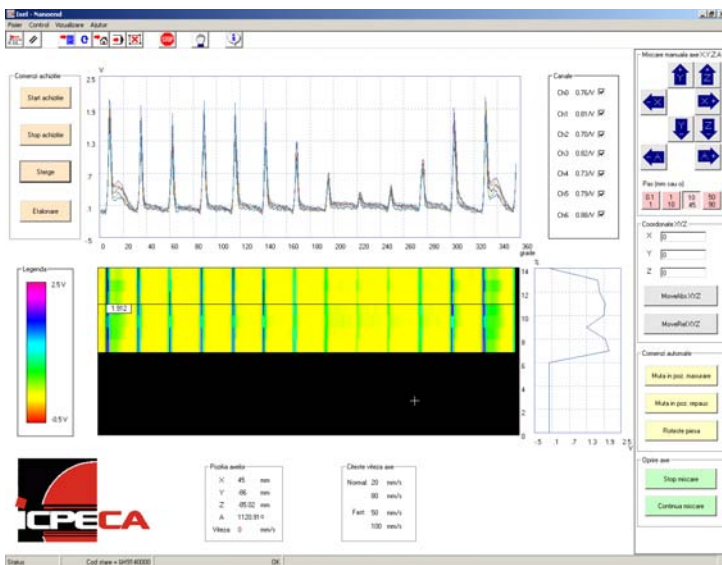
- data records are independently of attention and skill of operator;
- facility to read and to analyze the curves in a Cartesian axis system;
- obtaining of a data base having a history with values of: pressures, times, admitted errors;
- synthesis and diagnosis of measured phenomenon.

# Automatic non-destructive testing system for railway components

## Description

This equipment is made for non-destructive testing of railway ball races during the repair process of railway carriage. A magnetic sensor obtained from nanostructured materials located the facile errors by magnetic leakage process. It is making a map of current errors from the surface of bearing shown the shape and size of its. The equipment is made from a mechanical part (manipulator with four degree of freedom), a part for measurement and analyzing of data and a command and control part of equipment.

The equipment has new sensor obtained from nanostructured amorphous materials having a high sensitivity at low mangetic fields. Also, the result of testing is presented as a map which use a color scale which permits to locate the errors and to appreciate its depth.



## Constructive technical characteristics:

- used technique: magnetic flow;
- sensor: rows of 8 nanostructured sensors;
- mechanical system: four degree of freedom (3 translations X,Y,Z and a rotation);
- ring diameter: min. 120mm; max. 150mm x 1350mm.

## Economic effects:

- increasing the safety to estimate the quality of railway bearings at periodic inspections;
- avoiding the railway accidents.

# Stand for computerized testing and diagnosis of railway dampers



Graphical interface - operating diagram



Stand

## Description:

The computerized stand destined for testing dampers has the following main modules: handle-piston mechanism, automatization system which permits continue adjustment of frequency and testing drive, the command and acquisition of data, the transducers module.

On stand metallic structure are mounted the following main subassemblies:

- the drive plate (flywheel) which makes a common body using a gear system with reducing work gear;
- the attachment and sliding device for the testing damper;
- electric engine which ensures the rotation moving using wheels and trapezoidal belts and, implicitly, the flywheel;
- force and linear displacement transducers.

The command element in this process is represented by the central unit and acquisition of data block equipped with a computer, which ensures the control of measuring process, evaluation and processing.

The main components commanded by the central unit (U.C.) of information processing using the data acquisition board are: transducers module, signal adaptation / processing module, galvanic separation module, command module for system starting, speed command module.

The electrical and mechanical components which ensures the conversion and transmission of rotation moving in translation moving are: frequency converter, electric engine, network filter, reducing worm gear, driving disk, connecting rod. After the testing damper mounting and determining the piston path, the stand is supplied electric and is ordered the frequency converter for a required speed. It is ordered the data acquisition and carried out a cycle of measurements, in the end the force diagram depending on movement is displayed. Operating diagrams are checked with the computer system equipped with software and compared with the standard diagram imposed by the manufacturer and stored in the computer.

## Technical constructive characteristics:

- maximum nominal force: 20 kN;
- maximum piston path: 350 mm;
- maximum working speed: 57 rot/min  
(reducing ratio 1/50);
- measuring precision: +/- 0.1%;
- supply voltage: 400 V, 50 Hz;
- maximum consumed power: 12 kW;
- overall dimensions:  
computerized stand (600x600x1370) mm;  
electro-mechanical unit  
(700x1250x2675) mm.

## Novelty:

- automation of the whole testing process of dampers;
- setting the testing speed - fixed / continue variable;
- software for testing and diagnosis.

## Advantages:

- the records are independent of operator attention and skill;
- easy reading and interpretation of curves shown in a Cartesian axis system;
- achievement of a database with a history of acquired values: force, movement, time;
- facility of synthesis and diagnosis of measured phenomenon.

# Computerized stand for testing and control used in railway equipment

## Description:

Vibration and acoustic measurement stand for bearings is made from:

- mechanical system for catching and fixing of bearings;
- driving equipment of bearings;
- piezoelectric transducer which convert the mechanical vibrations in measurable electrical measures;
- noise transducer which convert the acoustic vibrations in measurable electrical measures;
- unit for processing the mechanical vibrations from transducer, which has the role to filter the useful information to increase the input level as is necessary, to incorporate values and to process the information at output;
- unit for processing of useful noise made by bearing when is rotating;
- board of data acquisition and processing;
- central processing unit having the role to process and to analyze the data and software (U.C.);
- monitor to display the measurements as graphics or alphanumeric characters;
- keyboard, mouse etc.

These components process the data from different sensors and transmit as serial type to acquisition board. Central processing unit is a basic configuration. On monitor can be display all data from transducers (inclusively graphics) according to norms.

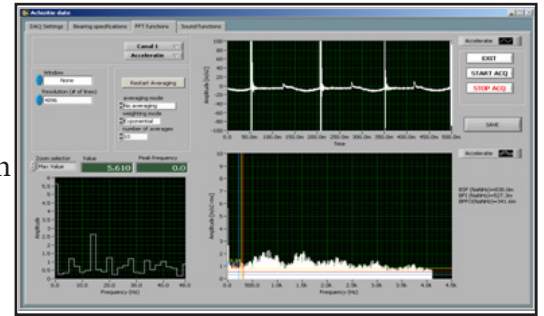
By this proposed system it can be distinguish the analyze capacities of inter-correlative methods with vibration, noise, acoustic inter-symmetry in octave in a large spectrum.

The vibration-acoustic analyze of bearings allows to determine the real state of functioning (monitoring) and to locate (diagnosis) and to eliminate the main sources of noise and vibrations.

The acoustic inter-symmetry measurements allow the measurement of acoustic power made by a bearing in the presence of a high background noise and can produce the noise supply of an inquiry component; in out case, it can be made a difference between the balls noise and the noise of internal rings of bearings, and this can give information on radial play etc.

## Technical characteristics:

- supply voltage: 230 V; 50 Hz;
- absorbed power: max. 0.5 kW;
- measure range (vibration): 0...2 g;
- measure range (useful noise): 20...140 dB;
- frequency range (acoustic vibration): 10...30.000 Hz;
- frequency range (mechanical vibration): 10...10.000 Hz;
- non-linearity in the measure range: +/- 0.5 dB;
- attenuation out of measure range: 40 dB/dec;
- analogical filter numerical controlled with autotune;
- tuning range of band-pass filter: 100...10000 Hz;
- quality factor of band-pass filter: min. 25;
- resolution of band-pass filter: 0.1 Hz in range 10...1000 Hz;  
1 Hz in range 1000...10000 Hz;
- range of sensitivity on three ranges 0.01...0.1 mV/(m/s<sup>2</sup>);  
0.1...0.5 mV/(m/s<sup>2</sup>);  
1...2 mV/(m/s<sup>2</sup>);
- it can check the types of bearings used in railway wagons;
- range of operating temperatures 0...40°C;
- gradul de protecție IP20;
- the possibility to inter-connection with another computer;
- displaying of measured data (acceleration in mm/s<sup>2</sup>, speed in mm/s, noise power in dB etc.) will be made by displaying on color monitor with alphanumeric characters and graphics;
- weight of computerized stand: max. 20 kg.





# Dynamic balancing equipment for rotors with weight less than 2 kg

## Description

The equipment is from a new generation of specialized machine tools, which involves to work with the computer and qualified staff.

The manufacture and exploitation of the equipment has not harmful effect on the environment.

The balancing equipment is made from:

### 1. Mechanical system:

- support frame, fixed on socle;
- bearings, on which is placed the balancing rotor;
- angle transducer – 1 piece;
- vibration transducer – 2 pieces of inductive type;

### 2. Electric and electronic system consists of:

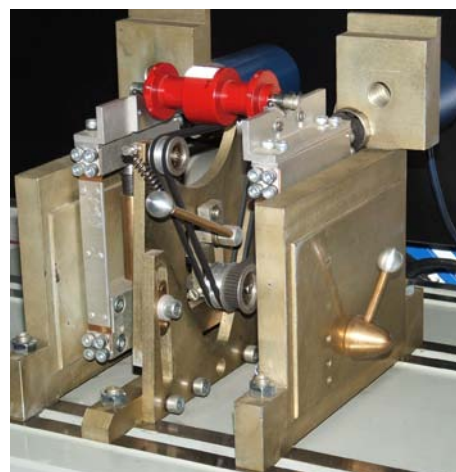
- driving engine system;
- electronic system to take up the signal from the transducers assembled on mechanical system and to process and display the data.

## Technical characteristics:

- balancing in two planes;
- balancing degree: G 16 according to ISO 1940;
- weight of balancing piece: minimum 0.150 kg;
- balancing speed: 1500/3000 rpm.

The computer has the following functions:

- it calculates the transfer functions and unbalancing of the tested rotor;
- it accumulates the transfer functions in order to reuse of them;
- it emits the test report which contain residual unbalancing;
- it assures the interface with user;
- it commands the action of driving motor by microcontroller.



## Economical advantages

Increasing the reliability of mechanical sub-assemblies, reducing the noises and vibrations.

# Electrosecurity and protection system of underground structures from concrete steel

## Description:

The complex system of electrosecurity and protection of underground structures from concrete steel, especially those available to subway tunnels, assures simultaneously:

- decreasing up to the elimination of destructive effect of DC dispersion currents produced by subway, on their own metallic structures but also on nearby;
- decreasing the destructive effect of DC dispersion currents produced by tram circulation, on resistance structures from concrete steel for subway and for base of structures from tram and / or subway;
- treatment for AC stray current which accelerate the corrosion of resistance structures from concrete steel.

The protection is obtaining by appropriate implementation of specialized device, licensed for this purpose. OSIM file 00480 / 21.06.2006 and OSIM file 00481 / 21.06.2006.

## Homologated devices



*Polarized drainage device in back centers of DDPSCI-4-S-S type*

Note:

DDPCI - polarized drainage device in back centers;  
4 - number of rectifier diode connected in parallel;  
SS - alarm fuse with LED burnt fuse.

### Technical characteristics:

- overload current supported: 2000A cycle 2s / 88s;
- environment temperature: -25...+60°C;
- maximum relative humidity: 98 % at 20°C.



*Device for electric distributed decoupling of DDED type*

Note:

DDPD - device for electric distributed decoupling

### Technical characteristics:

- overload current supported: 70A cycle 2s / 88s;
- protection backing-off voltage: 33V±5V.



*Device for polarized distributed drainage of DDPD-35 and DDPD-75 type*

Note:

DDPD - device for polarized distributed drainage  
35 respectively 75 – nominal voltage of Zener diode;

### Technical characteristics:

- overload current supported: 140A cycle 2s / 88s;
- protection backing-off voltage: 35V±5V, respectively 75V±5V.



*Device for electroprotection and polarized drainage to ground plated of DEDP type*

Note:

DE – electroprotection device  
DP – polarized drainage

### Technical characteristics:

- overload current supported: 130A cycle 2s / 88s;
- protection backing-off voltage: 35V±5V.

# System for monitoring and optimizing of the electrical consumption in the poultry farm

## Description

The equipment is made to measure and optimize the environment conditions in a poultry farm and to reduce the electrical energy consumption.

Most poultry farm from European Union have modern and economic ventilation, heating and climate systems which are controlled by a computer.

## Technical characteristics

Input data in controlled process:

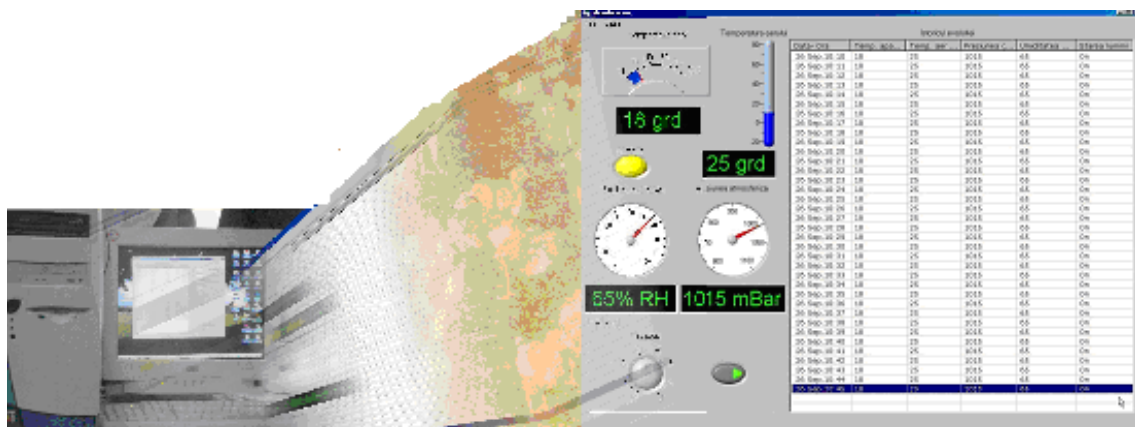
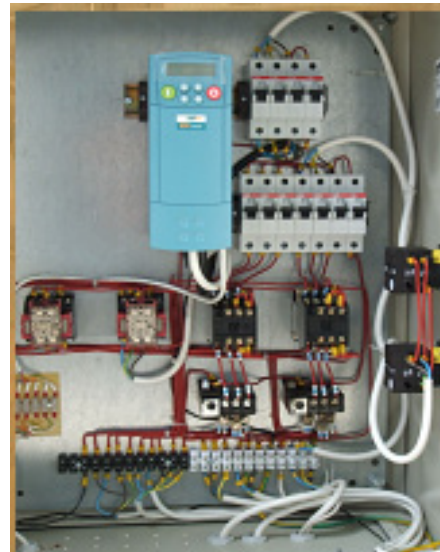
- environment temperature: 0 - 40°C;
- potable water temperature: 5 - 35°C;
- air humidity: 20 - 90%;
- air pressure: 900 - 1100 mbar;
- brightness from room: 0 - 50 W/m<sup>2</sup>.

Output data obtained by processing and analyzing:

- controlled command of ventilation system (with help of some frequency converter);
- controlled command of lighting system;
- alarm signal (exceeding the potable water temperature etc.);
- environment parameters with acquisition and history on last 24 hours.

## Economic effects

- maintaining of a microclimate in a poultry farm;
- reducing the energetic consumption;
- reducing the cost with staff;
- introducing of a new monitoring system of environment conditions, compatible with EU system;
- increasing the safety level and reducing the death-rate of animals.

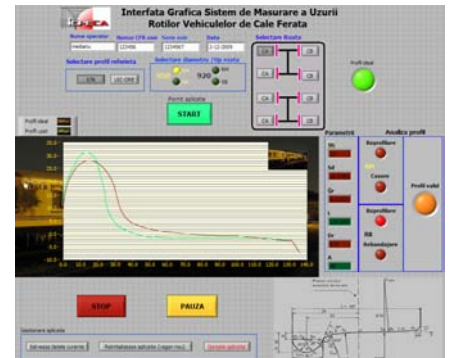
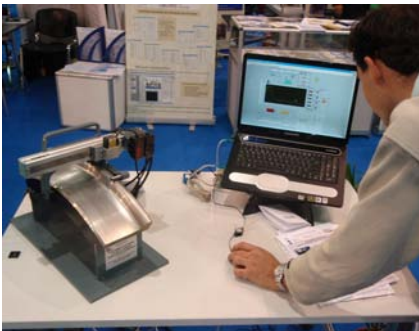


# Electronic equipment for scanning of geometric profiles

## Description

The equipment is made for measuring and control the wear of wheel profile for railway vehicles and consists of:

- laser sensor;
- control, driving and acquisition of data;
- translation axis with actuator;
- wheel attachment;
- software for plotting and analysis of tire tread wear;
- laptop;
- modem for data transmission.



## Constructive characteristics

The equipment is made from:

- \* laser sensor:
  - measuring precision: 16  $\mu\text{m}$ ;
  - focalisation center: max. 100 mm;
  - answer time: 150  $\mu\text{s}$ ;
- \* translation axis X:
  - useful path: max. 150 mm;
  - operated with actuator;
  - charge: max. 4.5 kg ;
  - measuring repeatability: +/- 0.02 mm;
- \* command electronics:
  - command and acquisition data controller;
- \* software for drawing and analysis with Labview programme;
- \* fixing device;
- \* laptop;
- \* modem.

## Applications:

- Mechatronics;
- railway rolling stock;
- many other fields, by increasing the number of axis and adapting the software for analysis and control.

## Advantages:

- portable equipment with the possibility of in-situ measurement;
- issuing test report;
- possibility to remote data transmission (by GSM/ Internet);
- versatility in applications.

## Operation mode

The equipment is based by scanning using a laser sensor and one or more translation axes, the profiles of various geometric shapes found in static or dynamic state.



*Unit for command, acquisition and processing of data*

# Equipment for measuring and control of dynamic unbalancing for drive shafts MRC

## Technical data:

- balancing in two planes;
- balancing degree – G 16 according to ISO 1940;
- weight of balancing piece: max. 250 kg;
- balancing speed: 1500/3000 rpm.

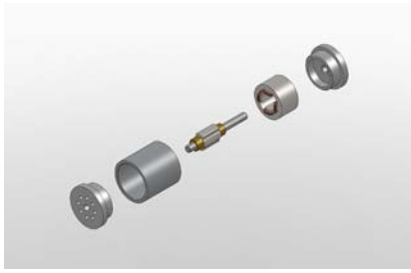
## Advantages:

- the equipment is from a new generation of specialized machine tools,
- it reduces the noises and vibrations of train wagons and increase operating performance.



*Beneficiary: S.C. Grivița SA Bucharest, Romania*

# Non-contact revolving angle micro-transducer



Structure of non-contact angle micro-transducer



Prototype of non-contact angle transducer (increase with magnifying glass)

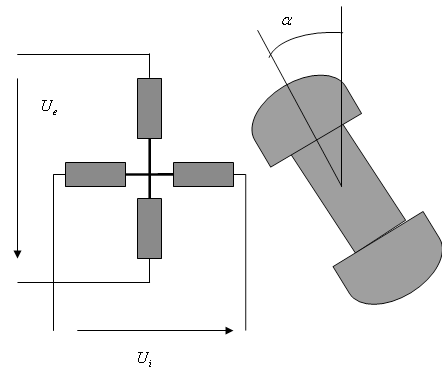


Diagram representing the operation mode of electromagnetic revolving angle micro-transducer

## Technical characteristics:

- voltage range: 0.5÷1.5 V effective value;
- nominal current: 110 mA;
- frequency range: 400÷1000 Hz;
- windings resistance: 3.2÷3.4 Ω;
- windings inductivity depending on angle given by the rotor position: 28.5÷61.8μH for 360 degree;
- friction torque at shaft: 0.1 mNm;
- range of residual voltage: 0÷5mV;
- insulation resistance between the microtransducer case and connections: >2 MΩ at 500V;
- turnover voltage between coils and case: 100±10V c.c;
- angle error: ~ 1'.

## Operating mode

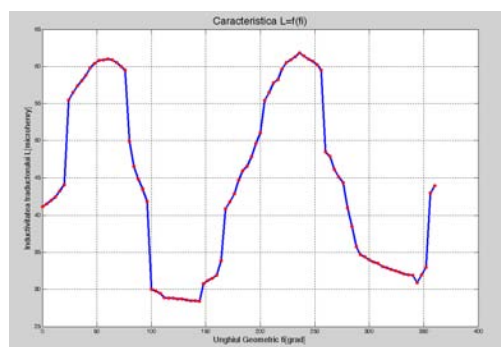
The operating mode of this microtransducer is based on the reluctance variation by rotating the rotor armature, such that the output voltage from a pair of poles is proportional to the rotation angle of the shaft. The principle scheme is shown above.

If we have a sinusoidal input voltage  $U_i$  applied on a pair of poles, the pair of poles located at 90° is obtained an dephased output voltage  $U_e$ .

The errors of this microtransducer are influenced decisively by stator and rotor geometry of magnetic circuit.



Fixing on transducer dividing head and fixing the measuring connections



Inductivity vs. geometric angle to the transducer shaft (indexing using dividind head)

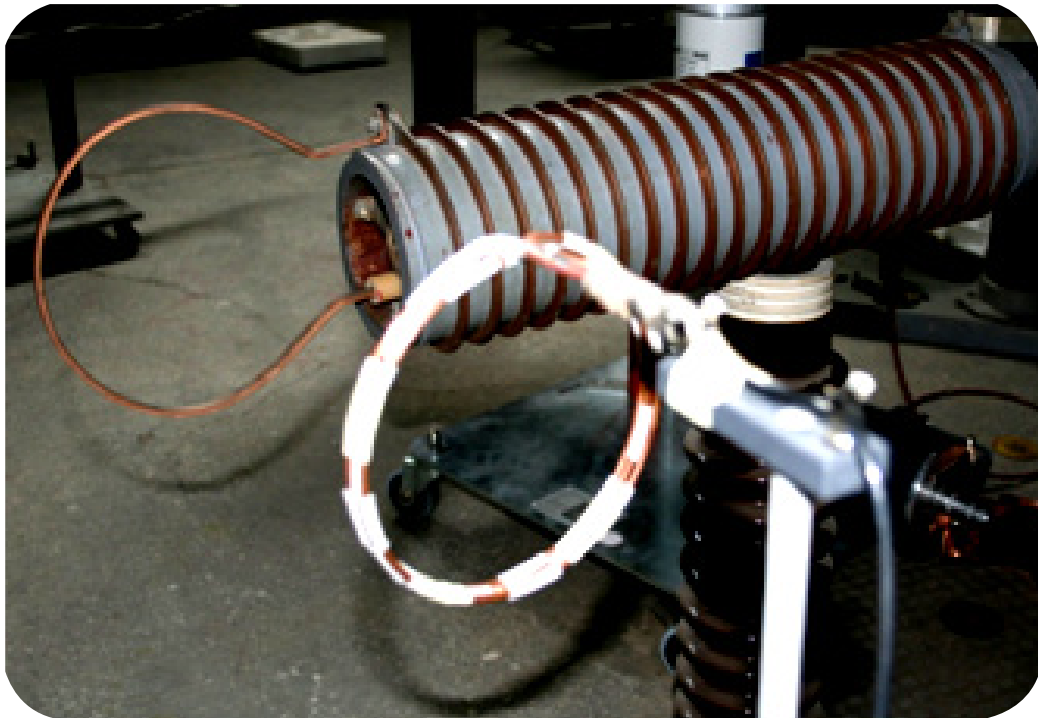
## Applications

Non-contact revolving angle micro-transducer is used in positioning systems, gyroscopes.

## Advantages

The technology to obtain is simple and new dimension system.

## Electromagnetic pulse generation system, by the controlled exploitation, with current loop



### Description

The system consists of the field coil, with rectangular cross section, wrapped on a stainless steel cylinder which does not influence the dielectrical rigidity of the assembly, a current loop having the role of emission antenna and Cu or soft Fe cylinder having the role of shorting of the field coil windings; between the field coil and the exterior case there is a space filled with inert material (ballast), and inside the field coil there is a subassembly destined for the main explosive charge.

The loop current has a circular shape and is fixing perpendicular on the field coil windings plane, to its end. The explosive compression of the magnetic field flux allows obtaining of electromagnetic pulses of powers of hundreds of MW for tens to hundreds of  $\mu\text{s}$ , as well as a radio frequency spectrum. These electromagnetic pulses are emitted by current transmitter loop.

### Main technical characteristics

- after the building-up of a controlled explosion, is done the progressive shorting of the field coil windings and is obtained the transient currents through the coil of large amplitudes in the range:  $I = (60000 - 120000)$  A, in a very short time, in the range:  $t = (50 \cdot 10^{-6} - 52 \cdot 10^{-6})$  s;
- the electromagnetic pulses of powers is of hundreds of MW for tens to hundreds of  $\mu\text{s}$ , in a wide radio frequency spectrum;
- the wavefront of the controlled explosion is of conic shape (the angle at peak is  $12-14^\circ$ ) and is propagated along the copper cylinder and causes the progressive shorting of field coil;
- the electromagnetic pulse generation system has a mechanically compact and strong construction.

### Applications

- in the field of civil protection;
- in the military field (protecting the environment because the biotope is not affected), having the capability to destroy the communication equipment and logistics which incorporated the electronic modules.

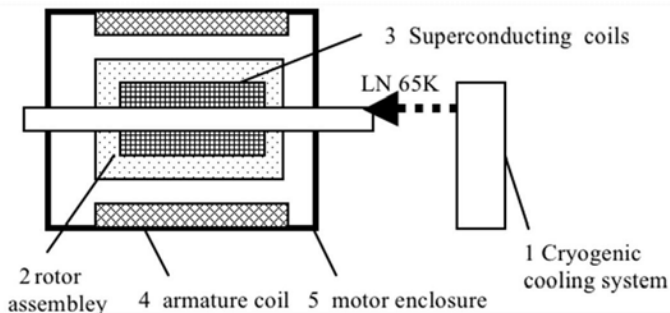
# Synchronous superconducting electrical motor

## Description

Synchronous electrical motor has the rotor windings from HTS superconducting tape, and the rotor is thermally insulated from the motor and is cryogenic cooled.

## Characteristics:

- rated power:  $P = 4 \text{ kW}$ ;
- rated voltage (AC):  $U = 380 \text{ V}$ ;
- number of turns:  $n = 1500 \text{ rpm}$ ;
- frequency:  $50 \text{ Hz}$ ;
- weight:  $\sim 55 \pm 0.2 \text{ kg}$ ;
- excitation current:  $80 \text{ A@ } 77\text{K}$ ;
- number of poles: 4;
- dimensions:  $D = 220 \text{ mm}$ ;  $L = 450 \text{ mm}$ ;
- cryogenic cooling system of rotor: supercooling liquid nitrogen at  $65\text{K}$ .



*Scheme of superconducting motor*

## Advantages:

- weight/power ratio is reduced compared to conventional engines;
- high energy efficiency;
- overall size / power ratio is reduced compared to conventional engines.



# 5kW cogeneration system based on fuel cells



## Description:

The system having a PEM fuel cell stack type with 5kW total power, of which 1.8kWe maximum electrical power and 3.2kWt maximum thermal power. Average temperature is 60°C, and maximum allowable working temperature is 80°C. The average temperature of the stack is controlled based on the recirculation system with an aqueous heat agent (deionization water / ethylene glycol). The fuel used is hydrogen. The oxidant used is air. The stack voltage is in the range 24V – 12V. Maximum current is up to 150A DC.

Variable voltage in the range 12V - 24V of the fuel cells stack is stabilized in a DC/DC converter and converted by an DC/AC inverter in the AC 220V/50Hz.

## Main characteristics:

The system consists of the following functional units:

1. PEM fuel cell stack type with 5kW total power ( $1800W_e + 3200W_t$ );
2. Back-up power source 24V/80Ah;
3. Converter DC-DC 9-24V / 27V, 65A;
4. Inverter DC-AC 24V / 220V, 50Hz;
5.  $H_2$  consumption at maximum power: 2.5 m<sup>3</sup>/h;
6. Air consumption at maximum power: 6.5 m<sup>3</sup>/h.

## Applications:

- stationary applications – electro-thermal hydrogen-based plant (230V / 50Hz / 1.8kWe + 3.2kWt);
- education - training students and pupils;
- experiments regarding the alternative technologies for producing green electricity.

# Double excited electric machine

## Novelty

Construction with ring armature - empty cylinder, coiled on the ferromagnetic yoke with both sides of the coil (outer side as well as the inner one) being active in the exterior and interior air-gap respectively, in the heteropolar magnetic field produced by both the outer and inner inductor, provided with either permanent magnets, electromagnets or mixed construction, the inductor block (outer and inner one) being in rotational motion.

## Technical characteristics

It allows the direct coupling of the wind or hydro turbines' rotor.

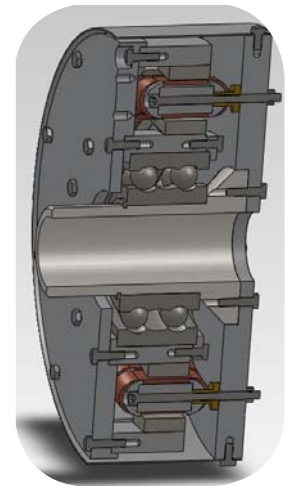
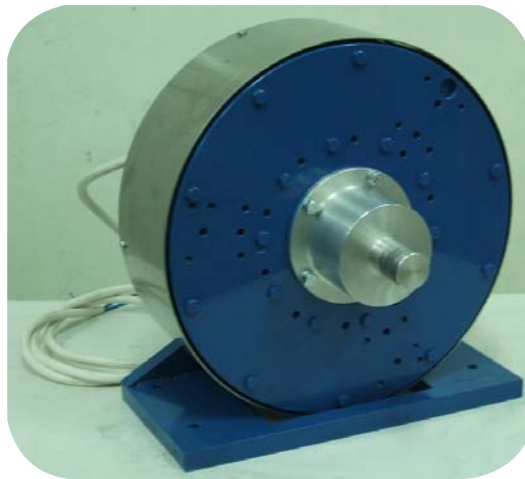
Speed [rpm]	Electric power [kW]	Voltage DC [V]
600	1.1	95
1000	1.9	160

## Description

The double excited electric machine, operating either as a generator or a motor, in synchronous or direct current construction, is provided with a ring armature induced, ferromagnetic yoke, hollow ring cylinder and winding with coiled wires, located at the surface of the yoke without notches, with output and input sides. The double inductor has two inter-consolidated sections which outflank the bilateral induced. Each section is consisted of an empty cylinder ferromagnetic yoke with heteropolar placed magnetic poles, located in the exterior for the inner one and in the interior for the outer one. The poles' sides set out along with the lateral sides of the empty cylinder induced, two available air gaps, exterior  $\delta_e$  and  $\delta_i$  interior, respectively. Both input and output sides of the armature winding conductors are active - base of series induced electromotive voltage, being located in the outer air gap  $\delta_e$  and the inner air gap  $\delta_i$ , under the double inductor's magnetic poles.

## Applications

Electric generators with low speed and usual frequency for wind or hydro energy conversion.



## Advantages

- overall dimensions and weight lower than in the case of conventional machines, especially for the low speed multipole machines;
- smart use of the central space, practically unused for the energy conversion effectiveness, especially at low speed multipole machines;
- higher degree of compactity and lower cost compared to the conventional low speed multipole electric machines, equivalent when comparing the conversion capacity.

## Wind power plant with rated power of 4 kW

Diameter of the wind rotor: 4.5 m;

Wind rotor speed corresponding to the rated power: 250 rot/min;

Speed multiplier with multiplication ratio: 3.

### Electric equipment for wind power plant of 4 kW



Rated power: 4 kW;

Maximum power: 5 kW;

DC output voltage: 48 V;

AC output voltage: 230 V;

**Electric generator (put in manufacturing by SC Electroprecizia Săcele - Romania)**

Terminal voltage corresponding to rated power: 3 x 37 V c.a.;

Rated speed: 750 rot/min.

#### **Electrical installation of power distribution and automation**

##### ***Controller (DC-DC converter)***

input voltage (DC): 30 – 80 V;

output voltage (DC): 56 V.

##### ***DC-AC Inverter***

input voltage (DC): 56 V;

output voltage: 230 V (pure sinusoidal wave).

The box can be fitted with 4 electrical accumulator of 12 V/150AH, serial connection.

# Light rig for water wells drilling FA 100

## Destination:

The light rig for water wells drilling FA-100 is a mechanical operated hydro-geological drilling rig suitable for water wells up to 100 m depth, with diameters up to 230 mm.



## Technical features:

- hook load: 1200 ... 1400 daN;
- maximum power: 7.5 ... 9 kW (10-12 CP);
- drilling depth: max. 100m;
- drilling diameter: max. 230 mm;
- pipe length:  $L_p = 1.5$  m;
- rig mast height: max. 2.5 m;
- drilling rig weight (mud pump, drilling stem and drilling bits excluded):  $m_{max} = 300$  kg.

FA 100 can use the following drilling methods:

- hydraulic rotary drilling rig with direct flow of the drilling fluid;
- dry drilling up to 20m maximum depth.

## DESIGNER

IPCUP Ploiești, Romania

## MANUFACTURER

Workshop - IPCUP Ploiești, Romania

# Manometers with elastic element for special fluids

## Description

The manometers are used to measure the pressure of some fluids as: drilling mud, oil products, cement paste, stimulation fluids, industrial water, air, non-corrosive gases.



## Technical features:

- strong elastic element;
- incorporated pulsation dampener;
- incorporated environment separator;
- indicating mechanism with oil immersed rotary dial for vibration mitigation, corrosion prevention and lubrication of the moving parts as well as with good visibility from distance;
- accuracy class: 2.5;
- operating temperature:  $-40^{\circ} \dots +80^{\circ}\text{C}$ ;
- pressure range (bar): 0 – 400; 0 – 700; 0 – 1000; 0 – 1400;
- connections: tapered thread or spherical nipple.

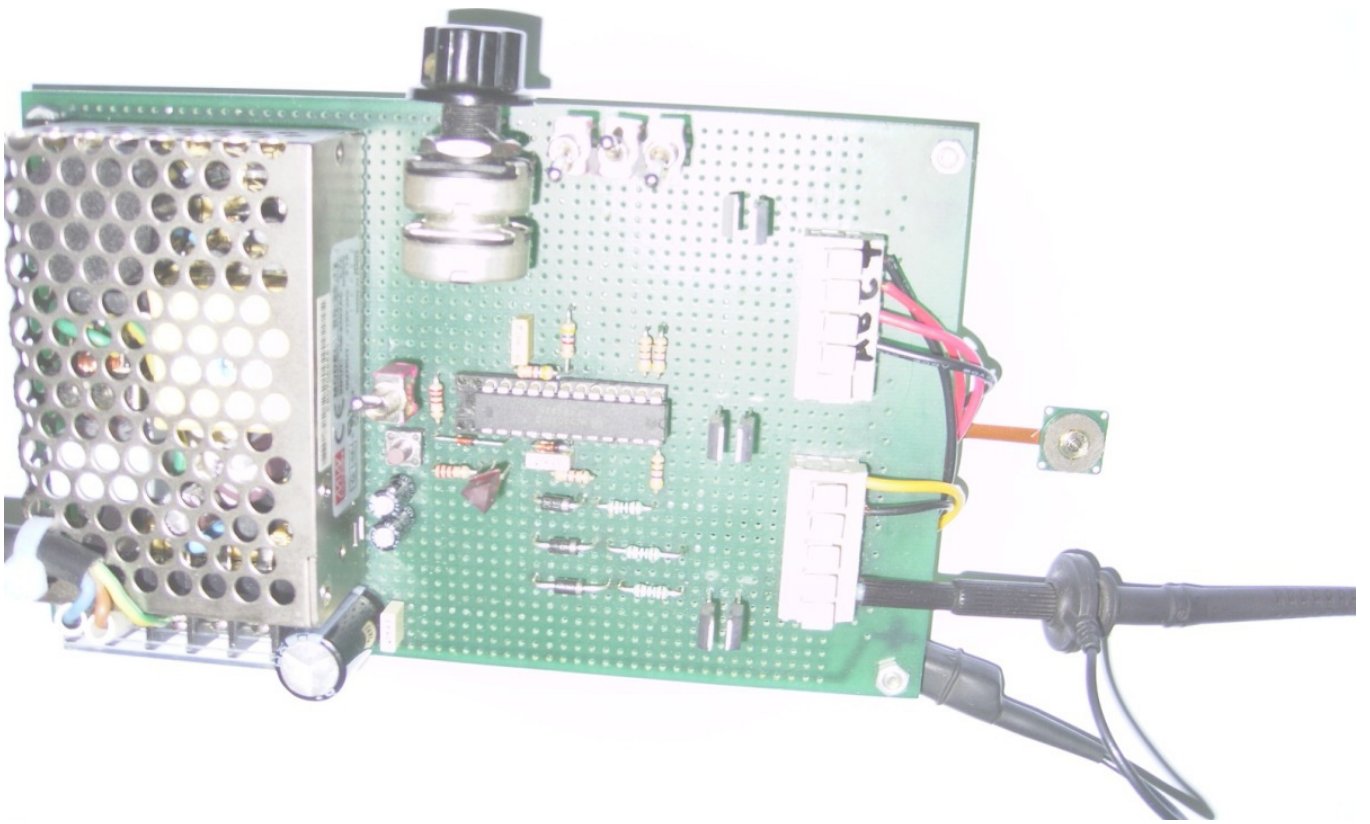
## Applications

These manometers can be mounted on equipment such as:

- mud pumps;
- cementing units;
- manifolds and Christmas Trees;
- supply pumps for steam boilers;
- steam supply systems.

**DESIGNER**  
IPCUP Ploiești, Romania

**MANUFACTURER**  
Workshop - IPCUP Ploiești, Romania



# COMPONENTS

## CONTENT

Magnetical system for dental field	49
Self-protector aerial electric conductor at the deposits of frost and ice for high voltage lines	50
Hydrogen tank on the basis of metal hydrides	51
Extruded bars and pipes based on light aluminium composite materials	52
Ferromagnetic microwires for securized paper	53
Microwires from Cu and FeBSi	54
Metallic microwires for electromagnetic shielding textiles	55
NdFeB sintered magnets with high magnetic stability	56
NdFeB bonded permanent magnets	57
AlNiCo permanent magnets	58
Nanocomposite magnets without rare earth	59
Ecological sintered electrical contacts based on AgZnO and AgSnO <sub>2</sub>	60
Electrical contacts for low voltage vacuum contactors	61
Nonconventional soft magnetic cores from iron-based composite materials	62
Products from sintered hard alloys	63
Electrical spark quenching chamber CECC 63 A	64
Electrical spark quenching chamber CECC 400 A	64
Ceramic interconnector for pressure aeronautical transducer	65
Insulating materials from steatic ceramics (support contact)	66
Ceramic supports for heating resistors	67
Distance pieces for heating element supports	68
Ceramic stuffing glands	69
HAP-based ceramic cranial implant	70
Granular product based on beta-TCP for bone reconstruction	71
Displacement sensor	72
Tactile sensors of nanocomposite materials	73
Micromechanical parts for MEMS applications carried out by specific technologies	74
Microsensors matrixes for medical specific procedures and medical rehabilitation assessments of the legs and in the field of sports	75
Supercapacitors with electrodes of polymer-CNT hybrid electroactive material	76

## CONTENT

Carbon based planar heater designed for thermal management of the space vehicles	77
Superconducting cylindric coils for particle accelerators	78



# Magnetical system for dental field

## Novelty elements

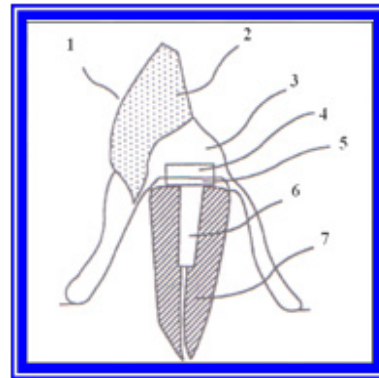
- this magnetical system to anchor dental prosthesis is a premiere at the national level;
- the pivot is achieved by atomic diffusion of two dissimilar materials: FeCoV ferromagnetic alloy and pure Ti biocompatible.

## Functional characteristics

- attractive force: 400 gf;
- assembly with permanent magnet:
  - dimensions:  $\Phi = 4 \text{ mm}$ ,  $h = 3.5 \text{ mm}$ ;
  - materials: NdFeB, FeCoV, CuZn;
- pivot for magnetical fixing:
  - dimensions:  $\Phi = 4 \text{ mm}$ ,  $L = 7 \text{ mm}$ ,  $h_{\text{disc}} = 1.2 \text{ mm}$ ;
  - materials: FeCoV with magnetical saturation  $B_s = 1.6 \text{ T}$ , pure Ti;
- protection of the oral cavity is assured by covering the ferromagnetic areas with Au or TiN.

## Action mode

The attraction force actions between the magnetic assembly with permanent magnet, embedded in a denture, and the magnetical fixing pivot from the tooth root..



- 1 – dental prosthesis;
- 2 – artificial tooth;
- 3 – material pe bază de rășină;
- 4 – magnetic assembly with permanent magnet;
- 5 – keeper;
- 6 – hole from the tooth root into which is placed the pivot;
- 7 – tooth root.

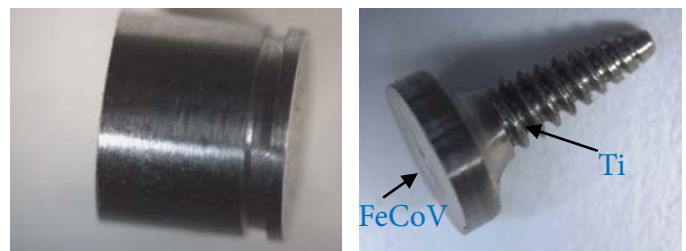
## Advantages

- a good retention of dental prosthesis is assured;
- a facile way to detach the dental prosthesis is allowed;
- standards for biological protection at magnetical field  $< 0.02 \text{ T}$  are guaranteed;
- the treatment and using method is simple and accesible.

## Applications

In stomatology, to anchor removable dental prosthesis.

## System magnetic constitution



Magnetic assembly with permanent magnet

Pivot for magnetical fixing

## Implants for fixing dentures



Top maxillary



Lower maxillary

# Self-protector aerial electric conductor at the deposits of frost and ice for high voltage lines

## Applications

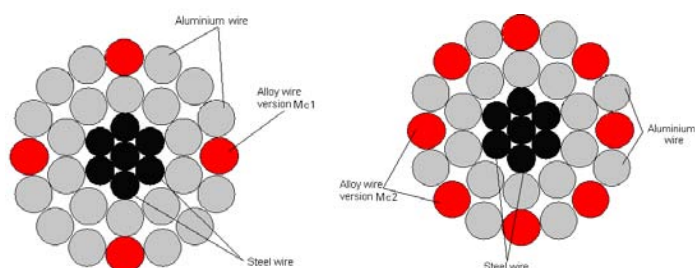
The high voltage lines for the electricity transmission, especially for the areas with severe / cold climate (example: RO – climatic zone E)

## Functional and technical characteristics

- the commutation Yes / No to extra calories that ensure the un-deposition of frost/ice on the aerial conductor is achieved by pre-stable and reverse modification of magneto-electric properties of the TcM multifunctional alloy wire, according with ambient temperature, so heat input gradually increases with decreasing temperature ;
- at positive ambient temperature there is no additional heat input;
- TcM multifunctional alloy is inserted in the EE-HVL conductor, as wires with the same diameter as the wires from the exterior layer, replacing a preset number of wires from the standard conductor;
- the construction and operating characteristics of the new EE-HVL conductor with self-protection at the frost / ice deposits are identical with those of the standard conductors used in the electricity transportation.

## Novelty elements

- multifunctional alloy Cr-Ni-Mn-Fe with thermo-sensitive magnetic properties and preset Curie temperature in the range  $T_c = -15^{\circ}\text{C} \div +120^{\circ}\text{C}$ ;
- using the electromagnetic dissipated field by the EE-HVL operating transportation conductor to provide the heat input (caloric energy) only for negative temperatures and quantitatively proportional to ambient negative temperatures;
- the constructive solution of the EE-HVL aerial electric conductor with the intrinsic properties of self protection to frost/ice deposition and which keep all other constructive and used characteristic properties identical to those used in standardized wires currently used for EE-HVL electrical energy transport;
- highlights the role of some elements (Cr, Mn) by ordering the atomic magnetic moments of antiferromagnetic type in alloys with ferromagnetic elements (Ni, Fe), regarding the correlation of the magnetic properties with crystalline structure and the ordering of atomic magnetic moments.



## Advantages in exploiting the EE-HVL transportation relays

- it ensures the self-protection at frost / ice deposits on the electricity aerial transport lines, without requiring additional energy consumption, without intervention of control (human or automatic), with no adverse ecological effects;
- as design and use properties, it is identical with the standard conductors used today for the transportation of EE-HVL;
- it completely eliminates the nowadays performing, cumbersome and the uncertainty in removing the frost / ice which is deposited on the aerial electricity transport conductors, in the areas with cold and severe climate;
- it ensures high energetic security, eliminating the EE-HVL transportation relays damage caused by the additional mechanical burden due to deposition of frost / ice on these conductors.

# Hydrogen tank on the basis of metal hydrides

## Description

The tank for hydrogen storage in solid phase like Mg hydrides, with minimum volume and maximum security, equipped with a heat exchanger for reactions at high temperatures (250 - 300°C).

## Technical characteristics:

- stainless steel tank with the volume of 1 l ( $\phi=77.5$  mm,  $h=303$  mm);
- stored material:  $\text{LaNi}_5$  nanocrystalline powder;
- quantity of stored material: 500 g;
- hydrogen loading pressure: 30 bar;
- hydrogen desorption pressure: 10 – 1 bar;
- storage capacity:  $\sim 60$  l  $\text{H}_2$ .



## Environmental and socio-economical effects

- obtaining small, lightweight and safe hydrogen tanks for its installation on vehicles or other applications;
- ensuring a long time operation of the hydrogen tank by providing a large number of reversible cycles of absorption-desorption of the hydrogen;
- development of ecological car, powered by hydrogen - clean, great quantities and inexhaustible energy source, by whose combustion generates only water vapors, which do not pollute the environment.

## Applications

- hydrogen supply for fuel cells or others independent power sources;
- hydrogen supply for ecological cars.

## Extruded bars and pipes based on light aluminium composite materials



Extruded bars of Al-SiC composite material



Extruded pipes of  $Al_2O_3$



Extruded bars of Al- $Al_2O_3$

### Comparative physical and mechanical characteristics

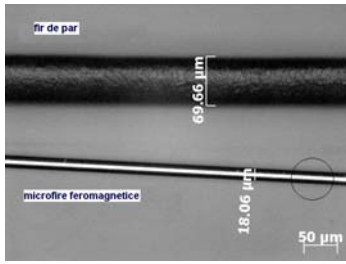
Physical and mechanical properties	Al- $Al_2O_3$ composite material (ICPE-CA)	Al alloys, commercial grades						
		6061 O <sup>1</sup>	6061 T4 <sup>2</sup>	6061 T6 <sup>3</sup>	SF Alcoa T6S9, T6S10 <sup>4</sup>	SF Alcoa T6S2, T6S15 <sup>5</sup>	Al 99,5 annealed	Al 99,5 hardened
Density, $\rho$ , [g/cm <sup>3</sup> ]	2.712	2.70	2.70	2.70	2.70	2.70	2.71	2.71
Ultimate tensile strength, $R_m$ , [MPa]	370	125	207	290	241	262	70	80
Tensile yield stress, $R_{p0.2}$ , [MPa]	123	55	110	241	206	241	12,5	75
Elongation, $A$ , %	30	30	16	8	8	8	40	22

<sup>1</sup> – annealed, <sup>2</sup> - heat-treated for introducing in solution and natural aging; <sup>3</sup> - heat-treated for introducing in solution and artificial aging; <sup>4, 5</sup> - 6061 alloys heat-treated and artificial aging, for pipes with wall thickness smaller than 6.3 mm (standard of ALCOA company).

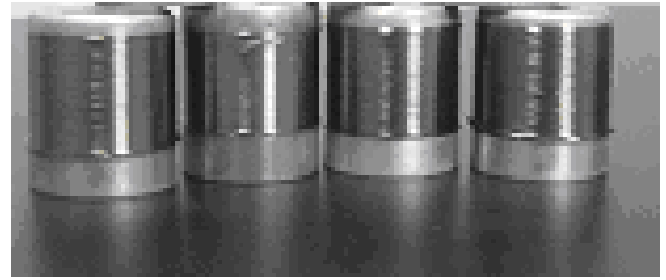
**Processing method:** powder metallurgy

**Applications:** component parts for aerospace industry, car industry, recreational products (bicycle frame and components).

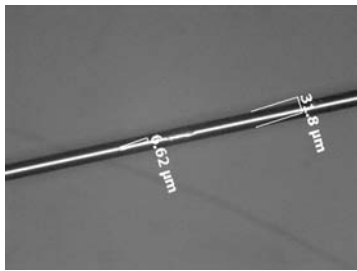
# Ferromagnetic microwires for securized paper



Optical micrograph of a FeSiB alloy microwire compared to a hair

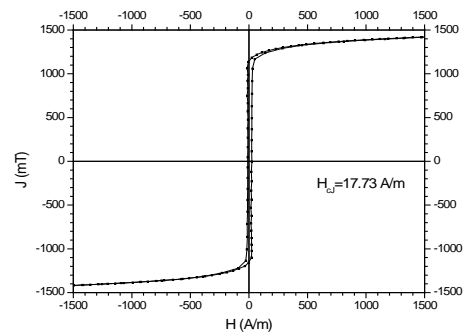


Different spools with microwired from glass insulated FeSiB alloy



Optical micrograph of a FeSiB ferromagnetic microwire

Hysteresis curve of a FeSiB ferromagnetic wire



## Main quality characteristics of the securized paper

Properties	
Basis weight, g/s.m.	60 - 130
Breaking length, km	5.0 - 6.5
Bursting strength, kPa	200 - 450
Flexural strength, number	380 - 450
Water absorption, Cobb <sub>60</sub> , g/m <sup>2</sup>	28 - 32
Ash content, %	5.0 - 8.5
Retention ratio of the ferromagnetic microwires, %	79 - 84

## Description

The security elements are made from intelligent composite materials, obtained by embedding of the ferromagnetic microwires in a cellulosic matrix (paper), which allows their use as security elements in the electronic validation.

## Advantages of microwires securized are:

- the possibility of identifying from distance;
  - constant magnetic properties, even at high temperature and corrosive media;
  - wide range of functional temperature;
  - stability in shielding – the codes shielded with metallic panels can be read;
  - stability in mechanical actions;
  - small size and low consumption,
- and for microfibers with special properties, from the latest generation (which allow the magnetic encoding of the information):
- very large amount of generated codes;
  - the information can be read from a stationary source and from a moving source;
  - the encoding is impossible to destroy, both in the continuous and variable magnetic field (reliable encoding);
  - the possibility to read the information from any random code, oriented in space.

## Applications

The main applications are related to securing of the value papers, fiscal documents and special stamps, through the magnetic encoding.

## Microwires from Cu and FeBSi

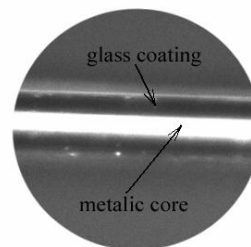
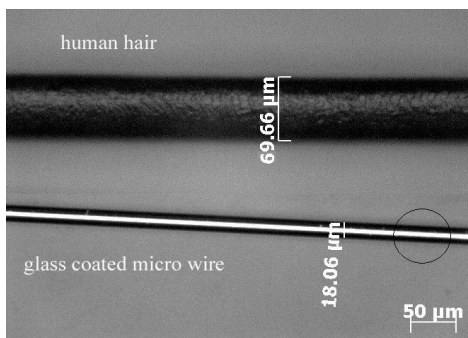
### Description:

Microwire with magnetic properties from different metals (Cu, platinum, cobalt, nickel and others), alloys (FeBSi), semimetals and semiconductors (silicon, germanium).

The microwire is made from a metallic core in a cylindrical shape which is covered with an insulating layer of glass, the diameter of the metal core can be from 1 to 50  $\mu\text{m}$ , respectively the glass insulation thickness of 1 to 20  $\mu\text{m}$  with a length up to 2-3 km.



*Different spools with microwires from FeBSi and copper*



*Microscop view of a microwire from FeBSi*

It can be obtained different structures of the metal core: polycrystalline with different sizes of crystals (micro-crystallites, nano-crystallites), amorphous.

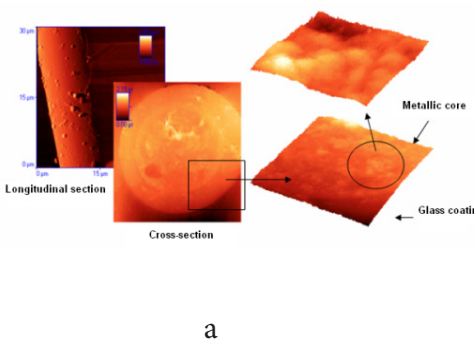
### Applications

- sensors;
- electromagnetic shielding;
- security device for products;
- securing the value papers;
- underfloor heating systems;
- miniature high-voltage transformers;
- micro-conductors.

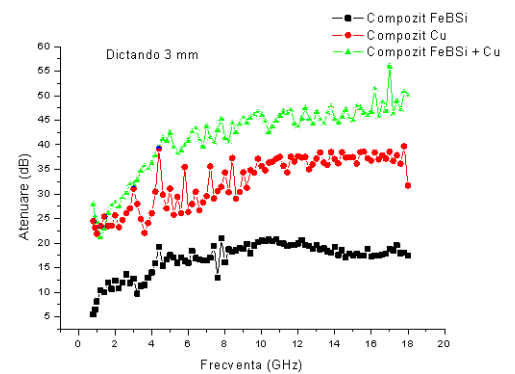
# Metallic microwires for electromagnetic shielding textiles

## Description

Ferromagnetic microwires and non-magnetic conductive microwires with a glass coating, with length up to 10 km, from which can be obtained mixed textiles for electromagnetic shielding, have applications in environments exposed to electromagnetic radiations, like naval, energy, military field, etc. The microwires have a core made from non-magnetic conductive materials such as Cu, Ag, Al, Zn, Pb and Sn or a core from alloys with ferromagnetic properties of type  $Fe_xNi_y$  where  $x=13-30\%$  at,  $y=70-87\%$  at;  $Fe_xCo_y$  where  $x=38-72\%$ at,  $y=62-28\%$  at with additions of Cr, Ni, Mo and V up to 5%at;  $Fe_xSi_yB_z$  where  $x=77-79\%$  at,  $y=8-10\%$ at and respectively  $Co_tFe_{(100-t-u-v-w-z)}$   $Cr_uMn_vSi_wB_z$  where  $t=80-82\%$  at,  $u=3-4\%$  at,  $v=0.8-1.3\%$  at,  $w=4.5-6.5\%$  at,  $z=0.025-0.035\%$  at. There microwires are used in the temperature range of  $-80 \dots +270^\circ C$  and have the saturation induction  $B_s=0.2-2.2$  T, coercive force  $H_c=1-6000$  A/m and a magnetic permeability in the range of  $\mu=100-165000$ . The diameter of the microwires metallic core can be between  $1-50 \mu m$  and the thickness of the glass coating is between  $1-20 \mu m$ .



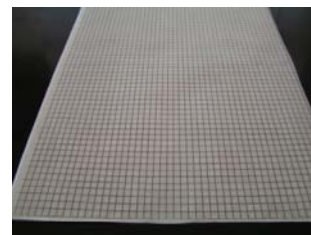
AFM micrographs (a) and optical micrograph (b) of the Fe-B-Si glass-coated microwires



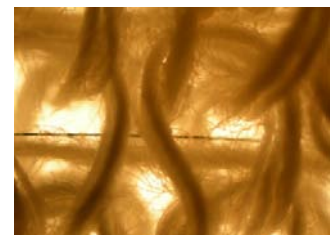
Attenuation vs. frequency

## Advantages:

- magnetic properties are constant at high temperatures and corrosive media;
- electromagnetic shielding are functioning at high temperatures;
- microwires have stability at mechanical actions and are suitable to be used in textiles;
- electromagnetic shields may be obtained in different designs and have a good electromagnetic shielding at frequencies of 0.2 MHz – 35 GHz.



Obtaining of the electromagnetic shielding



## Applications:

- environments exposed to electromagnetic radiations: naval field, military field etc.

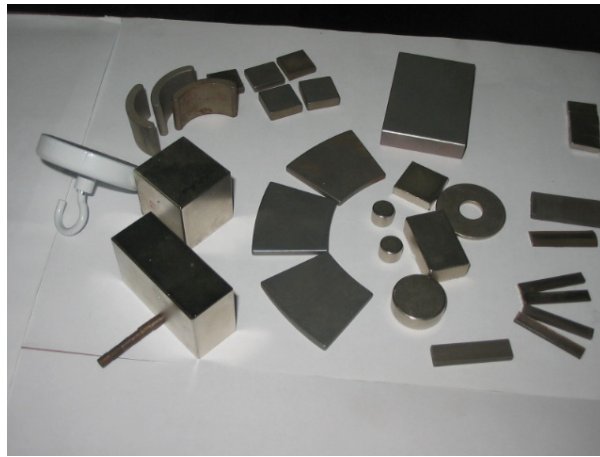
# NdFeB sintered magnets with high magnetic stability

## Magnetic characteristics:

- remanent induction,  $B_r$ : min. 10kGs;
- coercivity  $H_{cj}$ : min. 22 kOe;
- maximum energy density  $(BH)_{max}$ : min. 22 MGOe;
- maximum operating temperature: 150°C;
- temperature coefficient for  $B_r$ , in the range 20°C to 100°C: -0.1%/°C;
- temperature coefficient for  $H_{cj}$ , in the range 20°C to 100°C: -0.55%/°C;
- density: min. 7.5 g/cm<sup>3</sup>.

Obtaining method:

- by powder metallurgy.



## Sizes:

- $\Phi = 5 \dots 25$  mm;  $h = 1 \dots 10$  mm;
- $L = \text{max. } 40$  mm,  $l = \text{max. } 25$  mm,  $h = 2 \dots 10$  mm.

## Applications:

- magnetic circuits for engines, transducers, magnetic separators, pump magnetic couplings, devices for fluid magnetic treatment.



# NdFeB bonded permanent magnets

**Description:** isotropic or anisotropic permanent magnets, manufactured by powders metallurgy techniques.



Magnetic and physical properties  
of NdFeB bonded permanent magnets

Specific properties of the material	NdFeB bonded magnets	
Remanent induction $B_r$ (kGs)	4.8 - 5.8	6.0 - 6.5
Coercive force $H_{cb}$ (kOe) $H_{cl}$ (kOe)	3.9 - 4.8 >8.0	5.0 - 5.6 13 - 17
Maximum specific energy $(BH)_{max}$ (MGOe)	5.0 - 7.0	>8.0
Temperature coefficient for $B_r \alpha(B_r)$ %/°C	-0.12	-0.13
Temperature coefficient for $H_{cl} \beta(H_{cl})$ %/°C	-0.35	-0.40
Density $\rho$ (g/cm <sup>3</sup> )	4.8 - 5.0	5.8 - 6.0
Maximum operating temperature $T_{max}$ (°C)	140	150
Binder	PA-12	Epoxi
Moulding process	Injection	Compaction
Material (alloy powder)	MQP microcrystalline powder	
Anisotropy direction	Isotropic	

**Shapes, sizes:** various complex geometries.

**Applications:** electrical machines and special transducers for AC brushless micromotors.

## AlNiCo permanent magnets

**Description:** permanent magnets composed mainly of aluminum, nickel, cobalt and iron mixtures, but may also contain other elements: copper, titanium, niobium.

ICPE-CA can manufacture AlNiCo permanent magnets both in isotropic and anisotropic types. The isotropic magnets can be magnetized in any direction, while AlNiCo anisotropic magnets can be magnetized in one predefined direction and shows higher magnetic performance.



Magnetic and physical properties of AlNiCo permanent magnets

Specific properties	Anisotropic magnets	Isotropic magnets	
Remanent induction $B_r$ (T)	0.70 - 1.22	0.50 - 0.65	0.29 - 0.31
Coercive force $H_c$ (kA/m)	40 - 105	37 - 86	79 - 87
Maximum specific energy $(BH)_{max}$ (kJ/m <sup>3</sup> )	13 - 56	8 - 18	7 - 9
Temperature coefficient for $B_r$ $\alpha$ ( $B_r$ ) %/°C	-0.02	-0.02	-0.02
Temperature coefficient for $H_{cj}$ $\beta$ ( $H_{cj}$ ) %/°C	+0.03...- 0.07	+0.03...- 0.07	+0.03...- 0.07
Density $\rho$ (g/cm <sup>3</sup> )	7.1 - 7.3	7.1 - 7.3	5.5
Maximum operating temperature $T_{max}$ (°C)	500	500	80
Obtaining methods	moulded		bonded

**Shapes, sizes:** various complex geometries.

**Applications:** machines and apparatus working in difficult operating conditions (temperature, vibrations).

# Nanocomposite magnets without rare earth

## Magnetic characteristics:

- remanence induction:  $B_r > 0.6 \pm 0.1T$ ;
- coercivity:  $H_c = 75 \pm 5 \text{ kA/m}$ ;
- $(BH)_m = 5 \pm 0.5 \text{ kJ/m}^3$ ;
- maximum operating temperature:  $150^\circ\text{C}$ ;
- coefficient of variation with temperature for  $B_r$  in the range  $20^\circ\text{C} - 100^\circ\text{C}$ :  $- 0.15\%/^\circ\text{C}$ ;
- density: min.  $7.0 \text{ g/cm}^3$ .



## TECHNOLOGY FLOW

MANUFACTURE THE ALLOY → CASTING ON MELT SPINNING INSTALLATION → HEAT TREATMENT FOR RECRYSTALLIZATION → GRINDING IN PLANETARY MILL → SINTERING → MAGNETIZATION

**Sizes:** various sizes made directly by sintering or by cutting (disk or electroerosion).

**Advantages** of such materials used to produce permanent magnets are the following:

- they have low cost due to the lack of rare earths;
- there is a lower production cost compared to other types of permanent magnets based on rare earths;
- they present a high corrosion resistance due to the lack of rare earth content;
- they have a better mechanical strength (tensile strength) due to their fine nano grains structure and the existence of a relatively soft phase,  $\alpha\text{-Fe}$ .

## Applications:

- motors with hysteresis;
- magnetic circuits;
- transducers;
- magnetic separators;
- magnetic coupling pumps.

# Ecological electrical contacts based on Ag-ZnO and Ag-SnO<sub>2</sub>

## Description

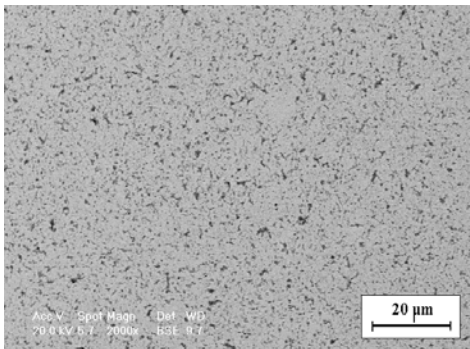
The electrical contacts are obtained by the techniques of powders metallurgy: pressing-sintering-calibration.



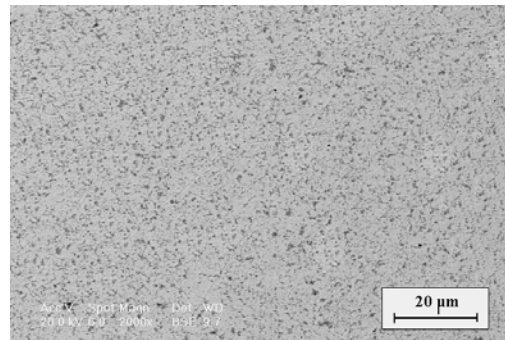
*Fixed electrical contacts*



*Moving electrical contacts*



a)



b)

*SEM images of the microstructures of the sintered electric contacts from the powder mixtures: a) Ag-ZnO, b) Ag-SnO<sub>2</sub>*

## Technical characteristics of sintered electric contacts

Physical and mechanical characteristics:

- level of compaction: min. 96 %;
- hardness in soft condition: min. 85 HV;
- resistivity: max. 2.4 μΩxcm;
- microstructure: Ag matrix with oxide fine particles uniformly distributed.

Functional characteristics:

- very good capacity for extinguishing the arc;
- high resistance to electric erosion;
- high resistance to arc welding;
- normal heating (checking according to the standard IEC 947-4-1:1992).

## Advantages

- new types of electric contact materials with superior performance in operating;
- new ecological products, without Cd;
- replacing the toxic and carcinogenic Ag-CdO electric contacts from low voltage air switching electrical apparatus.

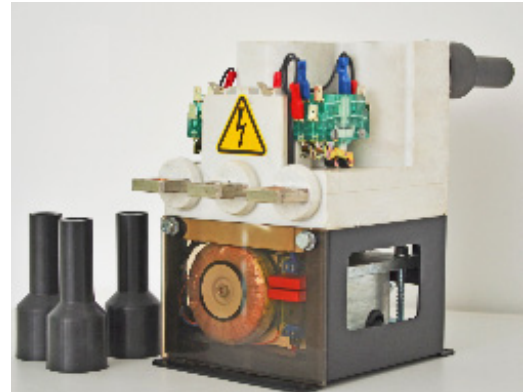
# Electrical contacts for low voltage vacuum contactors

## Description

Electrical contacts for low voltage contactors with vacuum switching and with low weight clearance who replace the classical electromagnetic contactors (with air switching) of 200A.



*Electrical contacts*



*Contactors functional model  
with vacuum switching*

## Processing method

Powder metallurgy: Spark Plasma Sintering - SPS.

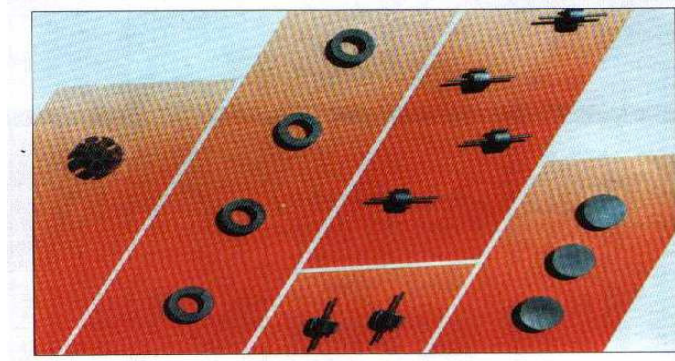
## Applications:

Low voltage vacuum contactors: 200A; 315 A; 400 A.

## Technical characteristics

- chemical composition: 35-40% Ag; 0.5-1%Co; WC - balance;
- density: 12.6 – 12.7 g/cm<sup>3</sup>;
- electrical conductivity: 21.50 - 21.75 m/Ωxmm<sup>2</sup>;
- electrical resistivity: 4.65 – 4.59 μΩxcm;
- Vickers hardness (HV<sub>5/10</sub>): 220 – 230 kgf/mm<sup>2</sup>;
- Young's modulus: 185–195 GPa;
- chopped current:  $I_{\text{mediu}} = 0.39 - 0.59 \text{ A}$ ;  
 $I_{\text{max}} = 0.75 - 1.03 \text{ A}$ ;  
standard deviation: 0.12 - 0.19.

## Nonconventional soft magnetic cores from iron-based composite materials



### Technical characteristics:

- chemical composition: Fe - organic binder 0.5 - 1 % of mass;
- density: 7.0 – 7.3 g/cm<sup>3</sup>;
- induction at 100 Oe: ~ 0.9 – 1 T;
- remanent induction: 0.07 – 0.11 T;
- intrinsically coercive field: 4 – 5 Oe;
- max. permeability: 70 – 200.

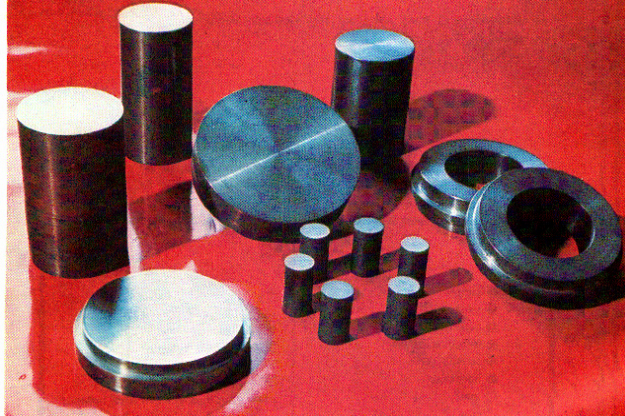
### Applications:

- in the construction of magnetic circuits of AC and DC electrical machines at frequencies of 10 Hz - 1 MHz, which can replace the classical cores made of stamping sheets.

### Environmental and socio-economical effects:

- increasing the labour productivity;
- reducing the product costs;
- very high reduction of wastes derived from stamping process of the sheets;
- recycling of copper conductors at end of life of cores;
- reducing the size, or even miniaturization of electrical motors and appliances.

## Products from sintered hard alloys



### Technical characteristics:

- chemical composition: W-Ni-Cu, W-Ni-Fe;
- W content: 87 ... 95%;
- density: 16.5 ... 18 g/cm<sup>3</sup>;
- electrical resistivity: 12 ... 14 μΩcm;
- elasticity module: 28000 ... 35000 kgf/mm<sup>2</sup>;
- tensile strength: 50 ... 80 kgf/mm<sup>2</sup>;
- hardness: 280 ... 350 HB;
- pieces weight: a few grams to several kilograms.

### Applications:

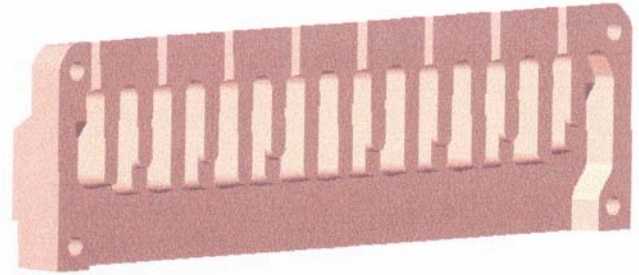
- in electrical engineering: electrical contacts and electrodes for high voltage technique;
- in medical and nuclear techniques;
- construction of equipment, instruments and tools: gyro-rotors, weights for accelerometers, counterweights, radar antennas etc.;
- in defense industry.

## Electrical spark quenching chamber CECC 63A

**Material:** zirconium ceramics CER 440

- insulation resistance:  $\geq 10^{11} \Omega\text{m}$ ;
- thermal shock strength: 150 K;
- open porosity: 0.5%.

Sizes: 163 x 47 x 156 mm.



**Applications:** *switching contactor*

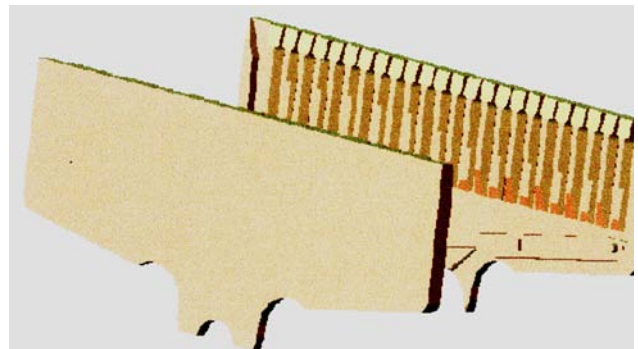
- max. operating current: 63 A;
- max. operating voltage (DC): 1200 V.

## Electrical spark quenching chamber CECC 400A

**Material:** zirconium ceramics CER 440

- insulation resistance:  $\geq 10^{11} \Omega\text{m}$ ;
- thermal shock strength: 150 K;
- open porosity: 0.5%;

Sizes: 280 x 121.5 x 10 mm



**Applications:**

*Switching contactor*

- max. operating current: 400 A;
- max. operating voltage (DC): 1200 V;

*DC switching disconnecter*

- max. operating current: 3150 A;
- max. operating voltage (DC): 1000 V.



# Ceramic interconnector for pressure aeronautical transducer

## Technical characteristics:

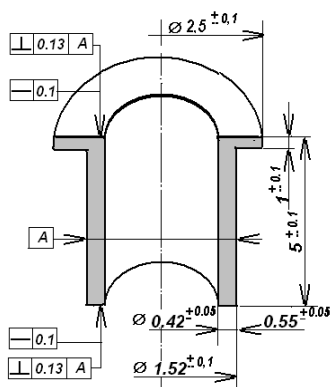
Material: cordierite – zirconia ceramic composite CZ10

Shapes:

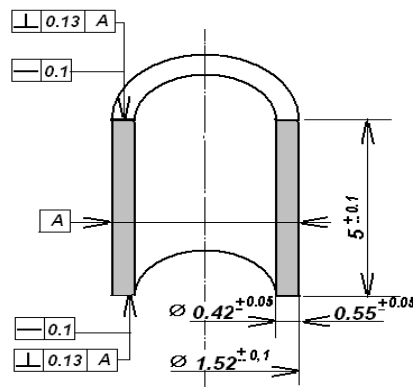
- cylindric tube with top collar;
- cylindric tube.



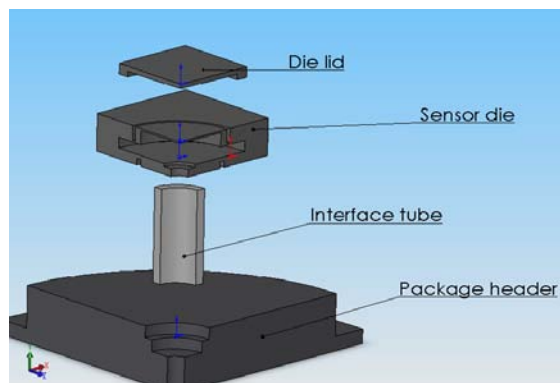
**Sizes and tolerances:** in accordance with the drawings



*Cylinder tube with top collar*

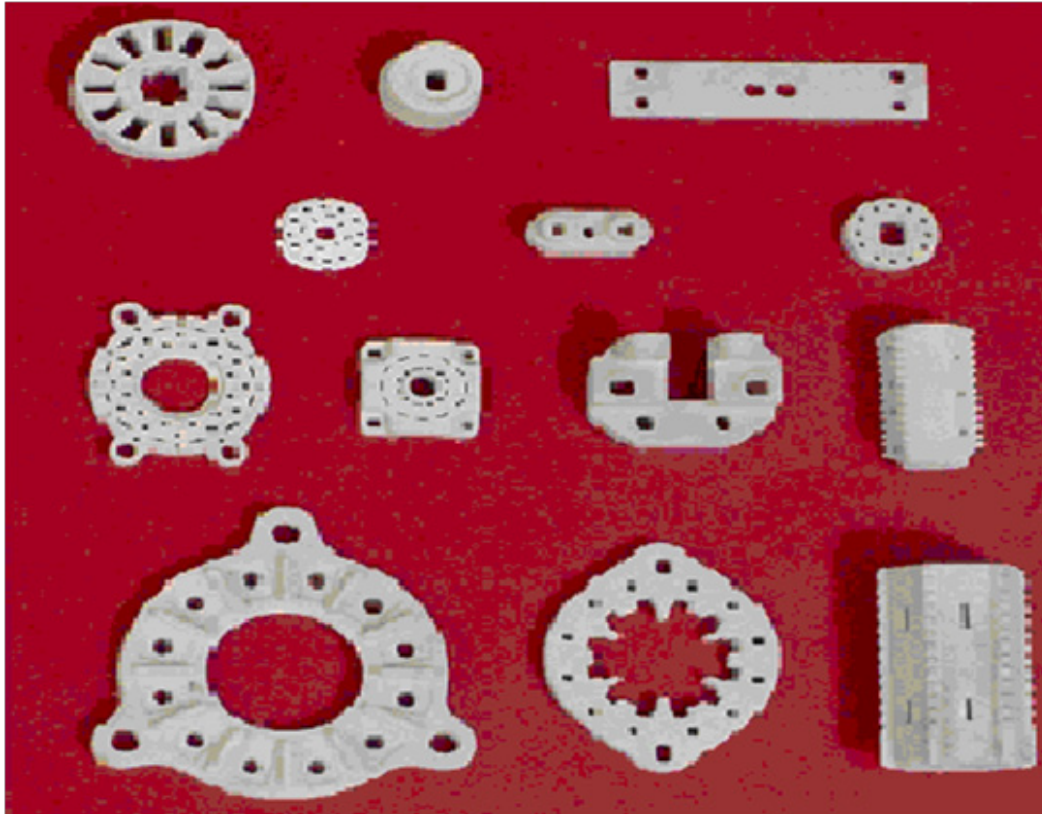


*Cylinder tube*



**Applications:** ceramic interface for pressure sensors assembly for high stability altimeter system for aircraft data computers.

## Insulating materials from steatic ceramics (support contact)



Bending strength	min. 140 MPa
Thermal shock resistance	100 K
Insulation resistance	25 kV, 1 min.
Dielectric coefficient	6, at 20°C and 50 Hz
Dielectric loss	$1.5 \times 10^{-3}$ , at 20°C and 50 Hz
Volume resistivity	$10^{11} \Omega m$ , at 20°C

### Applications

Pieces for high frequency devices, antenna insulator, socket insulator, pin insulator, support insulator for switching, coil case, insulated capsule etc.

## Ceramic supports for heating resistors



Sizes: Ø79 x 10 mm

**Material:** zirconium ceramic CER 440

- insulation resistance:  $\geq 10^{11} \Omega\text{m}$ ;
- thermal shock strength: 150 K;
- open porosity: 0.5%.

**Applications:**

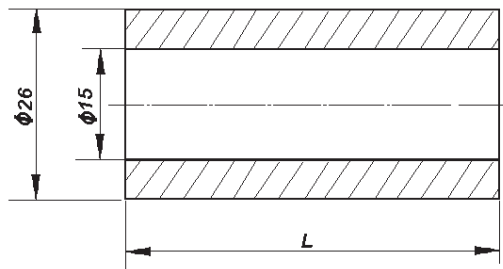
Ceramic support for heating resistors of electrical equipment.

# Distance pieces for heating element supports

## Technical characteristics:

Material: porous cordierite ceramic (aluminum and magnesium silicates), of CER 512 type

Material characteristics	
Apparent density (g/cm <sup>3</sup> )	1.3 ... 1.5
Apparent porosity (%)	38 ... 44
Average pores size (μm)	80 ... 120
Flexural strength (N/mm <sup>2</sup> )	> 15
Coefficient of linear thermal expansion (10 <sup>-6</sup> /°C)	1 ... 3
Thermal shock resistance (°C)	> 250



## Applications:

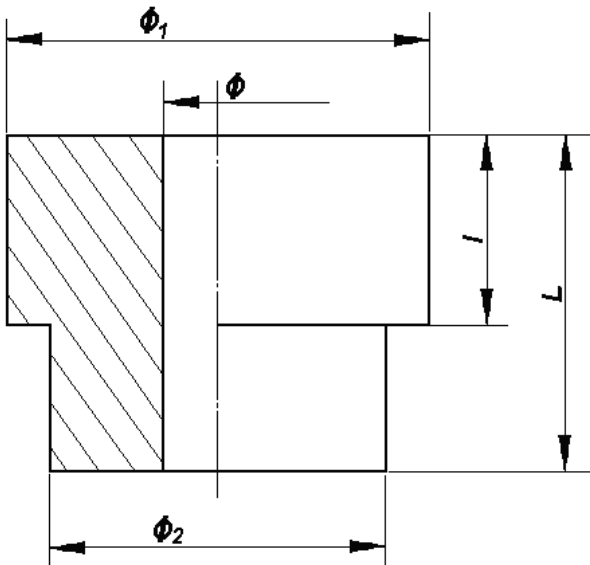
Distance pieces between heating element support of thermal treatment electric furnaces.

# Ceramic stuffing glands

## Technical characteristics:

Material: zirconica ceramic of CER 440 type

Material characteristics	
Apparent density (g/cm <sup>3</sup> )	0.5 ... 2.5
Apparent porosity (%)	2 ... 1
Flexural strength (N/mm <sup>2</sup> )	> 50
Coefficient of linear thermal expansion (10 <sup>-6</sup> /°C)	5 ... 7
Thermal shock resistance (°C)	> 120



<i>Product</i>	$\phi_1$	$\phi_2$	$\phi$	$l$	$L$
Ceramic stuffing glands terminal	39	32	14	16	32
Ceramic stuffing glands thermocouple	46	35	17	19	36

## Applications:

- insulating passing for thermocouples and heating element terminals from thermal treatment electric furnaces.

# HAP-based Ceramic Cranial Implant

## Motivation

- √ Cranial trauma and their sequelae are a major public health problem in the industrialized world.
- √ The new paradigm for medical industry: *“Implants must be fully adapted to the particular requirements of each patient”*.

## Manufacturing and characterization:

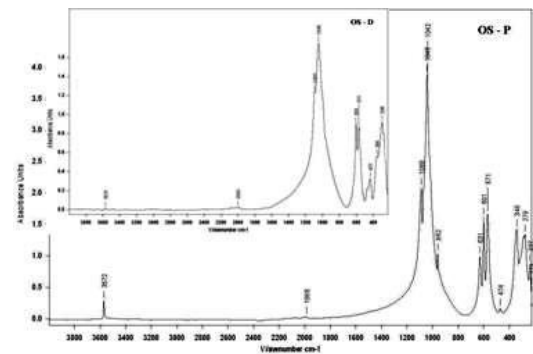
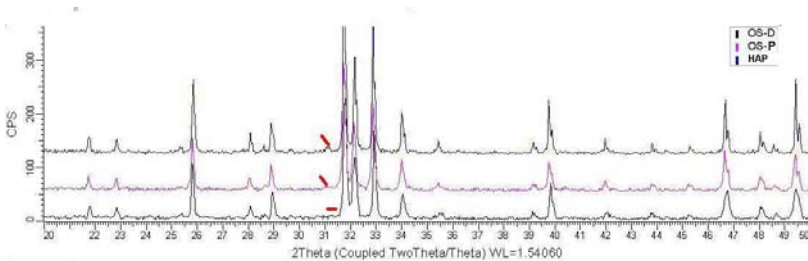
- there have been designed and developed experimental models of synthetic bone and cranial implants, using plaster molding technique of ceramic slips based on hydroxyapatite (HAP);
- the achieved experimental models: dense (OS-D) and porous (OS-P).

**Prototype**



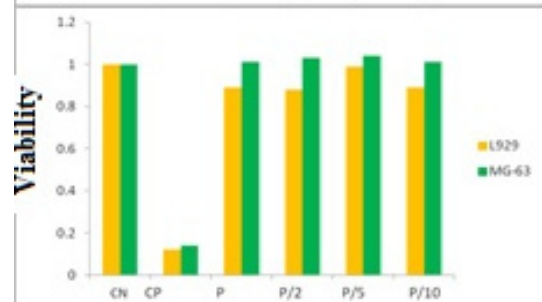
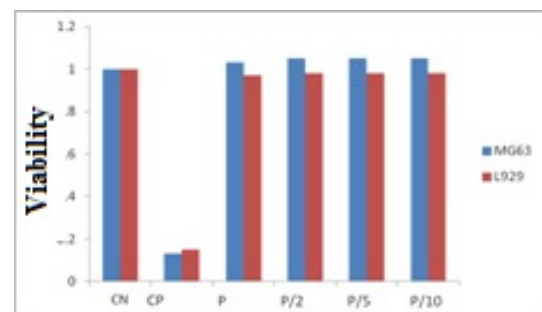
*Synthetic bone cranial implant*

Sample	Tsint [°C]	PT [%]	Strength [MPa]
OS-D	1300°C - 2h	≤ 10	~ 57
OS-P	1250°C - 2h	20 ÷ 40	min. 26



*XRD and IR patterns of experimental models*

*The viability of L929 and MG-63 cells, treated and untreated with the extract of the materials OS-D/OS-P*



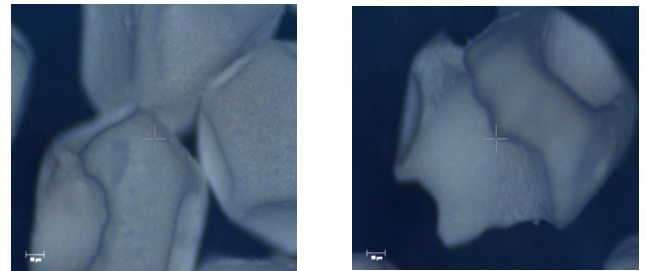
## Applications

The products are indicated for use to treat osseous defects surgically created or resulting from trauma in cranoplasty.

# Granular product based on $\beta$ -TCP for bone reconstruction

## Product characteristics:

- composition: unique phase  $\beta$ - $\text{Ca}_3(\text{PO}_4)_2$  ( $\beta$ -TCP);
- grains size: 500-1000  $\mu\text{m}$ ;
- biocompatible product with controlled porosity;
- osteoconductive: it allows the development of new biological bone gradually and develops favourable conditions for healing;
- bioresorbable: it is gradually replaced by newly formed bone / quick healing;
- it is a 100% synthetic product, no risk of disease transmission;
- it does not require a new surgery to remove the product from the affected area;
- it is radio-opaque at X-rays: it allows viewing during and after surgery;
- it is sterilized, does not require any special conditions for storage and preservation.

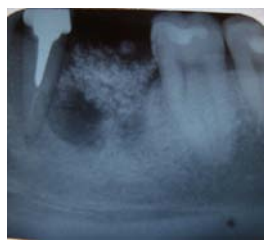


Optical images of  $\beta$ -TCP grains

## Clinical testing: *Addition of synthetic bone*



after extraction



1 day after addition  
of synthetic bone



6 months from  
addition of synthetic  
bone



12 months from  
addition of synthetic  
bone

## Applications

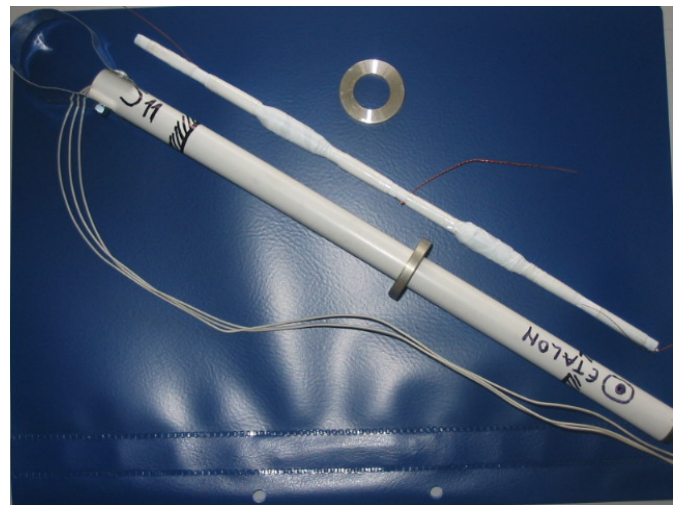
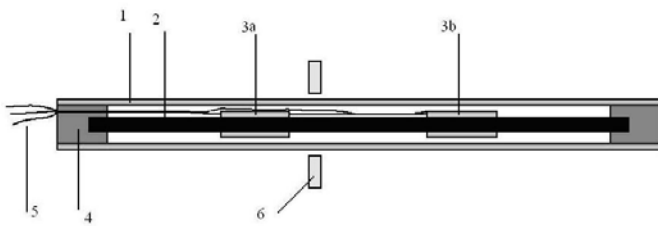
It is recommended to:

- *orthopedic surgery*:
  - in the case if fractures are not welded;
  - bone cysts;
  - bone defects resulting from tumors resection;
  - birth defects;
- *dentistry*:
  - after extraction;
  - filling the cyst type defects;
  - heightening the alveolar crest;
  - in the treatment of periodontal diseases;
- *tissue engineering*:
  - support for growth and transfer of bone cells;
  - support for therapeutically substances – with controlled release.

# Displacement sensor

## Description:

The sensor is made from a cylindrical case (1) with diameter between 8 -15 mm, length 200-300mm, from PVC type insulating material, necessary for external factors protection (humidity, casual mechanical pressure), having a ferromagnetic core (2) with a length of 180-280mm and diameter between 2 - 4 mm, on which are two windings (3a, 3b) with ratio 1:1, symmetrical distributed on core (2) and each on a distance which do not exceed 1/5 from core length (2), with two cylindrical support and sealing covers (4) fixing by adhesive process in ends of cylindrical case (1) and connections (5); on the external cylindrical case (1) slides the cursor (6), having a coaxial cylindrical geometry and its translation modifies the electrical voltage at secondary winding output.



Displacement parameters: 0.5 mm ..... 50 mm;  
Resolution: 0.2 mm;  
Sensitivity: 0.5 mm/mv.

## Electrical parameters:

F = 1k Hz;  
L = 5.2 mH;  
R = 27 Ohm;  
 $\Delta u_e = 15 \text{ mV} \dots 150 \text{ mV}$  for  $U_{ref} = 1.65 \text{ V}$ ;  
Overall size: 16x300mm; <0.5 Kg.

## Applications

- landslides;
- civil buildings: control of building stability.



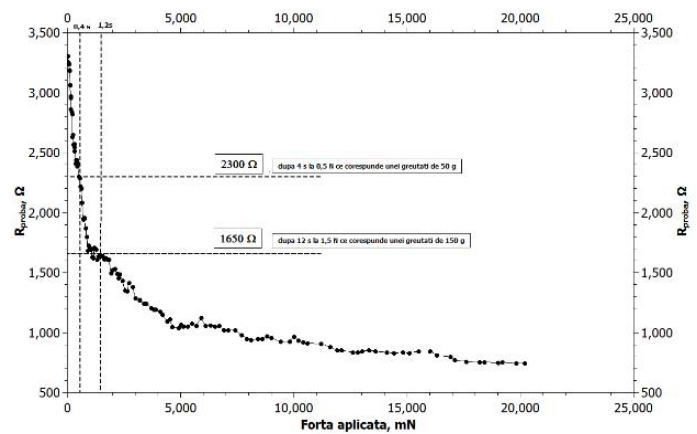
# Tactile sensors of nanocomposite materials

## Description

The sensors are made by cutting from polymer nanocomposite sheets (silicone-nanocarbon elastomer) carried out by a patented technique by INCDIE ICPE-CA. The sensors can be made with metallic contacts on one side or both sides, depending on the application requirements.

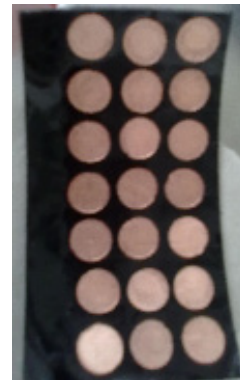
## Presentation mode

Disks with diameter of 12 mm and thickness  $\leq 2\text{mm}$  (average 1.4 mm).



Physical measures	Value
Sensitivity*, $dR/dF$ , ( $\Omega/N$ )	1500 ... 100000
Coefficient of elasticity, MPa	~ 0.3
Breaking elongation, %	~ 400%
Temperature strength, °C	-50 ... 150

\*) in the range (0 ... 1.5) N, depending on the type of nanocomposite material, respectively the nanoscale conductive phase concentration.



## Applications

- flexible keyboards with tactile element;
- tactile sensors in robotic elements;
- detection sensors - presence or alarm;
- monitoring the transport of sensitive elements etc.

## Advantages

- they are low cost;
- they can be obtained in various shapes, thickness and electrical resistences;
- there can be obtained tactile sensors with sensitivities required by specific applications by designing of nanocomposite material;
- controllable and adaptable obtaining process;
- they are waterproof and UV resistant, always flexible.



# Micromechanical parts for MEMS applications carried out by specific technologies

## Used equipment:

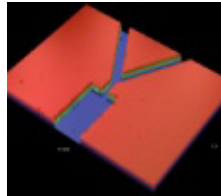
- for LIGA technology: laser lithography system, stripping tool for SU8, thermostatic oven and hotplate;
- for micro-metric processing: high-precision CNC machining center in 5 axes KERN MICRO;
- measurement and control apparatus: stereo-microscope with video camera, oscilloscope, multimeter, function generator;
- software: LabWindows/CVI, LabView, Siemens NX, Elcam.

## "Lab on a chip" type microfluidic catcher chips for cells and/or microorganism of the same type separation

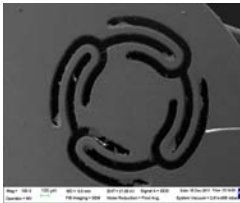
### Elements for microfluidics



Microfluidic channels in SU8,  
optical microscope x 50

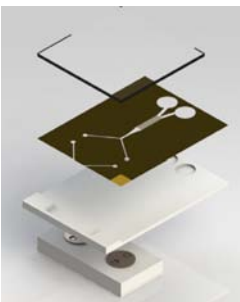


Microfluidic channels in SU8,  
Veeco microscope x 50

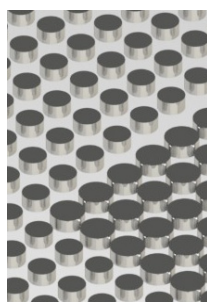


Membrane for micro-pump,  
SEM microscope x 100

### Microfluidic devices

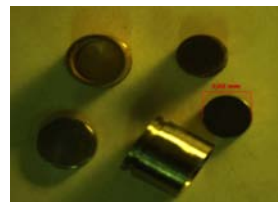


Device for erythrocytes  
separation  
(5-7) $\mu\text{m}$  of leucocytes  
(7-20) $\mu\text{m}$

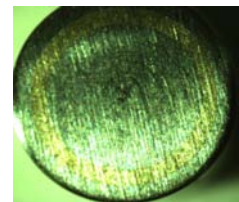


In detail - Pillars  
with vertical walls  
(diameters: 40 $\mu\text{m}$  and  
50 $\mu\text{m}$ )

## Components for dentistry

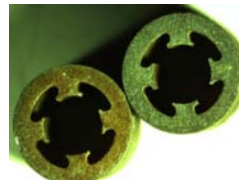


Magnetic valve case,  
optical microscope x 20,  
diameter=2.62 mm



Magnetic valve (3 pieces),  
optical microscope x20,  
outer diameter = 3 mm

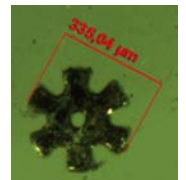
## Components for electrical micromachines and microreducers



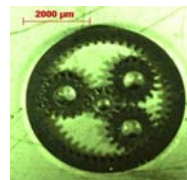
Fittings for electrical  
micromotor,  
optical microscope x20,  
D=11 mm



Sheet for electric  
microgenerator,  
optical microscope x 20,  
D=11mm



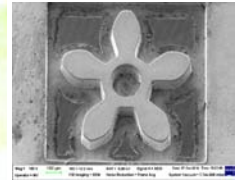
Rotor for electrostatic  
motor, 335  $\mu\text{m}$ , optical  
microscope x 50



Wheels for planetary  
microreducer,  
D=4.3 mm, m=0.08,  
optical microscope  
x 25



Port-satellites for  
planetary microreducer,  
3.4 mm,  
optical microscope x 25



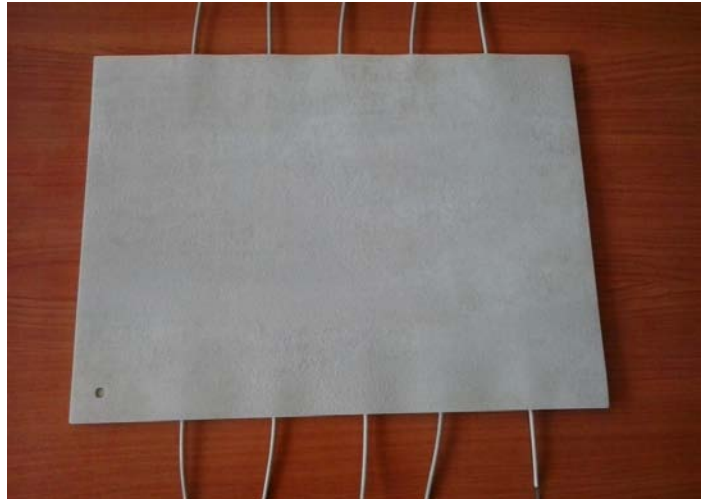
Gear,  
SEM microscope x  
198, thickness 0.2 mm  
and outer diameter  
0.8 mm

## Technical characteristics:

- lead matrix:  $\lambda_1 = 74 \mu\text{m}$ ;  $\lambda_2 = 60 \mu\text{m}$ ,
- distance between rows:  $L_1 = 74 \mu\text{m}$ ;  $L_2 = 60 \mu\text{m}$ ,
- lateral displacement:  $\lambda_{e1} = 4 \mu\text{m}$ ;  $\lambda_{e2} = 3 \mu\text{m}$ ,
- pillars diameter:  $D_1 = 50 \mu\text{m}$ ;  $D_2 = 50 \mu\text{m}$ .

# Microsensors matrixes for medical specific procedures and medical rehabilitation assessments of the legs as well as in the field of sports - Experimental models -

Force range: 0 - 1000N.  
Voltage range: 0 - 2V.



The variants of microsensors matrixes system for the assessment of legs motility:

m x n	D [mm]	L [mm]	d [mm]	l [mm]	g [mm]
3 x 3	30	30	15	15	5
5 x 2	150	150	30	30	10
5 x 0	150	10	15	0	5

### Applications:

- applications in the recovery procedures of the legs;
- medical assessments and applications in the field of sports;
- harvesting source (recovery of micro and mini energy from the environment): 0 - 1.5W.

# Supercapacitors with electrodes of polymer - CNT hybrid electroactive material

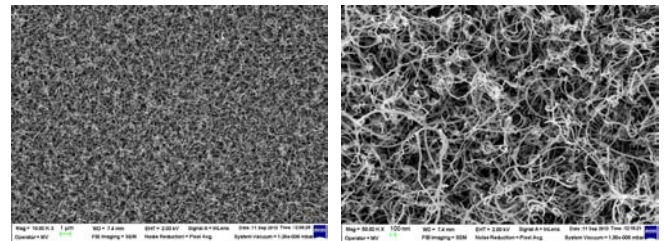
## Description

Polymer - CNT hybrid electroactive material obtained by: growth of carbon nanotubes (CNT) by CVD method, on the Ni catalyst deposited on metal substrates by magnetron sputtering, followed by deposition of polypyrrole by cyclic voltammetry.

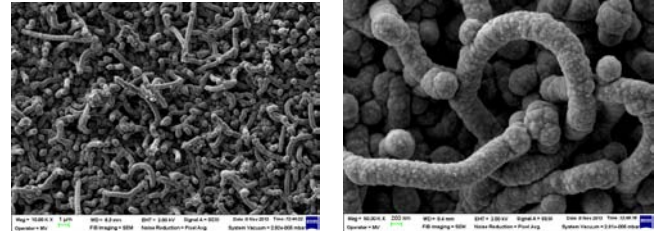
Electroactive polymer - CNT hybrid material type is used for electrodes in supercapacitors, as follows: electrodes are placed inside capsules coin-cell type, separated by a membrane of “nonwoven” from acetyl-cellulose soaked in  $H_2SO_4$  electrolyte 0.2 M. Between the capsule is positioned an insulating gasket, and the ensemble is pressed into a device for hermetic sealing of the cell.

**General specifications** of the polymer - CNT hybrid electrode material for supercapacitor:

- voltage: 0 – 1 V;
- specific capacity: 50 – 150 mF/cm<sup>2</sup>;
- total capacity: 500 – 1500 mF;
- frequency: 10 – 100 mHz;
- dissipation factor: <1.



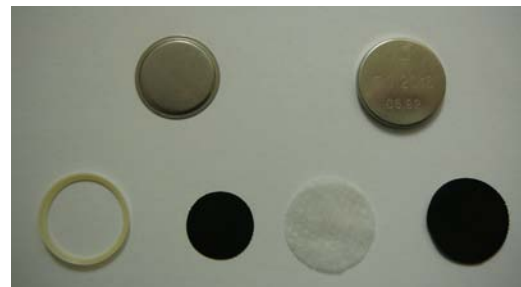
*SEM images with deposition of carbon nanotubes by CVD*



*SEM images with polypyrrole deposition by cyclic voltammetry*

## Applications:

- electronics;
- energy storage;
- electric cars.



*Supercapacitor components: capsules, gasket, electrodes, separating membrane*

# Carbon based planar heater designed for thermal management of the space vehicles



*Carbon based planar heater*

## **Description**

Planar heater based on carbon fiber heating element and KAPTON polyimide insulation system, designed for maximum safety operation & thermal transfer.

### **Characteristics:**

- active surface: 5x5" (125x125mm);
- rated electric power: 80W;
- nominal voltage: 28V (DC);
- operating temperature: -80 up to 110°C, vacuum;
- estimated endurance: over 100 000 hours at LEO irradiation level.

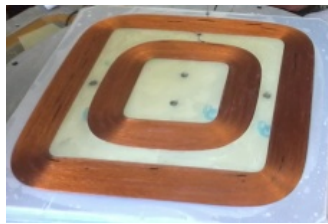
### **Advantages** over the existing solution for this application

The present planar heater relies on metallic heating elements, which consist in single metallic wire; when this wire fail, the heater is out of function. The new design consists in large number of carbon fibers or carbon fabric, which can be assimilated with a large number of elementary heaters, arranged in parallel configuration. If one of these elementary heaters fail, the others remain operational, so as the entire heater stays functional. The heater can operate even if half of total number of elementary heaters fail, maintaining the heating power by increasing the voltage supply.

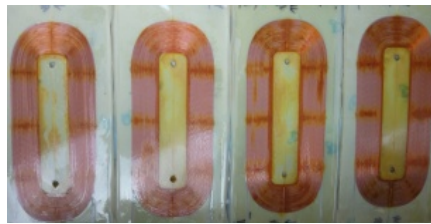
# Superconducting cylindric coils for particle accelerators



Assembly coil with cylindrical shape for particle accelerators



Dipole coil - planar shape

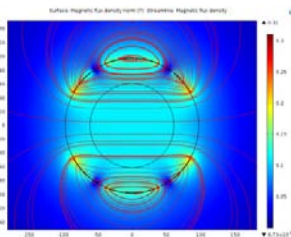


Quadrupole coil - planar shape

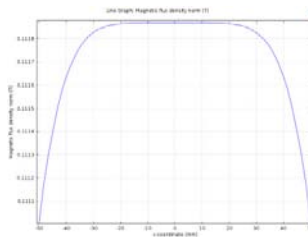


Sextupole coil - planar shape

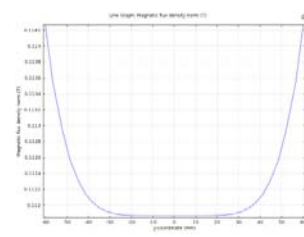
## Technical features:



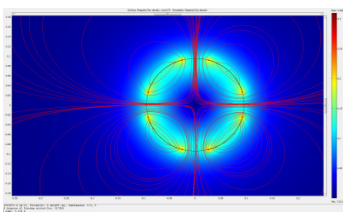
The magnetic flux density - dipole coil



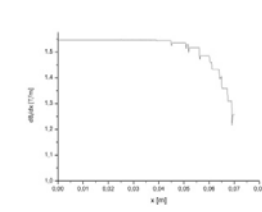
The gradient of the magnetic flux density vs. distance - dipole coil



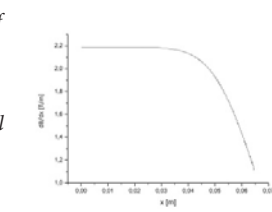
The gradient of the magnetic flux density vs. distance, on one pole - dipole coil



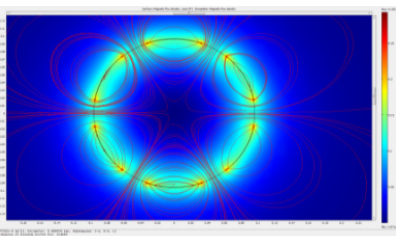
The magnetic flux density - quadrupole coil



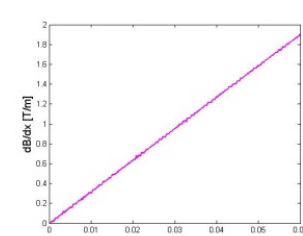
The gradient of the magnetic flux density vs. distance - quadrupole coil



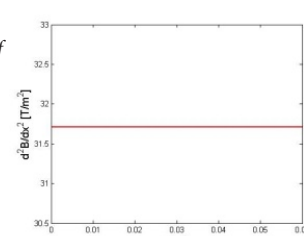
The gradient of the magnetic flux density vs. distance, on one pole - quadrupole coil



The magnetic flux density - sextupole coil



The gradient of the magnetic flux density vs. distance - sextupole coil



The gradient of the magnetic flux density vs. distance, on one pole - sextupole coil

## Applications

The technology could be applied to all kinds of superconducting corrector magnets destined to work in the structure of an superconducting particle accelerator:

- dipole superconducting electromagnets;
- superconducting electromagnets;
- sextupole electromagnets.

Overall dimensions:

a. Planar shape: 700 x 320 mm

b. Cylindrical shape:

L = 320mm

Diameter = 190 mm

Material: NbTi + Cu

Operating temperature: 2 - 5 K.







# MATERIALS

## CONTENT

Photocatalytic and biocidal nanocomposite powders and slimes	83
Colloidal silver solutions	84
Silver nanoparticles powders deposited on silver microcrystalline	85
Antibacterial and antifungal products doped with silver nanoparticles	86
Acrylic-styrene polymer doped with silver and titanium dioxide composite nanopowders	87
Silver nanoparticles	88
Hydrogel with silver nanoparticles	89
Photocatalytic solutions with self-cleaning and self-sterilizing properties for surfaces	90
Electromagnetic shields based on Cu, Fe, FeSi and AlNiCo alloys	91
Composite material of carbon fiber impregnated with epoxy resin reinforced with carbon nanotubes	92
Magnetite-saccharide - type magnetic composite for the diagnosis of malignant tumours	93
Natural antioxidants	94
Polymer composite nanofiber	95
Carbon fiber	96
Advanced composite materials of carbonic material-steel type obtained by physical-mechanical joining	97
Graphite-ceramics junctions	98
Steel/DLC planar junctions	99
Flexible electromagnetic shields	100
Soft magnetic materials based on $\text{FeNi}_3/\text{Al}_2\text{O}_3$ and $\text{FeCo}/\text{Al}_2\text{O}_3$ core-shell nanoparticles	101
Amorphous metallic glasses	102
Microporous spheres based on calcium phosphates for medical applications	103
3D ceramic structures based on calcium phosphates	104
Active elements (disks, rings) made from piezoceramic material belonging to titanate-lead zirconate system $\text{Pb}(\text{Ti,Zr})\text{O}_3$ modified with niobium (Nb)	105
Functionalized graphene with silver nanoparticles	106
Colloidal graphene solutions	107
Antimicrobial nanopowders of zinc oxide and titanium dioxide doped with silver	108
Sputtering targets and thin films made of antimicrobial nanopowders of zinc oxide and titanium dioxide doped with silver	109

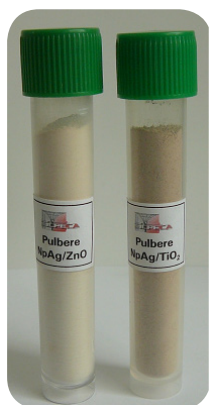


# Photocatalytic and biocidal nanocomposite powders and slimes

## Description

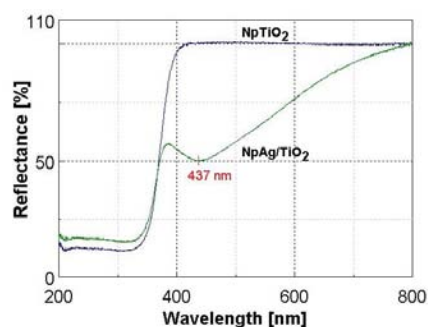
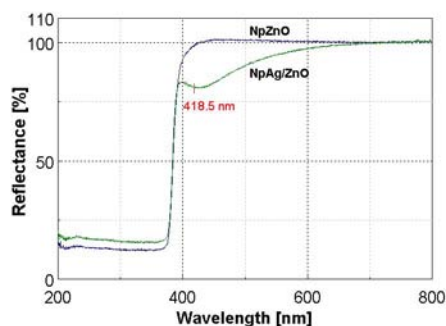
New materials in form of ultra fine powders or slimes of light to brown yellow color based on zinc oxide nanoparticles (NpZnO) or titania (NpTiO<sub>2</sub>) covered with silver nanoparticles (NpAg).

The high biocidal and self-cleaning activity is based on the synergism between antimicrobial and photocatalytic properties of the component nanoparticles.



## Technical characteristics

- composition: NpAg/ZnO, respectively NpAg/TiO<sub>2</sub> in various proportions, depending on the application field;
- high degree of finesse and dispersion of components;
- broad antibacterial and antifungal spectrum;
- photocatalytic and self-cleaning properties;
- dispersible in water;
- biocompatible and ecological.



*Reflectance spectra of composite nanopowders of NpAg/ZnO (a) and NpAg/TiO<sub>2</sub> (b)*

**Applications:** antibacterial and antifungal functionalization of some medical, cosmetic and consumer products (dyes, coatings with self-cleaning properties, textiles, leather, furs etc.)

# Colloidal silver solutions



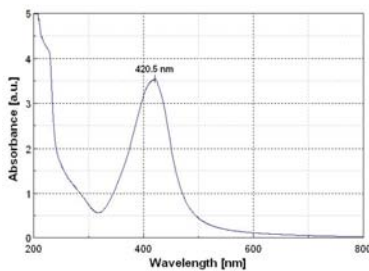
## Description

Antimicrobial ecologic product that consists of stable suspensions with different bioactive silver nanoparticles (NpAg), concentrations dispersed and stabilized in aqueous media.

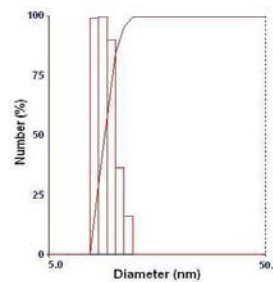
The product is obtained by a chemical, ecological and efficient procedure.

## Technical characteristics:

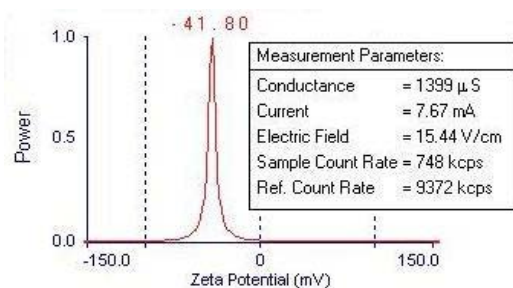
- NpAg concentration: 5...20.000 ppm;
- NpAg average diameter: 10 nm;
- high stability of solution (zeta potential: -65...-33 mV);
- high antibacterial and antifungal activity;
- regenerative properties;
- oligodynamic bioactivity.



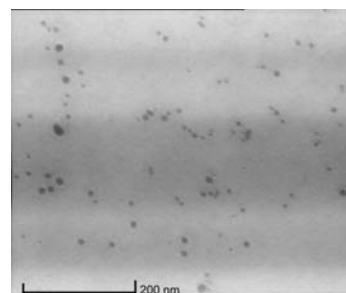
*UV-vis absorbance spectrum of a suspension of 50 ppm NpAg*



*Grain size distribution of a suspension of 50 ppm NpAg*



*Zeta potential of a suspension of 50 ppm NpAg*



*TEM image of a suspension of 50 ppm NpAg*

**Applications:** medicine, biology and production of antimicrobial functionalized consumer goods

# Silver nanoparticles powders deposited on silver microcrystalline



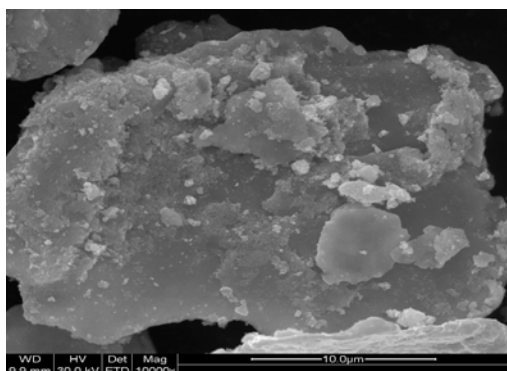
## Description

New product, ecological, with improved sintering capacity, based on silver nanoparticles (NpAg) deposited on the silver microcrystalline particles (MpAg) by an ecological and efficient chemical process.

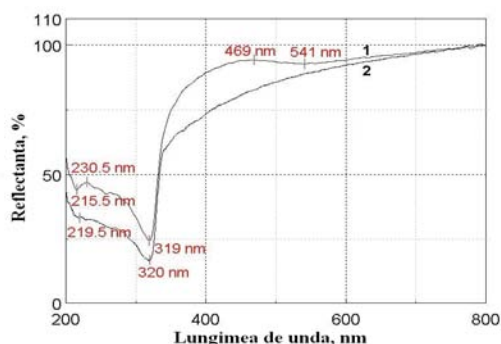
Fine powders of gray to brown color.

## Technical characteristics:

- NpAg average diameter: 50 nm;
- average Fisher diameter of NpAg/MpAg powder,  
 $D_{FSS} = 1.1 \mu\text{m}$ ;
- max. diameter of NpAg/MpAg powder: 32  $\mu\text{m}$ ;
- apparent density of NpAg/MpAg powder: 0.98g/m<sup>3</sup>;
- compaction density of NpAg/MpAg powder: 2.7g/cm<sup>3</sup>;
- sintering temperature of NpAg/MpAg powder: 200...600°C.



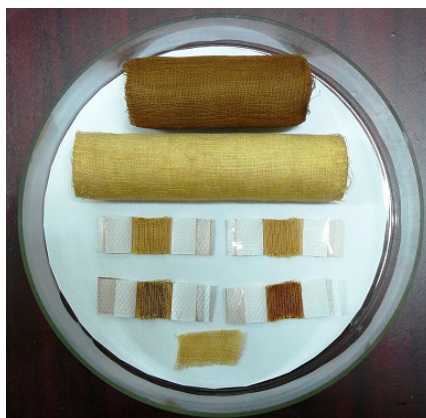
SEM micrography of NpAg/MpAg



Reflectance in UV-Vis of NpAg/MpAg(1) and MpAg(2)

**Applications:** obtaining conductive materials from electrical engineering and electronics industry (electrical contacts, conductive paste, ink etc.)

## Antibacterial and antifungal products doped with silver nanoparticles



### Description

Everyday products, for general domestic or public area, medicine and cosmetic use, obtained by antibacterial functionalization with bioactive silver nanoparticles.

The doping procedures are ecological.

### Technical characteristics

- NpAg average diameter: 10 nm;
- high antibacterial and antifungal activity;
- oligodynamic bioactivity;
- biocompatible.

**Applications:** household use, public area use, medicine and cosmetic.

# Acrylic-styrene polymer doped with silver and titanium dioxide composite nanopowders



## Description

New product, in form of viscous emulsion of light yellow to brown yellow color, based on acrylic-styrene polymer doped with silver (NpAg) and titanium dioxide (NpTiO<sub>2</sub>) composite nanopowders.

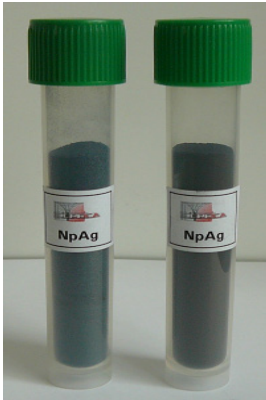
The product has a high bioactivity based on the synergism between the antimicrobial and photocatalytic properties of the component nanoparticles.

## Technical characteristics:

- NpAg/TiO<sub>2</sub> content: 20...30 %;
- high level of finesse and dispersion of components;
- broad antibacterial and antifungal spectrum;
- photocatalytic and self-cleaning properties;
- dispersible in water;
- ecological product.

**Applications:** obtaining the functionalized antibacterial, antifungal and self-cleaning coatings products, for indoor and outdoor building finishing.

# Silver nanopowders



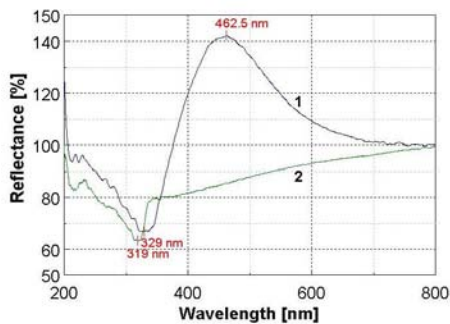
## Description

Fine powders of blue to black color, depending on the size of silver nanoparticles (NpAg). They are obtained by chemical method of reducing the Ag<sup>+</sup> ions in various media, in the presence of specific stabilizing and dispersing agents, followed by separation of the nanoparticles in the form of powders.

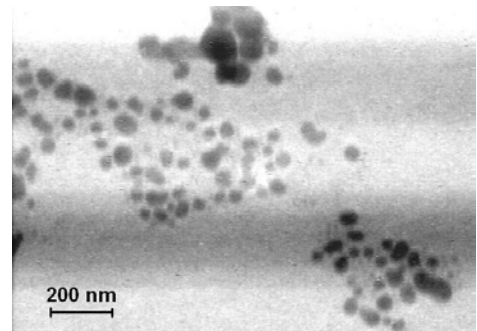
Depending on the working process, bioactive or conductive NpAg powders can be obtained.

## Technical characteristics:

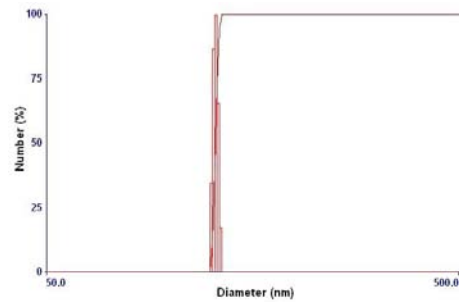
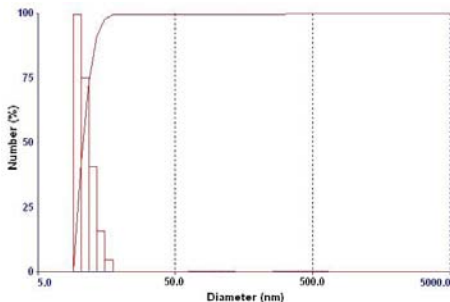
- average diameter of NpAg: 10...150 nm;
- restricted intervals of size distribution;
- particle shape: spherical.



Reflectance spectra of NpAg powder with  $d_{med} = 11.1\text{nm}$  (1) and  $d_{med} = 128.5\text{nm}$  (2)



TEM image of NpAg



Size distribution of NpAg powder with  $d_{med} = 11.1\text{ nm}$  (a) and  $d_{med} = 128.5\text{ nm}$  (b)

**Applications:** medicine, biology, electrical engineering and electronics



# Hydrogel with silver nanoparticles



## Description

Gel of light yellow to brown in form of silver nanoparticles (NpAg) bioactive, uniformly and finely dispersed in a biocompatible and biodegradable polymer matrix.

It can be easily removed with water and does not stain. The synthesis process is ecological and efficient.

## Technical characteristics:

- average diameter of NpAg: 10 nm;
- biocompatible;
- broad antibacterial and antifungal spectrum;
- regenerative action on the skin and hair follicles;
- oligodynamic bioactivity.

## Applications

Medicine and cosmetic, for the treatment of the skin problems.

# Photocatalytic solutions with self-cleaning and self-sterilizing properties for surfaces



## Description

Ag/TiO<sub>2</sub>-based photocatalytic solutions are obtained by an ecologic electrochemical process in the form of aqueous solutions, slurries or solid powders, having self-cleaning and self-sterilizing properties for the areas subject to UV and visible light.

## Advantages

- are in the form of aqueous solutions, slurries or powders and may be applied as a thin layer; thus: solutions can be applied by spraying or brushing; slurries can be embedded in ecologic water-based paint, forming adherent and transparent films on the applied surface, and powders which can be introduced into the process in finishing layer of construction materials as: roof tiles, pottery and ceramics;
- due to their self-cleaning effect, these solutions maintain clean exterior and interior surfaces of the building from the large urban areas and protect them from pollutants by COV decomposing;
- due to their antibacterial and antifungal effect, these solutions help to environmental sterilizing, especially in public companies such as schools, hospitals etc.;
- because of decreasing the maintenance costs for cleaning and hygiene, the solutions presents substantial economic advantages and help to environmental protection.

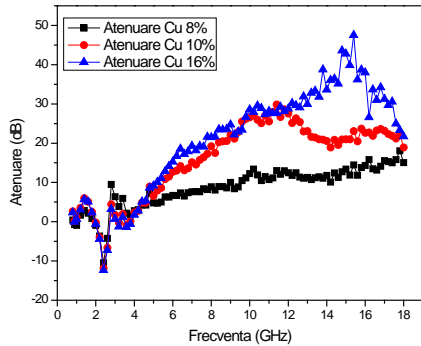
## Technical characteristics

1. Concentration in TiO<sub>2</sub>: 5 - 10g/l și Ag: 0.3 - 0.8% (versus TiO<sub>2</sub> );
2. Average diameters of particles: TiO<sub>2</sub>: 15...20 nm, Ag:5...20nm;
3. High absorption including visible area by reaching values of 475 - 525 nm;
4. High photocatalytic activity of degradation for solid or gaseous organic and inorganic pollutants;
5. Broad antibacterial and antifungal spectrum.

## Applications

- outdoor and indoor construction materials, including ceramic tiles, roof tiles, concrete, cement, washable and ecologic paints and dyes (water based);
- aluminium, galvanized steel and other metallic sublayers;
- plastics, tents, glass, textiles, leather etc.

# Electromagnetic shields based on Cu, Fe, FeSi and AlNiCo alloys



## Magnetic characteristics

Attenuation of electromagnetic shields with Cu concentration of 8, 10, 16%.

## Electromagnetic shields of Cu, Fe, FeSi and AlNiCo



Electromagnetic shields with Cu concentration of 4%, 8%, 16%



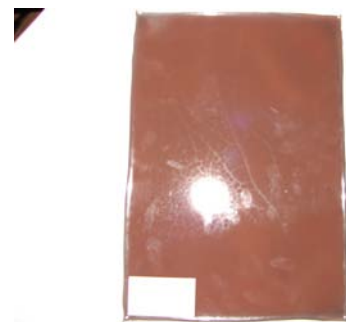
Electromagnetic shields with Fe grain size of 0.040 - 0.050  $\mu\text{m}$ , 0.050 - 0.080  $\mu\text{m}$  at concentration of 4%, 10%, 16%



Electromagnetic shields with FeSi grain size of 0.036 - 0.040  $\mu\text{m}$ , 0.040 - 0.050  $\mu\text{m}$  at concentration of 10%, 16%



Electromagnetic shields with FeSi grain size of 0.040 - 0.050  $\mu\text{m}$  at concentration of 10%



Electromagnetic shields with Cu at concentration of 4%

**Advantages** of such electromagnetic shields designed to be used for the absorption of electromagnetic radiations emitted by various devices such as: mobile phones, microwaves, GSM antennas can be:

- absorption of electromagnetic radiation at Cu screens up to 45 dB (for the 16% concentration);
- they are trying to create the screens for protection against magnetic radiations;
- optimization of working conditions in areas with electromagnetic radiations higher than average, leading to increase the level of employment and to reduce the medical "stress";
- to be created a competence center in the field of *ELECTROMAGNETIC ECOLOGY*.

# Composite material of carbon fiber impregnated with epoxy resin reinforced with carbon nanotubes

## Description

Double-reinforced composite material obtained by impregnating of carbon textile with epoxy resin reinforced with carbon nanotubes.



*FC composite impregnated with epoxy resin reinforced with carbon nanotubes*

## Characteristics

- specific weight: 1.2-1.6 kg/dm<sup>3</sup> (aluminium – 2.7 kg/dm<sup>3</sup>);
- mechanical strength: 100 – 200 MPa (steel – 150MPa);
- elasticity modulus: 20 – 50 GPa (steel – 27GPa).

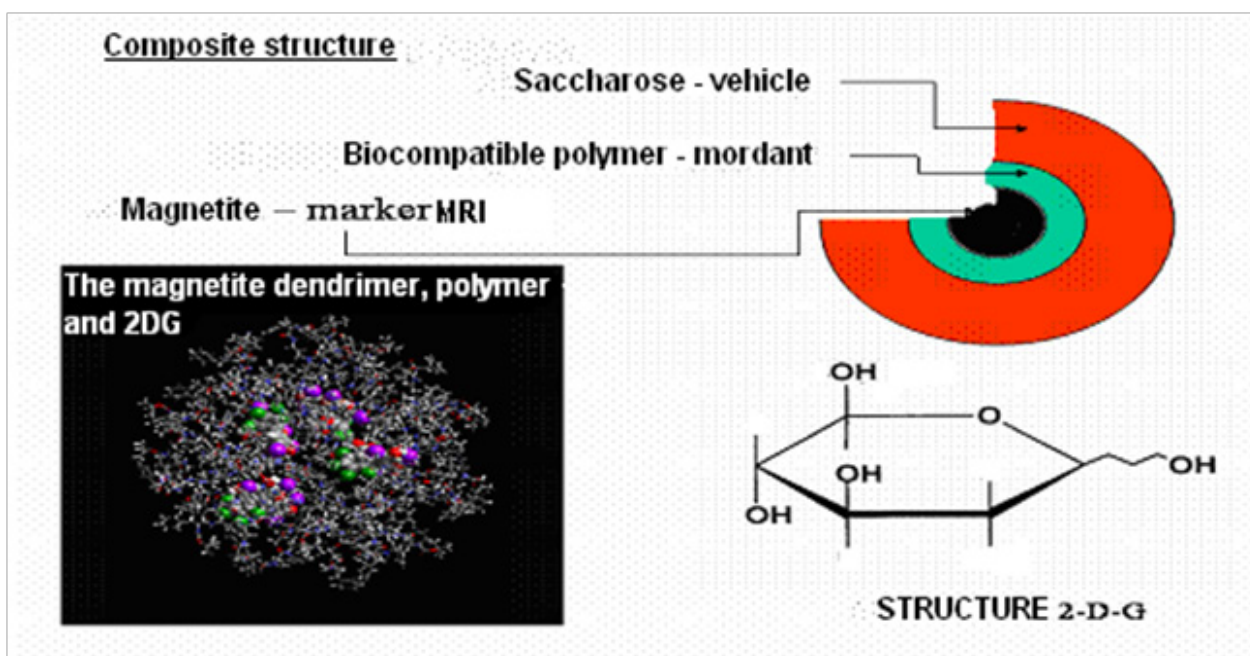
## Applications

- broad applicability for aircrafts and automotive components;
- possibility to extend the applications in the field of electromagnetic shielding, sports and fishing equipment.

## Advantages

- high mechanical strength compared to classical solutions obtained by impregnating of textile with epoxy resin, or fiberglass with direct effect on the maintenance costs;
- high rigidity and adjusting the structural properties with maintaining a minimum weight, by allowing the alignment of the textile folds in different directions;
- improvement the thermal and thermo-mechanical properties by increasing the temperature of transition the resin to glass due to effect of reinforcing with carbon nanotubes;
- technological advantages: the possibility of obtaining the smooth surfaces (without rivets), easy maintenance and repair;
- high ratio of performance / costs;
- reducing the weight of aircrafts body, which indirectly act on reducing the CO<sub>2</sub>.

# Magnetite-saccharide - type magnetic composite for the diagnosis of malignant tumours (BIOMAG)



## Description

BIOMAG is a magnetic composite: magnetite-saccharide covered with biocompatible polymer with particle sizes between 8 and 30 nm.

This product is used to increase the signal in the diagnosis of the malignant tumors using techniques of magnetic resonance imaging; it is a national and international novelty.

## Technical features:

- nanoparticles dimensions : 8 ... 30 nm;
- formation of magnetite-saccharide - type magnetic composite: IR spectrum must show characteristic bands for the following frequencies:
  - the 2-deoxy-d-glucose saccharide ring:  $\nu_{\text{saccharide}}$  in the range (800 – 900)  $\text{cm}^{-1}$ ;
  - the  $\nu_{\text{C-OH}}$  vibrations at the value 1100  $\text{cm}^{-1}$ ;
  - the  $\nu_{\text{C-C}}$  vibrations in the range (1000, 1100)  $\text{cm}^{-1}$ ;
  - the  $\nu_{\text{C-H}}$  vibrations in the range (1000, 1120)  $\text{cm}^{-1}$ ;
  - the  $\nu_{\text{OH}}$  vibrations in the range (1300, 1400)  $\text{cm}^{-1}$ ;
  - the  $\nu_{\text{HOH}}$  vibrations in the range (1400-1500)  $\text{cm}^{-1}$ ;
- coercive field: >100 Oe;
- saturation magnetisation: > 250 emu.

**Applications:** biomedical.

# Natural antioxidants

## Description

The natural antioxidants compounds obtained from plants are very efficient due to their activity in improvement of the thermal resistance and radiation action when they are added into the plastic packaging materials. Their beneficial effect on the human body is an intrinsic quality in relation with people health in spite of synthesis compounds which are used today and which are toxic for the biological systems.

Table 1. Isolated antioxidants from lamiaceae plants

Species	Compounds
Salvia	carnosic acid, carnosol, rosmanol, rosmarinic acid
Rosemary	carnosic acid, carnosol, rosmanol, rosmarinic acid
Thymus vulgaris	carnosol, rosmarinic acid, carvacrol, thymol
Oregano	phenolic acids derivatives, flavonoids, tocopherols

Table 2. Main characteristics of thermal stabilization process of some natural extracts

Extract	Witness point	Salvia	Rosemary	Thymus vulgaris	Oregano
Induction time (min.)	5	275	179	100	70
Oxidation speed (ur/g min.)	982	360	517	380	769

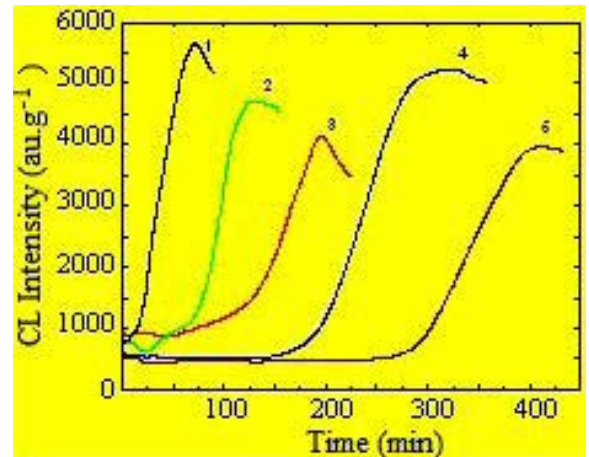


Fig. 1. CL spectrum (air, 150°C) at thermal degradation of paraffin  
(1) simple sample; (2) oregano; (3) thymus vulgaris; (4) rosemary; (5) salvia



## Potential users:

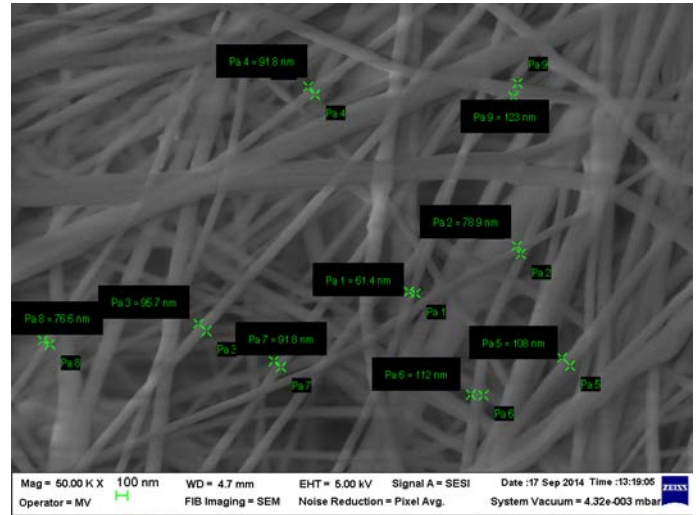
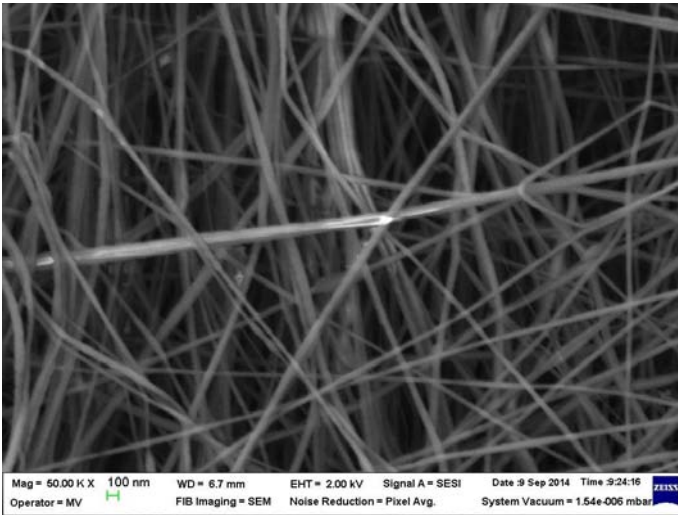
- manufacturer of packaging for agriculture and food industry;
- companies of vegetables conservation;
- small enterprises for preparing food products;
- agricultural associations and small enterprises for the conservation of cooking products, which are preserved on long time.

## Applications:

- manufacture of solar sheets;
- manufacture of bags for transportation and storage of seeds;
- manufacture of cooking oils, margarines, food essences, tinned foods;
- preparation of culinary products;
- cosmetic products.

# Polymer composite nanofiber

**Description:** Polymer composite nanofibers obtained by electrospinning method, using polymeric solutions of PAN, PAN/CNT, PAN/ZnO.



## Main technical characteristics:

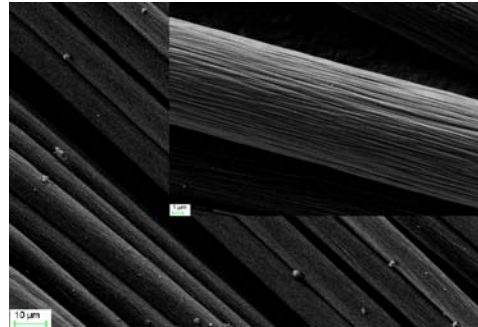
- fiber diameter: 50 – 150 nm;
- tensile strength: 2 – 10 MPa;
- elongation: 6 – 10%;
- electromagnetic attenuation: 2 – 4 dB in the frequency range of 12 - 14 GHz;
- UV absorption: min. 60%.

## Applications:

- filter medium in gas or liquid for fine particles;
- high temperature catalyst support;
- thermal management in aircraft or spacecraft;
- miniaturized semiconductor devices or electronic devices;
- rechargeable batteries.

# Carbon fiber

**Description:** The carbon fiber is obtained from PAN (polyacrylonitrile) precursors through oxidation, carbonizing/graphitization, by discontinuous process.



## Main technical characteristics:

- resistance to thermal stresses, coefficient of thermal expansion on the axis direction in the range:  $-0.4 \dots -1.0 \times 10^{-6}/K$ ;
- resistivity: max.  $10^{-3}\Omega\text{cm}$ ;
- tensile strength: min. 1 GPa;
- tensile modulus: min. 200 GPa;
- resistance to aggressive chemical media.

## Applications:

- replacing the classical electrical metallic conductors in applications which require miniaturization and low weights;
- passive anodes for reinforced concrete structures;
- replacing the classical conductors used on houses cabling;
- replacing the classical conductors used on electricity transmission lines etc.

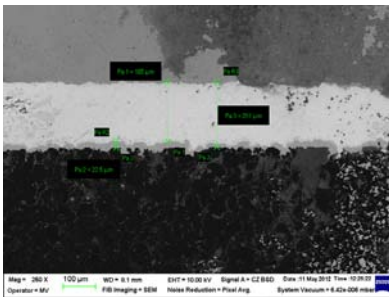


# Advanced composite materials of carbonic material - steel type obtained by physical-mechanical joining

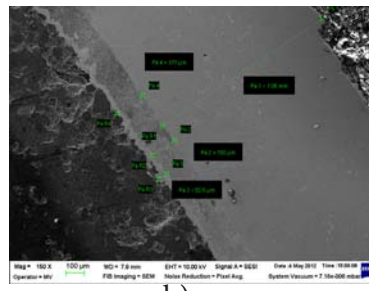
## Description:

The carbonic material-steel planar junctions are achieved by:

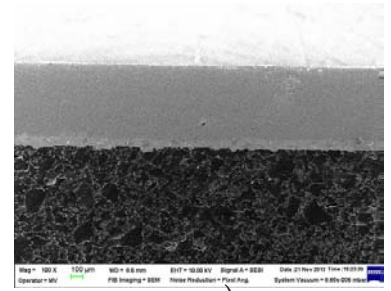
- a) joining with Sn alloy by brazing under pressure, with junction applications at working temperatures <220°C;
- b) combustion joining with Zn or Ni alloy by spark plasma sintering (SPS), with junction applications at working temperatures < 400°C, respectively < 900°C.



a)



b)



c)

SEM image - interface view:

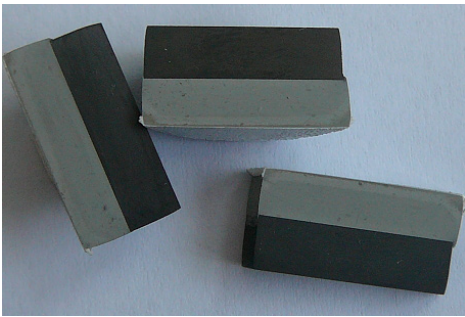
a) sample obtained by brazing with Sn alloy, sample obtained by SPS with an alloy based on: b) Zn and c) Ni

Technical characteristics	Brazing with Sn alloy	Combustion joining with an alloy based on	
		Zn	Ni
Three point flexural strength of the carbonic material from the developed junction, $R_m$ , MPa	98 - 100	81 - 117	55 - 102
Vickers microhardness HV 0.3/15 of the metallic material from the joining area, $kgf/mm^2$	15 - 17	26 - 65	250 - 372
Young's modulus of the metallic material from the joining area, GPa	52 - 59	13 - 61	104 - 158

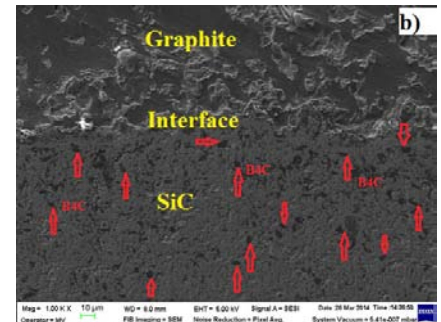
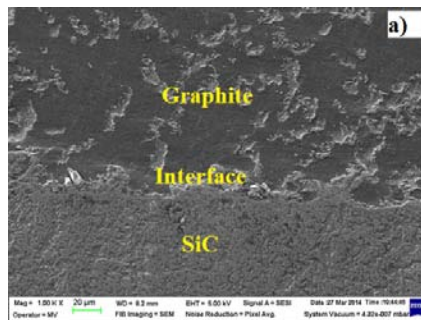
Technical characteristics of the support materials	Carbonic material	Steel
Three point flexural strength, $R_m$ , MPa	14 - 27	420 - 800
Vickers microhardness HV 0.3/15, $kgf/mm^2$	10 - 45	90 - 280
Young's modulus, GPa	4 - 12	40 - 220

**Applications:** electrodes for sensors and accumulators, brush-collector electrical contacts, radiators, components of power devices etc. in electrical engineering, automotive and aeronautics industry.

# Graphite-ceramics junctions



Macrographic appearance of graphite-ceramics junctions



SEM images of cross-section junctions:  
(a) C/SiC and (b) C/SiC+5% B<sub>4</sub>C/SiC

## Synthetic description

C/SiC and C/SiC+B<sub>4</sub>C/SiC junctions without any defects and pores obtained by a diffusion bonding mechanism.

## Technical characteristics

- Components characteristics:
  - SiC (α) powders: CTE=4.0 x 10<sup>-6</sup>/°C;
  - B<sub>4</sub>C powders: CTE=5.0 x 10<sup>-6</sup>/°C;
  - graphite compact disks of IBIDEN ET-10 type;
    - apparent density: ρ = 1.75 g/cm<sup>3</sup>;
    - CTE= 3.8 x 10<sup>-6</sup>/°C;
    - R<sub>m</sub> = 34.3 MPa, E= 10.8 GPa;
    - Shore hardness =50.
- C/SiC+5%B<sub>4</sub>C/SiC junctions characteristics:
  - HV = 11-14 GPa;
  - E= 180-197 GPa.

## Processing method

Powder Metallurgy: Spark Plasma Sintering- SPS

Technological parameters:

- vacuum: 6000 Pa;
- sintering temperature: 1900 ± 10°C;
- dwell time: 3 - 5 min.;
- pressing pressure: 30 MPa;
- heating/cooling temperature: 100°C/min.

## Applications

Components for high temperature applications.

## Steel-DLC planar junctions

**Description:** The steel – DLC planar junctions were achieved by physical deposition methods – Vacuum Thermo-Ionic Arc Method (VTA). The junctions are as C/DLC thin films and Cr/Cr+C/C(DLC) multilayer films deposited on steel support at different working voltage ( $U_a$ ) in the range of 1.2-3 kV.



a



b



c

Planar junctions: a) Steel – DLC, b) Steel - Cr- DLC, c) Steel -(Cr+DLC) - DLC

### Technical characteristics

Sample / DLC type	Voltage speedup [kV]	Coating thickness [nm]	Rugosity Ra [ $\mu\text{m}$ ]	Average friction coefficient	Wear speed $\times 10^5$ [ $\text{mm}^3/\text{Nm}$ ]	Average Vickers hardness [ $\text{kgf}/\text{mm}^2$ ]	Average Young modulus [GPa]
OL -DLC/ amorphous C sp <sup>2</sup>	1.5	200	0.10-0.14	0.156-0.237	0.76-6.06	4450 $\pm$ 851	566 $\pm$ 158
OL - DLC/ amorphous C sp <sup>2</sup>	2.2	260	0.06-0.10	0.158-0.264	1.78-9.72	763 $\pm$ 239	90 $\pm$ 13
OL-Cr-DLC/ amorphous C sp <sup>2</sup>	2.2	200-900	0.08-0.18	0.117-0.283	1.75-68.84	554 $\pm$ 134	28 $\pm$ 8
OL – (Cr+DLC)- DLC/amorphous C sp <sup>2</sup>	3	(38+362) -900	0.08-0.18	0.280-0.343	1.65-67.4	419 $\pm$ 68	25 $\pm$ 6
OL-(Cr+DLC)- DLC/amorphous C sp <sup>2</sup>	1.5	(38+362) -900	0.08-0.16	0.117-0.272	1.62-29.14	1193 $\pm$ 481	96 $\pm$ 40

**Applications:** These junctions are suitable for anti-friction and anti-wear applications, such as: cutting tools, molds and devices used in metallurgy and mechanics industry, different components used in automotive industry: pistons, camshafts.

### Environmental impact:

There is not any negative environmental impact.  
Sustainable resource management.

### Economic effects:

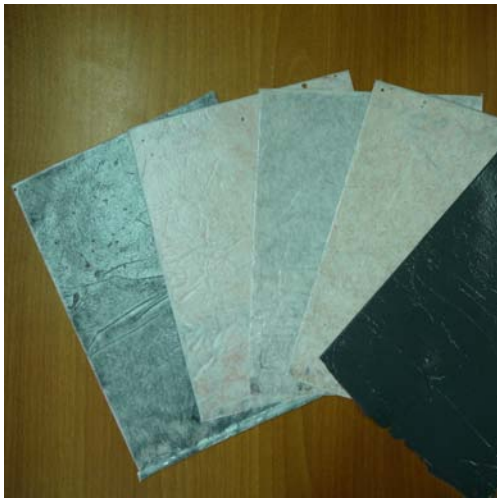
- increasing the functioning life of the fixed and mobile components;
- reducing the number of revisions to replace the used components;
- decreasing the supply costs;
- reducing the maintenance costs.

# Flexible electromagnetic shields

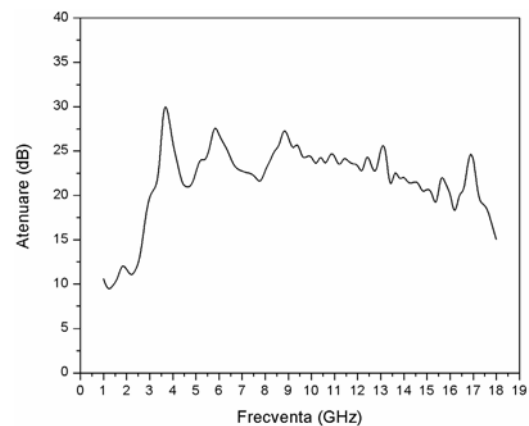
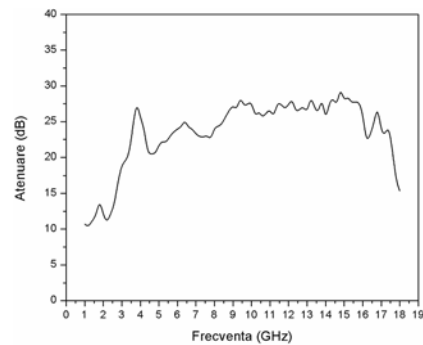
INCDIE ICPE-CA Bucharest, Romania, manufactures some composite materials obtained by embedding of copper and soft magnetic alloys based glass-coated microwires in an elastomeric matrix, with applications as electromagnetic shields.

## Physical and functional characteristics:

- density: 0.98 – 1.1 g/cm<sup>3</sup>;
- attenuation of electromagnetic radiation: 25–30 dB for the frequency range: 3 – 16 GHz and 1.0 mm thickness.



*Flexible electromagnetic shields*



*Attenuation vs. frequency for shields from composites with various glass-coated microwires mixtures*

## Advantages:

- high flexibility due to the elastomeric matrix;
- good adherence on various surfaces.

**Applications:** in aeronautics, for devices and equipment working in the super high frequency range: radar altimeters (4.3 GHz), microwave landing systems (5.0 – 5.1 GHz), Doppler navigation systems (8.8 GHz), weather radars (9.375 GHz).

# Soft magnetic materials based on $\text{FeNi}_3/\text{Al}_2\text{O}_3$ and $\text{FeCo}/\text{Al}_2\text{O}_3$ core-shell nanoparticles

INC DIE ICPE-CA Bucharest, Romania, manufactures soft magnetic materials based on  $\text{FeNi}_3/\text{Al}_2\text{O}_3$  and  $\text{FeCo}/\text{Al}_2\text{O}_3$  core-shell nanoparticles, prepared by chemical synthesis techniques.



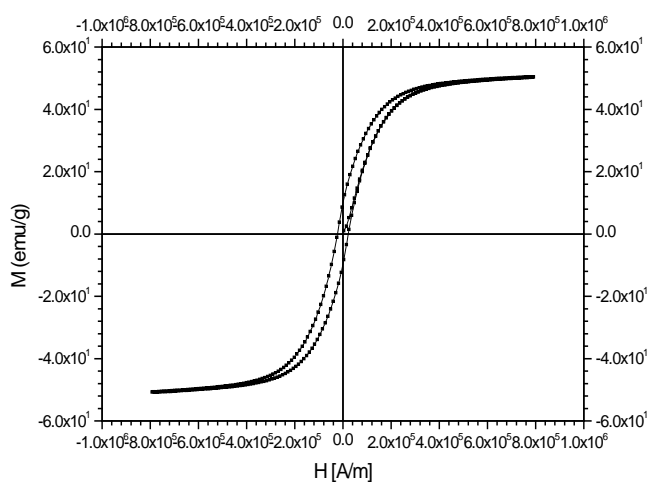
*$\text{FeNi}_3/\text{Al}_2\text{O}_3$  and  $\text{FeCo}/\text{Al}_2\text{O}_3$  core-shell nanopowders*

## Physical characteristics

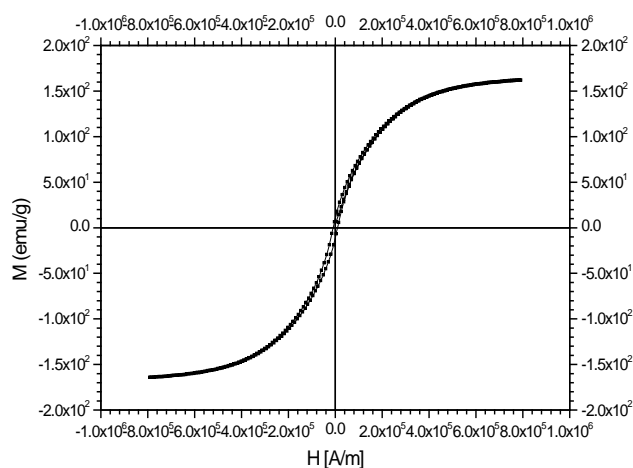
	$\text{FeNi}_3/\text{Al}_2\text{O}_3$	$\text{FeCo}/\text{Al}_2\text{O}_3$
Specific remanent magnetisation, $M_r$ (emu/g)	8 – 10.5	9.70 – 14.50
Specific saturation magnetisation, $M_s$ (emu/g)	44 – 50	100 – 160
Coercivity, $H_c$ (kA/m)	25.50	14.30
Resistivity, $\rho$ ( $\Omega \cdot \text{m}$ )	0.02 - 0.073	5.50 - 17.50

## Advantages:

- increasing the saturation magnetisation due to the FeCo nanoparticles;
- improvement the electrical resistivity due to the presence of  $\text{Al}_2\text{O}_3$  layer;
- decreasing the magnetic losses;
- improvement the mechanical strength for the bulk sized components, compared with the Fe-Si alloys available today, used as metallic punched sheets for the making of the magnetic cores.



a



b

*Hysteresis loops of soft magnetic materials based on  $\text{FeNi}_3/\text{Al}_2\text{O}_3$  a) and  $\text{FeCo}/\text{Al}_2\text{O}_3$  b) core-shell nanoparticles*

**Applications:** these soft magnetic nanomaterials can be used in high speed electrical machines for producing of sintered rotoric cores.

# Amorphous metallic glasses

## Description:

The Fe-based amorphous metallic glasses were made by two rapid solidification methods: melting in vacuum induction furnace and copper mould casting and spin melting on copper rotating drum. Amorphous metallic glasses are in the form of sheets with 50x50x 3/1.5 mm sizes and 3 categories of strips with thickness of about 0.5µm.



a

b

*Amorphous metallic glasses: a) Fe-based amorphous sheets - copper mould casting, b) Fe-based amorphous strips - spin melting on copper rotating drum*

## Technical characteristics

Characteristics	UM	
Amorphous-crystalline microstructure		Mixed ~(50:50)
Vickers hardness, HV <sub>2</sub>		>350
Strength in compression test at F <sub>max</sub> of 20kN, Rm	MPa	>1200
Three point flexural strength, Rm	MPa	1492 (F=0.9KN)
Yield strength in bending test, Rp <sub>0.2</sub>	MPa	950
Young's modulus, E	GPa	190

**Applications:** Structural components and complex geometry components used in automotive and aerospace, drill bits, gas storage tanks and canisters for liquefied natural gas storage.

## Economic effects:

- increasing the functioning life of the fixed and mobile components;
- reducing the number of revisions to replace the used components;
- decreasing the supply costs;
- reducing the maintenance costs in automotive industry – decreasing the vehicles weight, reducing the fuel consumption, reducing the amount of pollutants.

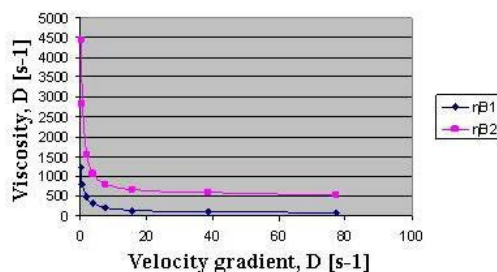
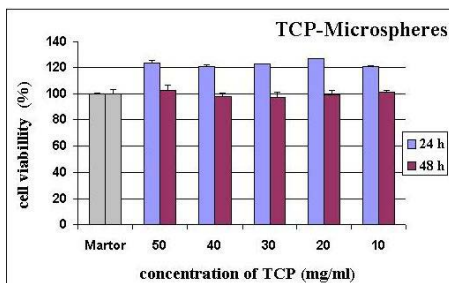
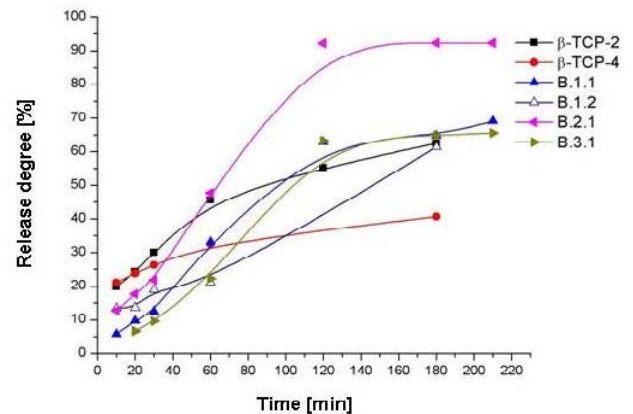
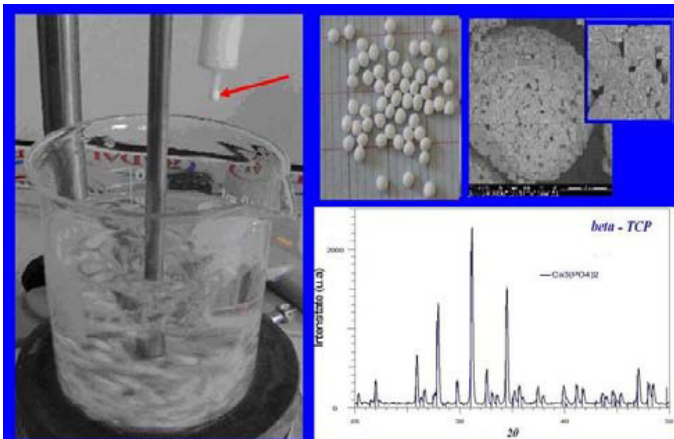
## Environmental impact:

There is not any negative impact on the environment.  
Sustainable resource management.

# Microporous spheres based on calcium phosphates for medical applications

## Characteristics

- **material:** calcium phosphates ( $\beta$ -TCP; HAP; HAP/TCP);
- **technique:** immiscible liquids/ionotropic gelation – “extrusion” ceramic microspheres in aqueous solution of gelling (crosslinking - sol.  $\text{CaCl}_2$ );
- **products:** ceramic microspheres with  $\text{Ø} = 500 \div 2,500 \mu\text{m}$ .



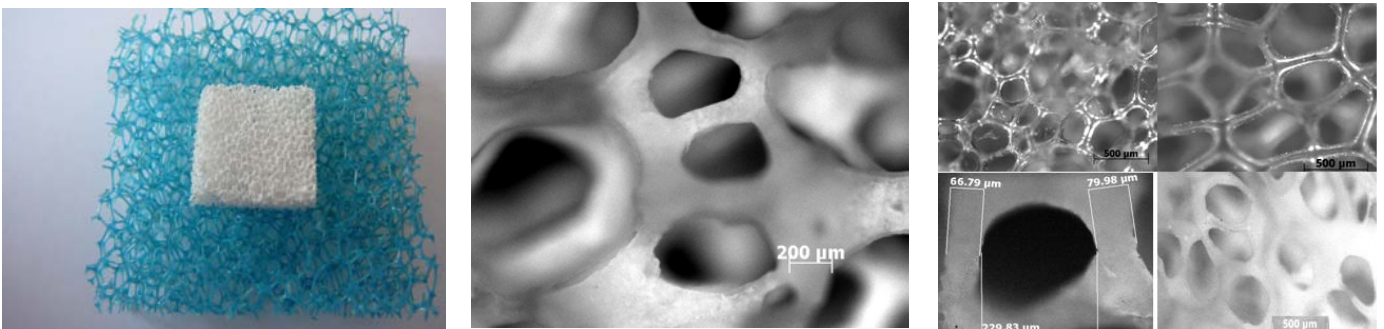
## Applications

**Tissue engineering** - orthopedic and maxillo-facial surgery as **bone filler**, and/or ceramic matrix for transport and release of active / therapeutic substances (**carriers**).

# 3D Ceramic structures based on calcium phosphates

## Description

The ceramic biomaterials are used as temporary or permanent replacement materials in bone defects resulting from tumors, trauma or infection in orthopedic or maxillo-facial surgery.



## Characteristics:

- compositions: calcium phosphates based on  $\beta$ -TCP, HAP,  $\beta$ -TCP/HAP;
- technique: polyurethane foam replication technique;
- products: nontoxic 3D structures, doped/non-doped with silver nanoparticles;
- compressive strength: 6.77-11.88 MPa;
- pores size: 150-500  $\mu\text{m}$ , 200-700  $\mu\text{m}$ ;
- relative density: 2.7  $\text{g}/\text{cm}^3$ ;
- Ag nanoparticle content: 2.5...60 ppm;
- average diameter of Ag nanoparticles: 10 nm.

## Applications:

- *tissue engineering*: support for growth and transfer of bone cell; support for therapeutic substances – with controlled release;
- *orthopedic surgery*: for clinical applications of bone reconstructions,
- *dental and maxillo-facial surgery*.



# Active elements (disks, rings) made from piezoceramic material belonging to titanate-lead zirconate system $\text{Pb}(\text{Ti}, \text{Zr})\text{O}_3$ modified with niobium (Nb)

## Description

Active elements made from piezoceramic materials belonging to solid solution system-based of  $\text{Pb}(\text{Ti}_{0.52}, \text{Zr}_{0.48})\text{O}_3$  modified with  $\text{Nb}^{5+}$ , in different shapes and sizes.

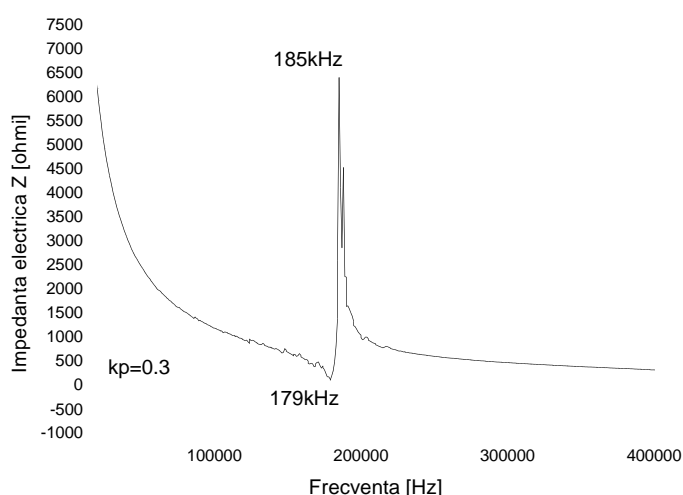
The piezoceramic materials are processed by conventional technology, from raw materials of oxide type, in specific conditions of pressing and air sintering.

## Main technical characteristics

Piezoceramic active elements



Characteristics for material	PZTN
Apparent density - $\rho_a$ [ $\text{g}/\text{cm}^3$ ]	7.4
Dielectric coefficient - $\epsilon_r$	1150±50
Loss tangent - $\text{tg}\delta$ ( $\times 10^{-3}$ )	15
Planar electromechanical coupling impedance - $k_p$	0.20...0.35
Curie point $T_c$ [ $^{\circ}\text{C}$ ]	>400
Piezoelectric module - $d_{33}$ [ $\text{m}/\text{V}$ ] ( $\times 10^{-12}$ )	200



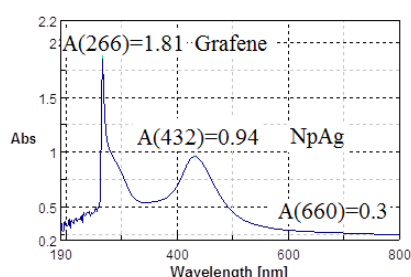
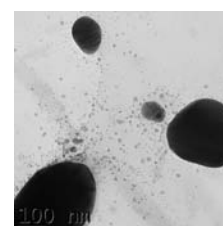
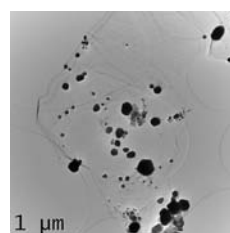
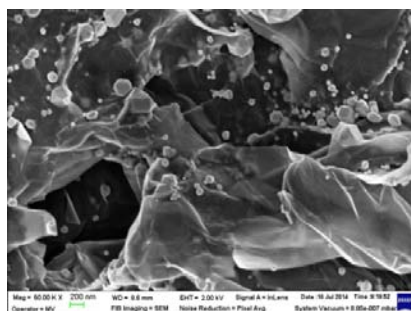
## Applications

These active elements are used in obtaining of sensors, transducers, actuators etc. (for example: sensors for determining the viscosity, pressure sensors).

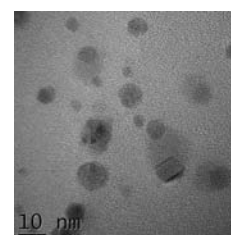
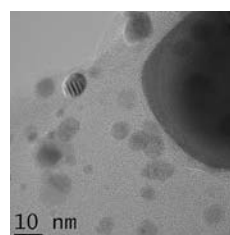
# Functionalized graphene with silver nanoparticles

## Technical characteristics:

The graphene was functionalized with silver nanoparticles (NpAg) with different shapes (spherical, octagonal) and different sizes (10-300 nm) and with antimicrobial activity.



Dilutie: 53 μg/ml NpAg si 53 μg/ml Grafene



## Functionalized graphene with NpAg

Functionalized graphene with silver nanoparticles were synthesized in the framework of PCCA project of type 1, no. 147/2012 "Laser direct writing of graphene-polymer composites" ("Scriere directă cu laser a materialelor compozite polimer-grafene"), acronym: POLIGRAPH.

**Applications:** polymer-graphene composites for laser lithography used in electronics, biomedical applications etc.

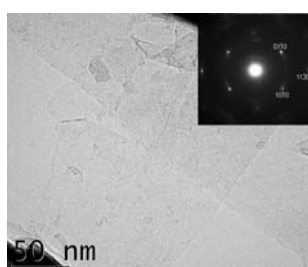
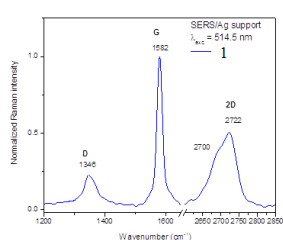
# Colloidal graphene solutions

## Technical characteristics:

- Colloidal graphene solutions in protic solvents
  - preponderant n=3-4 layers,
  - concentration: >200 µg/ml.
- Colloidal graphene solutions in aprotic solvents
  - preponderant n=3-4 layers,
  - concentration: 200-800 µg/ml.

### Colloidal graphene solutions in protic solvents

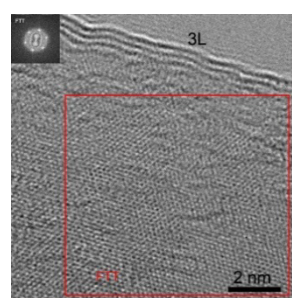
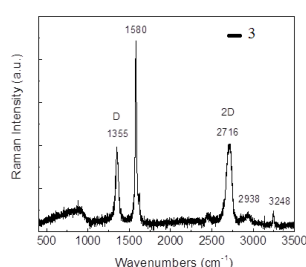
$$I(G)/I(D)=1.175$$



Graphene (preponderant n=3-4)

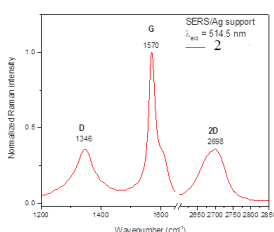
### Colloidal graphene solutions in aprotic solvents

$$I(G)/I(D)=1.172$$



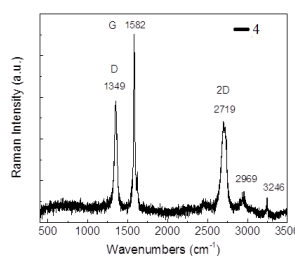
Graphene (preponderant n=3-4) (500-800 µg/ml)

$$I(G)/I(D)=1.170$$

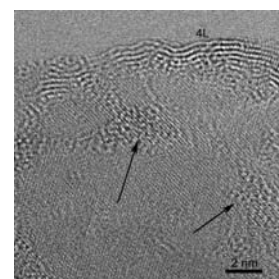


Multilayers graphene (n>10)

$$I(G)/I(D)=0.080$$



Graphene with 3-4 layers (200-500 µg/ml)



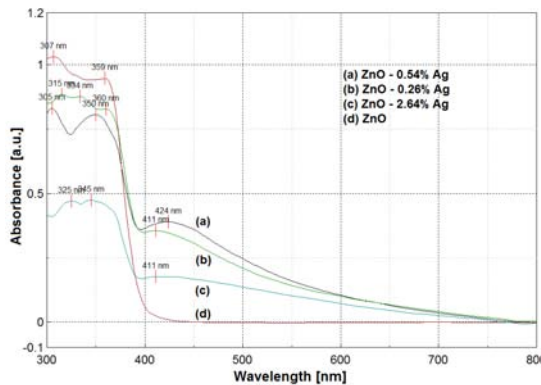
Colloidal graphene solutions were synthesized in the framework of PCCA project of type 1, no. 146/2012 "Laser direct writing of graphene-polymer composites" ("Scriere directă cu laser a materialelor compozite polimer-grafene"), acronym: POLIGRAPH.

**Applications:** polymer-graphene composites obtained by direct laser writing.

# Antimicrobial nanopowders of zinc oxide and titanium dioxide doped with silver

## Description

Nanopowders of ZnO or TiO<sub>2</sub> chemical or mechanical doped with 0...2.8 wt.% of bioactive Ag nanoparticles having antimicrobial and antibiofilm activity, for medical applications.



ZnO - 0.26% Ag



ZnO - 2.64% Ag



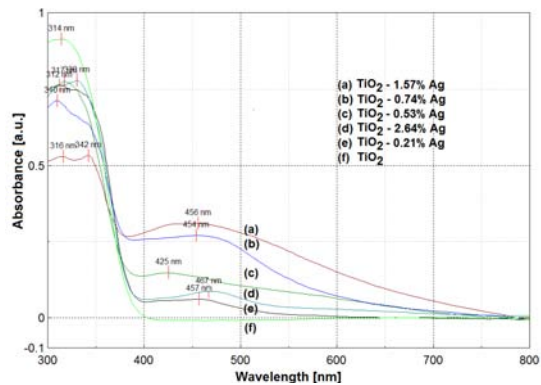
TiO<sub>2</sub> - 0.21% Ag



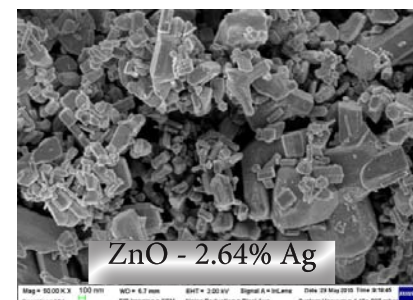
TiO<sub>2</sub> - 1.57% Ag



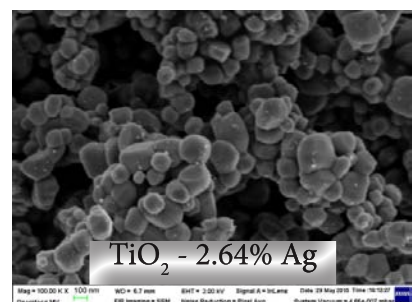
TiO<sub>2</sub> - 2.64% Ag



ZnO - 0.54% Ag



ZnO - 2.64% Ag



TiO<sub>2</sub> - 2.64% Ag

*UV-Vis diffuse reflectance spectra for composite nanopowders of Ag/ZnO and Ag/TiO<sub>2</sub>*

## Technical characteristics:

- aspect: nanopowders of white (ZnO, TiO<sub>2</sub>) and cream/brown color (Ag/ZnO, Ag/TiO<sub>2</sub>);
- content of Ag nanoparticles (AgNP): 0...2.8 wt.%;
- apparent density: 0.24...1.08 g/cm<sup>3</sup>;
- wavelengths at which surface plasmon resonance of AgNP occurs in UV-Vis spectra: 411...467 nm;
- antimicrobial and antibiofilm activity against a broad spectrum of Gram-positive and Gram-negative strains and Candida albicans fungus;
- biocompatible and ecological nanopowders.

**Applications:** in medical applications for biocidal functionalization of some stainless steel critical surgical instruments to reduce surgical site infections and to improve life quality.

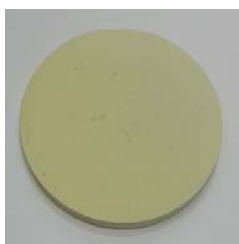
# Sputtering targets and thin films made of antimicrobial nanopowders of zinc oxide and titanium dioxide doped with silver

## Description

Sputtering targets made of ZnO or TiO<sub>2</sub> nanopowders doped with 0...2.8 wt.% of bioactive Ag nanoparticles are obtained by spark plasma sintering in vacuum, in form of disk with Ø50.8±0.1 mm, h3±0.1 mm with homogeneous aspect without cracks. From these targets, thin films with thickness of 200...1000 nm are deposited on stainless steel substrate by RF magnetron sputtering.

*(patent application submitted to OSIM, no. A/00605 of 20.08.2015, Sputtering targets and thin films made of antimicrobial zinc oxide nanopowders doped with silver and process for preparing the same, authors:*

M.Lungu, D. Pătroi, F. Grigore, M. Lucaci, D. Tălpeanu, V. Tsakiris, S. Mitrea, A. Brătulescu, C.D. Cîrstea, N. Stancu, V. Marinescu, A. Sobetkii, A.A. Sobetkii, M-C. Chifiriuc, M. Popa)



ZnO



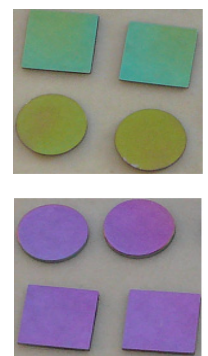
ZnO - 0.54% Ag



TiO<sub>2</sub>



TiO<sub>2</sub> - 0.74% Ag



## Technical characteristics of sputtering targets:

- shape and sizes: disk with Ø50,8±0,1 mm, h3±0,1 mm;
- aspect: homogeneous disks without cracks, having yellow (ZnO), cream/brown (Ag/ZnO), dark gray (TiO<sub>2</sub>), dark gray/brown (Ag/TiO<sub>2</sub>) color;
- content of Ag nanoparticles (NPAg): 0...2.8 wt.%;
- wavelengths at which surface plasmon resonance of AgNP occurs in UV-Vis spectra: 402...465 nm;
- density: 4.8...5.5 g/cm<sup>3</sup> (Ag/ZnO) and 3.2...4.0 g/cm<sup>3</sup> (Ag/TiO<sub>2</sub>);
- rugosity Ra: 0.2-0.7 µm;
- Vickers microhardness HV2/15: 102...280 (Ag/ZnO) and 560...721 (Ag/TiO<sub>2</sub>);
- Young's modulus: 30...87 GPa (Ag/ZnO) and 127...156 GPa (Ag/TiO<sub>2</sub>);
- stiffness: 5.1...8.6 N/µm (Ag/ZnO) and 9.5...11.3 N/µm (Ag/TiO<sub>2</sub>).

## Technical characteristics of thin films:

- aspect: uniform and homogeneous thin films deposited on stainless steel substrate;
- thickness of thin films: 200...1000 nm;
- content of Ag nanoparticles (NPAg): 0...2.8 wt.%;
- antimicrobial and antibiofilm activity against a broad spectrum of Gram-positive and Gram-negative strains and Candida albicans fungus.

**Applications:** in medical applications for biocidal functionalization of some stainless steel critical surgical instruments to reduce surgical site infections and to improve the life quality.



# SERVICES

## CONTENT

### A. MATERIALS

#### A.1. Advanced materials testing and characterization

Investigation of the materials composition	117
Investigation of the materials structure	122
Mechanical stress testing	123
Study of the surface properties	127
Determination of the characteristic properties of all magnetic materials	132
Direct and derived measurements with Lake Shore 7604 HMS (Hall effect measurement systems)	134
Examination based on chemiluminescence measurement	135
Measurements of the electrical parameters for ferroelectric materials	136
- drawing hysteresis diagram for ferroelectric materials	
- impedance measurement	
- dielectric permittivity measurement in complex	
- magnetic permittivity measurement in complex	
- volume and surface resistivity measurement	
TG, DTG, DTA, DSC, DIL, DMA Analysis	138
Electrochemistry and physical-chemistry services	144

# CONTENTS

## A.2. Material processing techniques

Plastic processing and composite materials obtaining	146
Samples processing from thermoplastic polymer composites	147
Deposition and / or growth of layers and / or organic thin films	148
Services for obtaining the oxide/metal thin layers	150
High precision prototyping	153
Determining the structural changes by aging or composition change by optical RAMAN spectroscopy, evaluation of the stability of polymeric materials according to the stress factors	154
Radiochemical materials processing in order to achieve new technologies for endurance test, for obtaining new materials by grafting, crosslinking and compatibilization, quality materials expertise	155
Studies of climate degradation (stability assessment, expanding areas of use, material quality expertise), preparation of materials by UV irradiation	157

## B. MEASUREMENT OF PHYSICAL PROPERTIES, AT LOW TEMPERATURES 158

### B.1. Materials

Measurement of physical properties, at low temperatures (4.2 - 300 K)	158
Obtaining and maintaining low temperatures (4.2 - 300 K)	159
Determining the critical parameters ( $T_c$ , $I_c$ ) to superconducting materials and determining the critical and functional parameters to superconducting coils	162
Measuring and monitoring the temperature in the range of 4.2 - 300 K	162

### B.2. Superconducting coils

Measuring of magnetic field in the range of 0 - 9 T and in the temperature range of 4.2 - 300 K	163
Processing and testing the superconducting coils HTS and LTS	163



# CONTENTS

<b>C. MEASUREMENTS OF ELECTROMAGNETIC COMPATIBILITY</b>	
164	
CEM measurements	164
- measurement of electromagnetic shielding efficiency	
- measurement of electromagnetic field	
Spectral analysis	171
- spectral analysis in the range of THz	
- spectral analysis of infrared images	
Impedance spectrometry	172
<b>D. MEMS and NEMS MEASUREMENTS</b>	174
Processing the micro and nanoelectromechanical systems	175
Manufacturing the mechanical parts on Numerical Controlled Processing Center for 5-axis Turning and Milling	178
<b>E. MEASUREMENTS BY PHOTOGRAMMETRY (IMAGING)</b>	179
<b>F. ELECTRICAL TESTING IN TRANSITIONAL REGIME INTENSE ELECTRICAL CURRENTS for the research-development of medium and high voltage protection systems</b>	180
<b>G. TESTING in the field of BIOCHEMISTRY and BIORESOURCES</b>	180
<b>H. TESTING EQUIPMENT in the field of HYDRO-GAS-DYNAMICS MEASUREMENTS</b>	182
<b>I. MECHANICAL and ELECTRICAL DESIGN</b>	183
<b>J. DYNAMIC BALANCING TESTING; VIBRATIONS and NOISE MEASUREMENTS</b>	184

## C O N T E N T

<b>K. ELECTROMAGNETIC MEASUREMENT with HALL PROBE</b>	185
<b>L. TESTING in the field of FLUID MECHANICS</b>	186
Wind tunnel for testing wind turbine experimental models	186
Testing stand for scale models of axial water turbines	187
Wave channels	188
Installation for two-phase mixture studies	188
Ultrasound measurement system for water flow and speed	189
Acoustic Doppler Velocimeter 3D	189
Fluid water velocity measurement equipment - PIV 3D	190
<b>M. TESTS of CELLS, MODULES and INVERTORS for applications with PHOTOVOLTAIC PANNELS</b>	191
Solar array simulator power supply	191
Solar power simulator for PV modules tests	191
Testing at high potential for PV modules	192
Electroluminescence inspection system for PV modules	192
In-situ system for testing and monitoring of PV modules and systems	193
Softwares for systems photovoltaic	194
<b>N. ELECTRIC MOTORS TESTING</b>	195
Testing the electric motors with maximum power of 130 kW	195
Testing the electric generators with maximum power of 7.5 kW	195
Testing stand for high speed electric motors	195
<b>O. SERVICES of INTEGRATED MANAGEMENT of QUALITY-ENVIRONMENT</b>	196
<b>P. MOBILE ENVIRONMENTAL LABORATORY</b>	198
Chemical and microbiological analysis	202
<b>R. SERVICES offered by the INCDIE ICPE-CA Sfântu Gheorghe BRANCH</b>	207
<b>S. SERVICES offered by the Tehnological and Business Incubator ITA ECOMAT ICPE-CA Avrig</b>	207
<b>T. SERVICES offered by the Tehnology Transfer Center ICPE-CA (CTT ICPE-CA)</b>	208
<b>U. MARKETING</b>	208
<b>V. BIBLIOGRAPHIC INFORMATION offered by the BUREAU OF MANAGEMENT OF KNOWLEDGE and INFORMATIONS / PUBLIC RELATIONS</b>	208

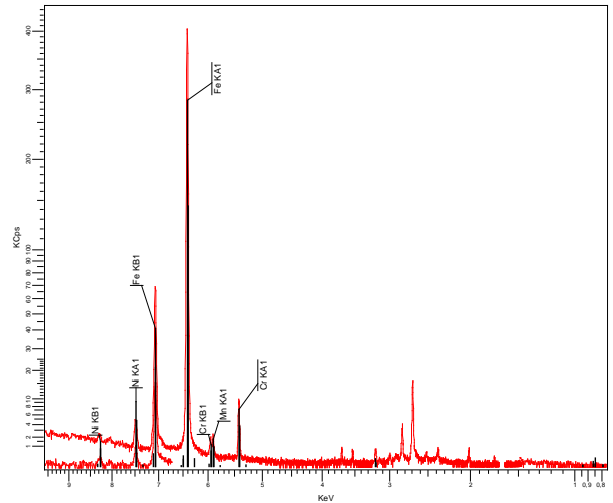
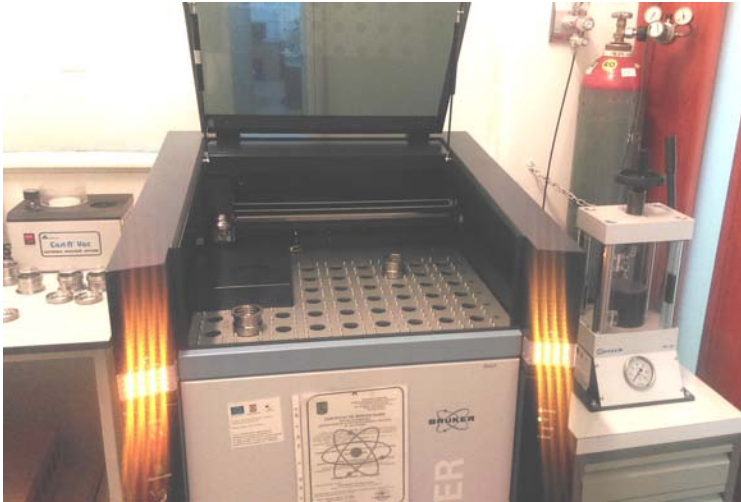




## A. MATERIALS

### A.1. Advanced materials testing and characterization

#### Investigation of the materials composition



Wavelength Dispersive X-ray Fluorescence Spectrometer (WDXRF) S8 Tiger

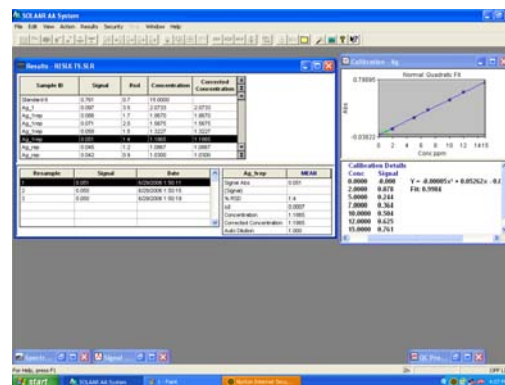
#### Field of applications:

- qualitative, quantitative and "standard less" analysis of elements from Be to U, in solid, powders and liquid samples;
- elements analysis range: Na-U;
- it can be determined the elemental concentrations from ppm to 100%, with a relative deviation between approx. 0.2% (for high concentrations) and approx. 5% (for concentrations at ppm level);
- it allows the qualitative and semi-quantitative analysis on the totally unknown samples using analysis module „QUANT EXPRESS”;
- it allows to conduct the analysis in a very short time (from 3 minutes to „quick” analysis and 15 minutes to „best detection” analysis);
- it allows simultaneous charging of 35 samples in prefixed positions, with automatic loading - unloading of samples.

#### Functional parameters:

S8 TIGER sequential spectrometer consists of:

- radiation shield made of steel with thickness of 1.5 mm;
- hermetically sealed proof room during the measurement, in which can be introduced samples with max. 70 mm diameter;
- high voltage generator type K410, with the following features:
  - max voltage: 50kV;
  - max. electric currents: 50mA;
  - max. electric power: 1kW.
- 60, 82, or 108 positions for convenient handling;
- the system can be equipped with up to 4 programmable collimators, thus providing an optimal resolution for almost the entire spectral range;
- it allows installation of up to 8 analyzer crystals;
- the system has:
  - SPECTRAplus standard software;
  - specialized software for different applications;
  - software for remote and teleservice.



Atomic Absorption Spectrometer type SOLAAR S4, fitted with a disaggregation oven

### Field of applications:

- it allows qualitative and quantitative elemental chemical analysis at the level of ppm;
- it can be analyzed liquid samples or solid samples processed in liquid solutions (using the Millestone type digestion);
- it allows the detection of a wide spectrum of metal - about 70 elements - contained in the *Periodic Table of the Chemical Elements* between Li and Bi, as well as the lanthanides groups (from Ce to Lu).

### Main applications:

- environmental protection: metallic impurities in water analysis;
- pharmaceutical industry: detection of the impurities from medicines;
- heavy industry: chemical composition of steels, castings and other materials;
- forensics;
- materials science.

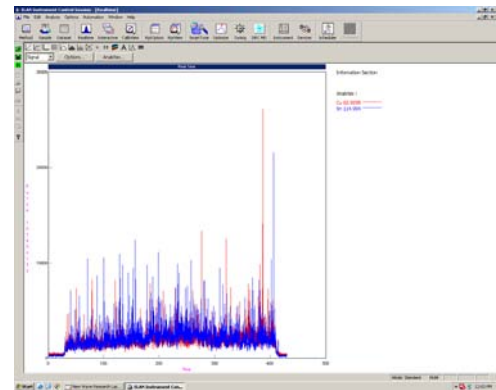
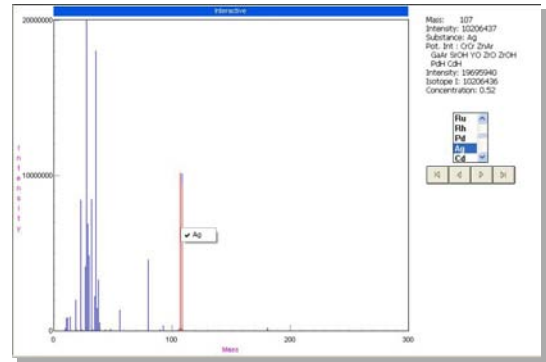
### Functional parameters:

- detection limit: 0.1 – 1.0 µg/ml.

It is a technique for the detection of the elements in solutions with concentrations ranging between the maximum detection limit of 5% to the minimum detection limit of 1 ppm. This very wide detection range enables detection of a large spectrum of metallic elements (70 elements) namely from Li to Bi and lanthanide group (from Ce to Lu).

Due to the method based on Beer-Lambert law there are using a series of lamps which are unique for each analyse of interest; the atomization of the analyzed matrices occurs in the oxyacetylene flame or nitrous oxide flame. This results in a very high repeatability and traceability, this instrument being very powerful analytically.

Bringing the matrices into solution is done by using the microwave digestion oven ETHOS and appropriate methods for the related elements.



*Laser Ablation Mass Spectrometer  
ELAN DRC type*

#### **Field of applications:**

- it allows the qualitative and quantitative elemental analysis of elements in solid samples or to the solution;
- to determine the elements and element trace (that are in concentrations of ppm and ppb range);
- it allows to determine the concentrations of elements contained in the *Periodic Table of the Chemical Elements* in the mass range 5 – 270 amu (not including C, N, O, F, Cl);
- it allows to determine the qualitative and quantitative elemental analysis of elements - by using standards.

#### **Main applications:**

- materials science: thin films analysis, detection of impurities in ppb range, it allows the detection of the impurities in a large range of digested materials that do not interfere with the material's principal matrix;
- nuclear field: isotopic ratio determination;
- geologic field: rock's composition, isotopic ratios and geological age determinations.

#### **Functional parameters:**

- mass range: from 5 to 270 amu;
- laser to work directly on solid samples;
- it allows determination of elemental composition: semiquantitative - directly and quantitatively – by use of standards;
- resolution of detection: 0.5 amu;
- multi-element quick recovery;
- low limits of detection;
- isotopic information;
- axial field technology type (all generation and detection system is on a single axle).

It is a device dedicated to trace analysis of materials (UltraTrace Analysis) either of solid materials (using laser ablation) either of liquid by the nebulizer chamber Scott (digested material brought into solution).

The field measurement is between 500 - 100 ppm (upper limit of detection) and 1 ppm (lower limit of detection).



*X-ray Diffractometer D8 ADVANCE type*

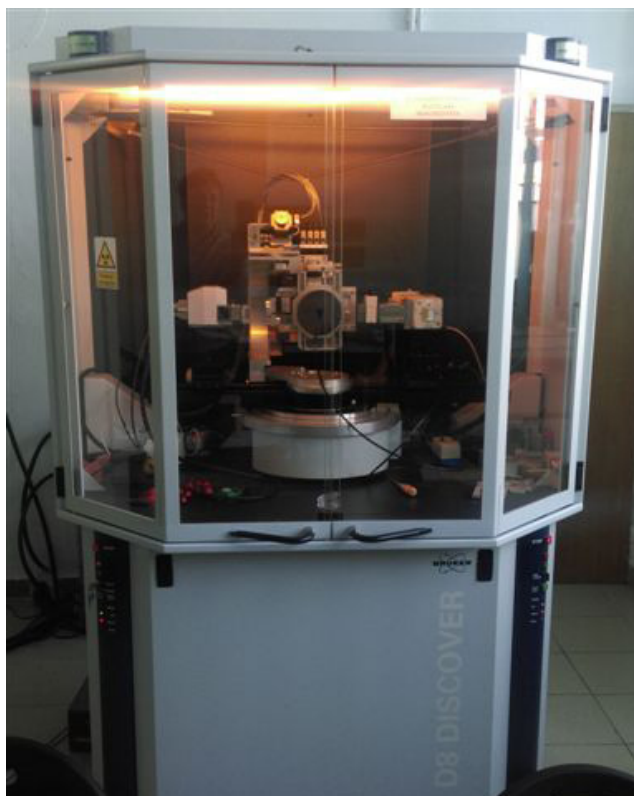
**Field of applications:**

- the equipment allows the qualitative analysis of polycrystalline materials;
- it allows the determination of average crystallite size and unit cell parameters.

**Functional parameters:**

- acquisition and interpreting software;
- dynamic scintillation detector with low background (0.4 cps) and high dynamic range (up to  $2 \times 10^6$  cps);
- X-ray tubes with Cu and Mo anode;
- vertical goniometry;
- $\theta$ - $2\theta$ , or  $\theta$ , or  $2\theta$  scanning modes, minimum step size  $2\theta = 0,0001^\circ$ ;
- maximum scanning velocity  $25^\circ/\text{s}$ .





*X-ray Diffractometer D8 DISCOVER type*

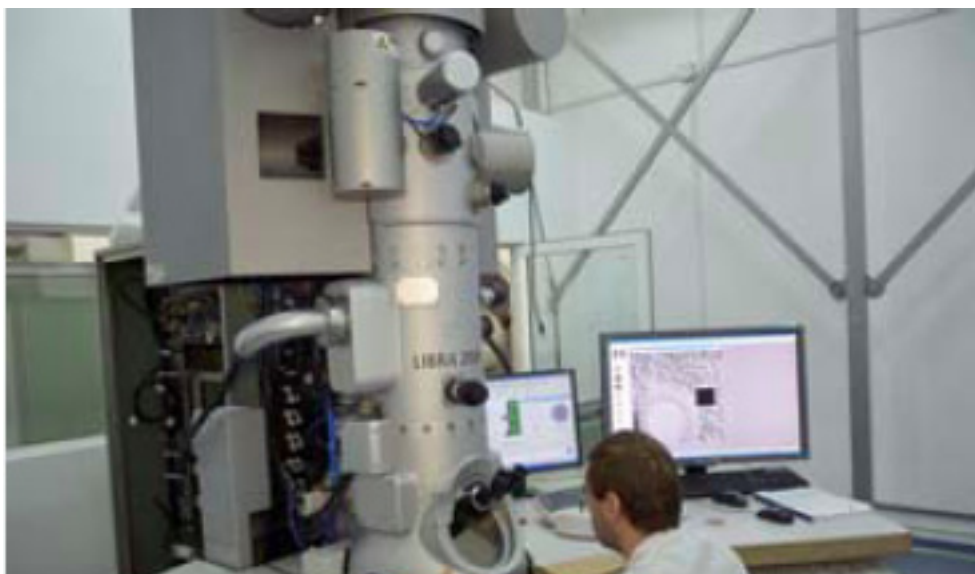
**Field of applications:**

- the equipment allows qualitative analysis for crystalline materials as thin films, micro, small samples;
- assessing change network parameters and analysis of phase transformations based on temperature range: -180°C .... +1100°C in vacuum or iner atmosphere.

**Functional parameters:**

- $\theta$ -2 $\theta$  geometry diffraction and to grazing incidence GIXRD;
- stress and texture analysis;
- microdiffraction in capillary tubes;
- reflectometry (XRR).

## Investigation of the materials structure



*High Resolution Transmission Electron Microscope (HRTEM)  
LIBRA 200FE-HR type*

### **Field of applications:**

- study of properties and lattice structure for different types of materials;
- types of samples which can be studied: bulk materials, thin layers, wires, powders (all processed to electronic transparency); conducting, semiconducting, insulating, magnetic, non-magnetic and ferroelectric materials with crystalline, amorphous and nanocrystalline structure.

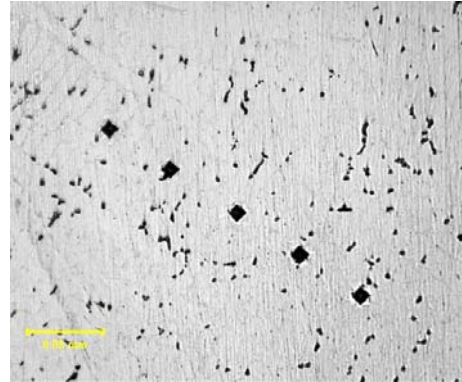
### **Functional characteristics:**

- punctual space resolution (point to point) of 0.24 nm;
- minimum magnification range: 50x - 1.000.000x;
- accelerating voltage: 80 - 200 kV selectable;
- field emitter system for the electron source by thermal Schottky effect (FE);
- energy filter corrected for all conventional modes and for all imaging, analysis and diffraction modes;
- electron spectrometer: for EELS (Electron Energy Loss Spectroscopy) and EFTEM (Energy Filtered Transmission Electron Microscopy);
- SSCD camera with minimum resolution of 2048x2048 (2kx2k pixels);
- software for controlling the electronic optics and subsystems.

### **Modes of operation:**

- a. EFTEM imaging;
- b. TEM diffraction with related lighting modes:
  - selected area electron diffraction (SAED);
  - convergent beam electron diffraction (CBED);
  - nano-beam diffraction (NBD);
  - electron spectroscopy diffraction;
- c. TEM analysis.

## Mechanical stress testing



*Microhardness Tester  
FM 700 type*

### **Field of applications:**

- the equipment allows the Vickers and Knoop hardness testing in the range of 25 - 2000 gf.

### **Functional parameters:**

- the equipment is fitted with a CCD camera. The digital image capture offers the opportunity to investigate the metallography of the sample before and after indenting it and to see if it exhibits some inhomogeneities.



*Equipment for tribological characterization of the thin films*

**Field of applications:**

Determination of tribological properties (friction and wear) of the thin films of inorganic materials (metals, semiconductors, conductors, magnetic materials, DLC), organic materials (polymers, plastics, paints); ceramic materials; composites or biomaterials deposited on cylindrical or paralelipipedical samples by ball-on-disk or pin-on-disk tests with rotative or linear motion.

**Functional parameters:**

- base unit:
  - ball-on-disk and pin-on-disk tribometer;
  - manual loading system with „dead-weight” in the range: 0.25...38.75 N;
  - weights of 0.25N; 0.5N; 1N; 2N; 5N; 10N; 20N;
  - rotating module: maximum rotation speed: 1500rpm, maximum test radius: 30 mm;
  - linear module: maximum test speed: 100mm/s;
- control unit with data acquisition and analysis:
  - software for data control, acquisition and processing: TriboX;
  - software for the surface to determine the wear profile; elastic modelling software: X Model; ASCII exportable data; realization of measurement report;
- measurement systems:
  - sensor for friction force  $\leq 20\text{N}$  (LVDT);
  - sensor for online wear depth measurement:  $<1.2\text{ mm}$  (RVDT);
  - sensor for humidity and temperature measurement;
  - gas sensor;
  - sensor for electrical contact resistance measurement in the range  $0 \dots 1000\ \Omega$ ;
  - profilometer of Stylus type for wear measurement;
- heat chamber at high temperature ( $T_{\text{max}}=150^{\circ}\text{C}$ ) – for rotating module; maximum rotation speed: 150 rpm.



*Static Universal Testing Machine for Materials  
LFM 30kN type, Walter & Sai AG Switzerland*

**Mechanical characteristics to be determined:**

- maximum mechanical strength or tensile strength,  $R_m$  or  $\sigma_p$  (MPa);
- flow limit,  $R_{p0.2}$  (MPa);
- elongation, A (%)
- elasticity modulus or Young's modulus, E (GPa).

Testing will be made in accordance with **EN Standard 10002-1:2001**.

**Type of tests:** tensile, compression, bending in 3 points.

**Testing temperature:** room temperature and at  $T_{max} = 600^\circ\text{C}$ ;

**Sample sizes:**

- traction for rectangular sample:  $L = \text{min. } 30 \text{ mm}$ ;  $h = \text{max. } 15 \text{ mm}$ ;  $l = \text{max. } 30 \text{ mm}$ ;
- traction for round sample:  $\varnothing = 4 \div 10 \text{ mm}$ ,  $L = \text{min. } 30 \text{ mm}$ ;
- compression:  $\varnothing = \text{max. } 40 \text{ mm}$ ;
- bending in three points:  $L = 30 \div 80 \text{ mm}$ .

Capacity: 30 kN in static condition;

Vertical testing space: 1 m;

Horizontal testing space: 2 columns;

Speed sleeper: 0.001 – 350 mm/min;

Transducers: force (force cell), displacement (encoder), elongation (extensometer):

**Force transducer** has the following features:

- maximum strength: 30 kN;
- measurement accuracy: 0.5 %;
- race sleeper: 1 m;
- distance between adapters: up to 800 m;
- distance between benches: 0 – 600 mm;
- speed sleeper: 0.001 – 350 mm/min;
- frame rigidity at 1 m: 150 kN/mm;
- required power: 1 kW;
- working height: 750 mm;
- depth: 720 mm;
- width: 820 mm.



*Mechanical Testing Equipment  
Zwick T1 - FR005TN type*

**Field of applications:**

- it allows to measure the tensile strength, compression and bending strength in 3 points;
- it allows testing the plastics, carbonm metal and textiles.

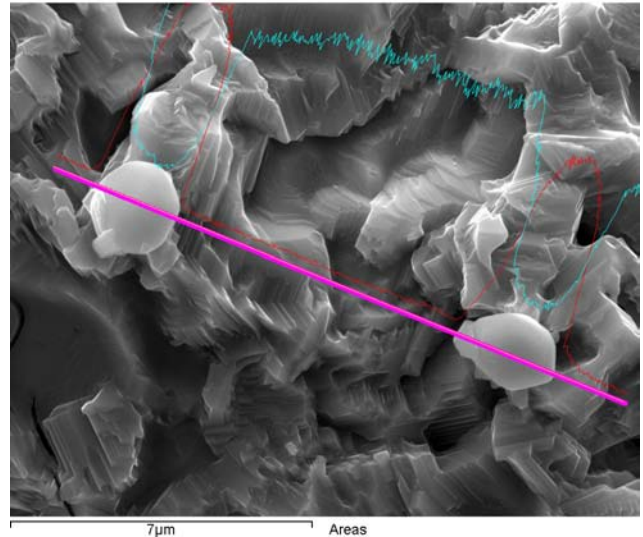
**Functional parameters:**

- nominal power: 5 kN.

**Working method:** in accordance with ISO 7500-1.

Uncertainty measurement: 0.2%.

## Study of the surface properties



*Scanning Electron Microscope (FESEM-FIB)  
Auriga Zeiss type*

### **Field of applications:**

The equipment is intended to microstructural investigations of the surface of different types of materials.

They can be studied:

- inorganic or organic samples (polymers, plastics, composite materials), conductive or electric non-conductive, magnetic materials;
- bulk materials, powders or thin layers.

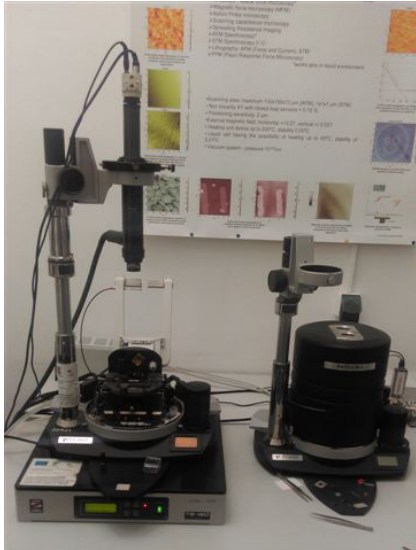
### **Functional parameters:**

SEM Gemini column with resolution of 1nm (15kV), 1.9nm (1kV):

- accelerating voltage: 0.1- 30kV;
- source FEG;
- zoom: 67x-1000000x;
- SE, BSE detectors in column and in chamber;
- FIB processing module for mechanical grinding or platinum deposition;
- EDS INCA Energy 250 chemical mapping probe (energy dispersive);
- EDS standardless analysis software;
- DC charge compensation system for viewing the high vacuum non-conductive samples of about  $2.66 \times 10^{-6}$ mbar.

### **Modes of operation:**

- SEM imaging;
- Imaging and SEM and EDS chemical elemental quantification;
- SEM and FIB imaging.



*Scanning Tunneling Microscope and Surface Analysis  
STM-Ntegra Aura NT-MDT type*

**Field of applications:**

STM Ntegra Aura NT-MDT Platform provides opportunities to investigate the topography by 3D imagistic and of physical properties of the surface material from the microscopic to the nanometer level.

**Main field of applications:**

- surface metrology;
- 3D imagistic quantitative surface measurements (roughness, line profile, particles dimension evaluation etc.);
- qualitative mapping of physical properties (electric, magnetic, tribology).

**Particular field of applications:**

- high resolution surface profilometry;
- evaluation and optimization of thin layers for different applications (optics, packaging, microelectronics etc.);
- fixed particles and grains dimension evaluation;
- microstructural studies, surface morphology;
- evaluation of the magnetic fields structure by mapping (with the possibility to apply an external magnetic field transverse or perpendicular to the surface);
- the topological evaluation on elasticity, friction and adhesion surface properties, identifying the contaminants, AFM spectroscopy;
- the topological study on electric surface properties (local resistivity, local density of electronic state), STM spectroscopy.

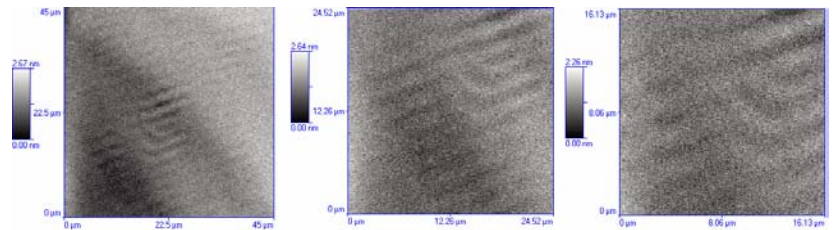
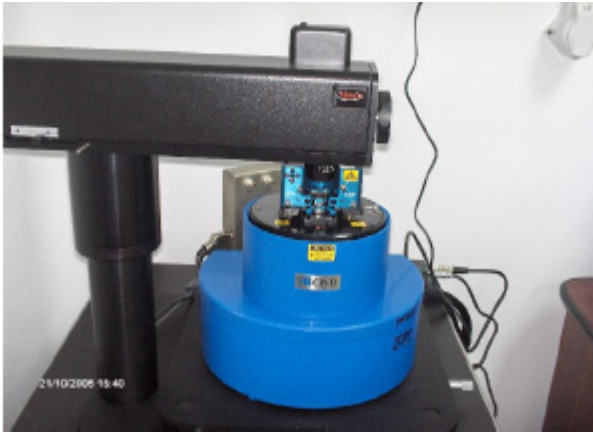
**Functional parameters:**

Investigations can be carried out in ambient, liquid medium\* (on fixed samples) or in vacuum (up to  $10^{-2}$  torr). It can be investigated a variety of materials (metallic, ceramic, carbon, polymer, magnetic, semiconductors etc.) with nano roughness smooth and flat surface, conductive or non-conductive depending on the investigated properties.

The equipment allows to work with a variety of imaging and high resolution measurement in order to investigate the surface physical properties:

- 3D topography AFM (contact, semicontact, noncontact)\*;
- STM topography (constant current, constant peak-surface distance);
- phase imaging, force modulation microscopy, adhesion force microscopy\*, LFM\*;
- magnetic force microscopy (MFM);
- Kelvin Probe microscopy;
- scanning capacitance microscopy;
- spreading resistance imaging;
- AFM spectroscopy\*;
- STM spectroscopy (I-V);
- AFM and STM lithography;
- nanomanipulation;
- PFM (Piezo Response Force Microscopy).





*Atomic Force Microscope  
Veeco type*

**Field of applications:**

- the equipment allows the operation in the following modes: Contact Mode, Force Modulation (FM), Tapping Mode, Phase Imaging and Scanning Tunneling Microscopy (STM).

**Functional parameters:**

- with hard or software accessories, the equipment allows the operation in the following modes: Magnetic Force Microscopy (MFM), Conductive Atomic Force Microscopy (CAFM), nano-lithography by mechanical scratch, nano-manipulation by pushing objects;
- it accepts samples with sizes up to 50x50x25mm;
- ScanMaster software allows closed loop, it enables the linearization of the sweep in closed-loop and the position control for system (with the scan mode of 100µm);
- it is equipped with platform for samples translating with manual displacement of 6 mm on XY, manual and motorized displacement on Z with tilt correction and mechanical game.



*NU 2 Optical Microscope  
Carl Zeiss type*

**Field of applications:**

- the equipment allows the study of different solid materials in natural or polarized light, by transmission or reflectance at optical zoom: max. 600 x.

**Functional parameters:**

- recording and images processing with digital camera is possible;
- micro and macrostructure, their assessment before and after the chemical attack, selective superficial corrosion.



*Automatic gas adsorption / desorption analyzer  
AUTOSORB 1C series  
Quantachrome UK Limited type*

**Types of tests:**

- determination of the specific surface (BET, Langmuir);
- plotting the adsorption / desorption isotherms;
- the pore size distribution;
- total pore volume;
- plotting the chemical adsorption isotherms;
- determination of the active specific surface (metal).

**Functional parameters:**

- pressure range: 0 – 0.13 MPa;
- the specific surface: > 0.0005 m<sup>2</sup>/g;
- pore volume: minimum detectable limit of 0.0001 cm<sup>3</sup>/g;
- pore diameter: 0.35 – 500 nm (in N<sub>2</sub>);
- adsorbent gases: N<sub>2</sub>, O<sub>2</sub>, Ar, CO, CO<sub>2</sub>, H<sub>2</sub>, NH<sub>3</sub>, Kr.



*Spectroscopic Ellipsometer  
UVISEL type*

**Field of applications:**

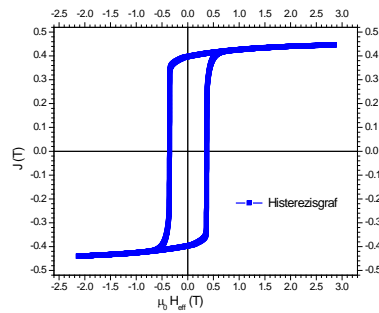
The study of thin films, nanostructured materials, mixed oxide, oxide nanoporous structures, solid/liquid interface with applications in chemistry and biology.

By non-contact measurements there are determined the optical constants, thin films thickness, materials composition.

**Functional parameters:**

- spectral range: from 190 to 2100 nm;
- detection: high resolution monochromator;
- sample stage: 200x200mm;
- goniometry with automatically adjustable angle from 40° to 90° by step of 0.01°;
- accessories: temperature controlled cell, liquid cell, electrochemical cell;
- vision: CCD camera;
- accuracy:  $\Psi=45^\circ\pm 0.02^\circ$  and  $\Delta=0^\circ\pm 0.02^\circ$  measured in air configuration 1.5 - 5 eV;
- repeatability: NIST 1000Å SiO<sub>2</sub>/Si (190-2100 nm):  $d\pm 0.1\%$  -  $n(632.8\text{nm})\pm 0.0001$ .

# Determination of the characteristic properties of all magnetic materials



*Hysterezisgraph type AC/DC Hystograph  
- Brockhaus Messtechnik -*

## Field of applications:

- the device allows the determination of the retentivity, the coercive field, maximum energy product, total loss of power, polarization and relative permeability.

## Applications:

- hard magnetic materials (AlNiCo, SmCo, NdFeB, hard ferrite and bonded magnets);
- steels and other soft magnetic materials in the frequency range from 0 to 10 kHz.



VSM is an instrument that measures magnetic properties.

*Vibrating Sample Magnetometer (VSM)*

**Field of applications:** magnetic properties of all types of magnetic materials, superconducting materials; the following parameters can be determined:

- hysteresis loop (saturation magnetization, residual magnetization,  $H_c$  coercive field,  $H_c$  slope,  $H_c$  differential susceptibility, rectangularity ratio, hysteresis loss);
- vectorial magnetic moments;
- data magnetization – function of time;
- data magnetization – function of temperature (4.2 ÷ 1273 K);
- transition temperatures, including the Curie point.

**Features:**

- resolution: 7 calibration fields –  $10^3$ ,  $10^2$ ,  $10^1$ ,  $10^0$ ,  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ;
- precision: 2%, reproducibility: 1%;
- time constant: 10ms, 100ms, 1s and 10s;
- the sample can be 360° rotated in the horizontal plane;
- temperature range: 4.2 K ÷ 1273 K;
- maximum intensity of the used magnetic field:  $H_{\max} = 14$  kOe;
- measurements on compact solid samples, powders, thin films, liquids.

## Direct and derived measurements with Lake Shore 7604 HMS (Hall effect measurement system)

### Applications:

This Lake Shore Hall effect measurement system are used to characterize and to analyze the electronic transport of the materials and thin layers.

It can be determined by direct and derived measurements:

### Characteristics:

- Hall voltage;
- I-V curve;
- Hall resistance;
- magnetoresistance;
- anomalous of Hall effect (AHE);
- Hall coefficient;
- carrier concentration and density;
- Hall mobility;
- quantum Hall effect;
- magneto-transport;
- Shubnikov de Haas oscillations (SdH).



### Materials:

#### 1. III-V semiconductors:

- GaAs based devices:
  - HEMTs (High Electron Mobility Transistors);
  - pHEMTs (pseudomorphis High Electron Mobility Transistors);
  - HBTs (Heterojunction Bipolar Transistors);
  - FETs (Field Effect Transistors);
  - MESFETs (Metal-Semiconductor Field Effect Transistors);
- InP, InAs, GaN and AlN based devices;

#### 2. Semiconductors:

- a-Si, Si, Ge, SiC, Si on insulator (SOI) devices, HgCdTd, ZnO;
- SiGe based devices: HBTs and FETs;

#### 3. Dilute magnetic semiconductors:

- MnGaAs and ZnO;

#### 4. Multi quantum well structures:

- IR applications (LEDs, laser diodes and detectors);

#### 5. Other conducting materials:

- metal oxide;
- organic and inorganic conductors;

#### 6. Magnetoresistors:

- MR, GMR, TMR and CMR devices;

#### 7. High temperature superconductors;

#### 8. Ferrites.

## Examination based on chemiluminescence measurement



### Applications:

- assessment of the oxidation state and/or ageing of polymeric materials;
- establishment of the efficient level of antioxidant activities for natural and synthesis compounds;
- control of some obtaining techniques of polymeric materials;
- study of changes induced by action of different stress factors: heat, UV and nuclear radiations, inclusively the determination of life-time of polymeric products and of polymer composite materials;
- correlation of structural changes induced by climate factors;
- establishment of the functioning limits of polymeric products by acceleration degradation tests;
- characterization of the degradation conditions for organic products like oils, mineral fats.

### Features:

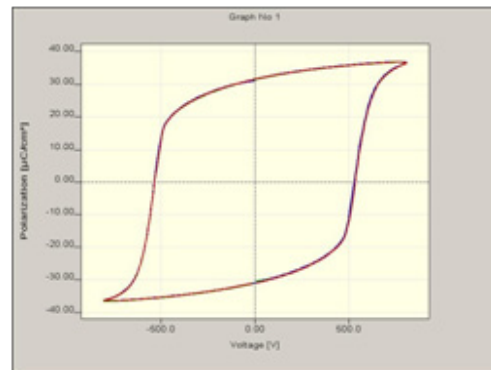
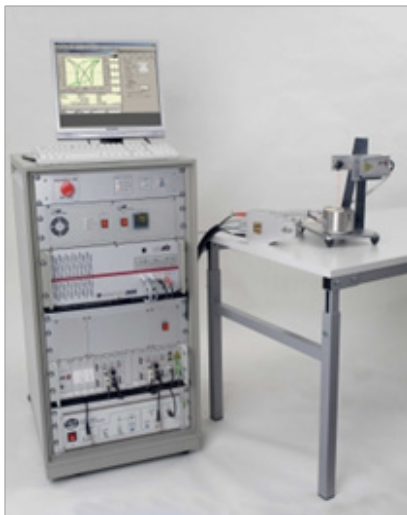
- temperature range: room temperature: -250°C;
- temperature measurement error:  $\pm 0.25\%$ ;
- measurement methods:
  - isothermal (intensity/time);
  - ramps -87 programmable steps;
  - non-isothermal (intensity/temperature);
- max. heating speed: 20°C/min;
- operating atmosphere: nitrogen, oxygen, air;
- flow range: 0 - 150 ml/min;
- measurement: numbering of photons.

## Measurements of the electrical parameters for ferroelectric materials

### Offered services:

- measurement of the Curie temperature;
- drawing hysteresis dynamically and statically;
- determination of  $d_{33}$ ;
- voltage range: 0.1 - 10 kV;
- sample height: 0.1 mm;
- sample diameter: min 5 mm – max 20 mm.

*Measurement System of the electrical parameters for ferroelectric materials*







## TG, DTG, DTA, DSC, DIL, DMA Analysis

By using the equipments from *Laboratory of Evaluation of Thermal Behaviour of Products and Materials by Thermal Analysis* it is obtained a complex „thermal spectrum” (thermogram) of material, which allows to be determined directly:

- temperatures at which the phase transitions occur (melting, softening, glass transition);
- temperature range at which the material is thermally stable;
- temperature range in which the material is thermo-oxidation stable;
- dimensional and mechanical properties change of a material due to heating;
- thermal effects of the processes from the thermogram;
- the variation of the heat capacity which occurs at a glass transition.

- thermogravimetry (TG);
- derivative thermogravimetry (DTG);
- differential thermal analysis (DTA);
- differential scanning calorimetry (DSC);
- dilatometry (DIL);
- dynamic-mechanical analysis (DMA);
- electrochemical technologies (electrochemical deposition with functional and/or decorative role);
- electroforming of metallic foils: Ni, Ni-Fe, Ni-W.

By processing data obtained with these thermal analysis equipments, the followings **can be determined indirectly**:

- crystallinity degree;
- the compatibility of the compounds used for the production of the composite materials;
- physical and chemical processes mechanisms from the thermogram;
- kinetic and thermodynamic parameters of these processes;
- thermo-oxidative or thermal relative stability;
- the relative efficiency of some antioxidants;
- the optimal composition of a composite material suitable for its use;
- thermal endurance (thermal lifetime) of a material or product suitable for an operating temperature and for a specific end of life criterion;
- stability of the ceramic or metallic materials depending on the temperature;
- the effect of ingredients on the expansion coefficient of the material;
- the reproducibility of producing the solid materials (quality control).



*System for Thermal Analysis (TG-DTA-DSC-FTIR) STA 409PC,  
made by NETZSCH Gerätebau GmbH - Germany*

**Field of applications:**

Thermal characterization of chemical compounds, materials and products; quality control.

**Functional parameters:**

- temperature range: 25 ... 1500°C;
- heating rate: 0 ... 50 K/min;
- mass of the sample, including crucible: max. 20g;
- mass resolution: better as 2 µg;
- maximum relative errors of DTA and DSC signals: ±3%;
- measurements in controlled atmosphere; vacuum system;
- TA-FTIR coupling system;
- measuring range of the FTIR spectrometer: 7500 ... 370 cm<sup>-1</sup>;
- the accuracy of determining the wave number of the FTIR spectrometer: < 0.01 cm<sup>-1</sup>;
- software and computer.



*Differential Scanning Calorimeter DSC 204 F1 Phoenix,  
made by NETZSCH Gerätebau GmbH - Germany*

**Field of applications:**

Thermal characterization of chemical compounds, materials and products; quality control.

**Functional parameters:**

- temperature range: -85 ... 600°C;
- resolution: < 0.3 µW;
- noise (RMS): < 0.5 µW;
- signal: maxim ≤ 1450 mW;
- reproducibility: < 0.5 % for enthalpy variation; < 0.1 K for temperature;
- time constant: < 3 s ;
- baseline linearity: < ± 0.5mW ;
- heating rate: 0.001 K/min – 100 K/min ;
- Intracooler.



*Dilatometer DIL 402 PC/4, made by NETZSCH Gerätebau GmbH - Germany*

**Field of applications:**

Thermal characterization of the chemical compounds, materials and products; quality control.

**Functional parameters:**

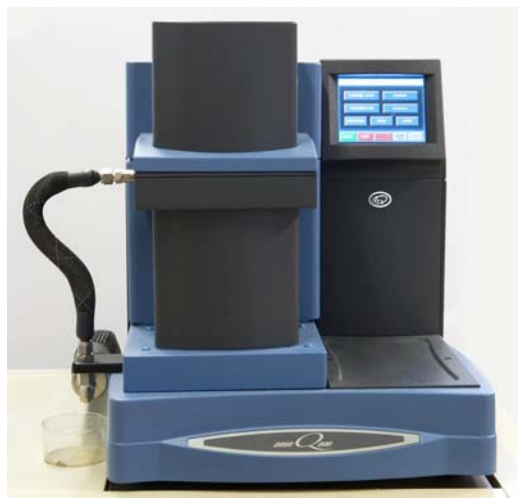
- temperature range: 25 ... 1600°C;
- relative errors of determining the temperature:  $\pm 0.5^\circ\text{C}$ ;
- resolution: 12.5 nm;
- the accuracy of determining the coefficient of expansion  $\alpha$ :  $1 \times 10^{-8} \text{ K}^{-1}$  (or  $\pm 0.5\%$  for most materials);
- reproducibility for  $\alpha$ :  $1 \times 10^{-8} \text{ K}^{-1}$ ;
- controlled atmosphere;
- accessories for: volume expansion, puncturing, mechanical stress.

**Field of applications:**

Thermal characterization of the chemical compounds, materials and products; quality control.

**Functional parameters:**

- maximum force: 18 N;
- minimum force: 0.0001 N;
- force resolution: 0.00001 N;
- strain resolution: 1 nm;
- modulus range:  $10^3 \dots 3 \cdot 10^{12} \text{ Pa}$ ;
- precision mode:  $\pm 1\%$ ;
- sensitivity  $\tan\delta$ : 0.0001;
- resolution  $\tan\delta$ : 0.00001;
- frequency range: 0.01 ... 200 Hz;
- dynamic sample deformation range:  $\pm 0.5 \dots 10000 \mu\text{m}$ ;
- temperature range:  $-150 \dots 600^\circ\text{C}$ ;
- heating rate: 0.1 ... 20°C/min;
- cooling rate: 0.1 ... 10°C/min;
- accessories for liquid nitrogen cooling;
- clips available: single and dual cantilever, compression, tension (film), three-point bending;
- information provided: modulus of elasticity, viscosity,  $\tan\delta$ , creep experiments, relaxation.



*Q800 Dynamic Mechanical Analyzer DMA, made by TA Instruments - USA*



*High Temperature and Resolution Dilatometer for Metallic Alloys  
L75HS2000C + L75HS700LT type*

**Field of applications:**

Density and volume expansion measurement of compacted materials from metallic powders (ceramic materials, glass, metallic materials, composite materials, polymers, paste, powders, foils).

**Functional parameters:**

- temperature measurement: from -180°C until to 2000°C;
- continuous monitoring (measurement, control and display) of temperature;
- gas dynamic atmosphere and inert atmosphere measurement (nitrogen, argon), reducing and oxidizing atmosphere;
- digital resolution: max. 0,125nm/digit for measurement range 500µm;
- digital resolution: max. 1,25nm/digit or measurement range 5000µm;
- sample dimensions: length max. 50-52 mm; diameter max. 12 mm;
- software for DTA analysis.



*Thermal Analyzer TG-DSC  
STA 449 F3 Jupiter type  
made by NETZSCH Gerätebau GmbH - Germany*

**Field of applications:**

Thermal analyzer TG-DSC of STA 449 F3 Jupiter type, made by NETZSCH, Germany, allows the determination of the mass changes and thermal changes for different types of materials, including heterogeneous substances.

**Functional parameters:**

- temperature range: -150°C ... 1550°C;
- heating rate: 0.1 - 50°C/min;
- cooling duration: 1500 – 50°C <30 min;
- maximum capacity of balance: 35 g;
- balance resolution: 1 µg;
- resolution DSC < 1 µW (depending on sensor);
- work atmosphere: inert, oxidizing, reducing, static or dynamic gases;
- vacuum system: max. 10<sup>-2</sup> mbar;
- simultaneous real measurement TG/DSC ;
- software for results analysis: Proteus.



*Light Flash Apparatus LFA 447 Nanoflash  
made by NETZSCH Gerätebau GmbH - Germany*

**Field of applications:**

Thermal diffusivity, specific heat, and thermal conductivity samples can be measured by the flash method using a NETZSCH LFA 447 Nanoflash instrument.

**Functional parameters:**

- materials to be analyzed: metal, graphite, coatings, composites, ceramics, polymers etc.;
- sample dimension: diameter = 12,7 mm, thickness = 2 – 3 mm;
- temperature range: 25 – 300°C.

## Electrochemistry and physical-chemistry services



*"All-in-one" potentiostat / galvanostat VoltaLab 40 Radiometer Analytical*

**Used techniques:** cyclic voltammetry, potentiodynamic polarization, open circuit potential, electrochemical impedance spectroscopy, chronoamperometry, chronopotentiometry, chronocoulometry.

VoltaLab 40 is a dynamic system that combines high performance and easiness of use. This represents a major progress in the field of ohmic falls compensation by offering dynamic controlled compensation of the impedance measurement. It is the obvious choice for high-level researchers. This is the easiest to use and most versatile "all-in-one" potentiostat on the market and it is ideal for electrochemical impedance spectroscopy combined with conventional methods such as voltammetry.

- Standard electrochemical cell: BEC / EDI is a basic electrochemical cell designed to be compatible with the EDI101 rotating disk electrode. Its body is made of Pyrex and presents a double jacket which allows performing experiments under regime thermostat. This cell can also be used with any type of solid electrode. The configuration includes a reference electrode (SCE; Ag / AgCl, Hg / HgO; Hg / Hg<sub>2</sub>SO<sub>4</sub>) and a platinum auxiliary electrode.
- Rotating disc electrode: EDI101 is a rotating disc electrode, versatile and robust, ideal for use with any potentiostat / galvanostat. This is available with a wide range of fast changeable endings from standard or customized materials: platinum, glassy carbon, gold etc.
- Speed Control Unit: The speed control CTV101 controls the rotation speed of the EDI101 up to 5000 rpm. It offers a better accuracy of than  $\pm 0.1\%$  for accurate and fully reproducible experimental conditions. The measured rotation speed is clearly displayed on a four-digit LCD. It is possible to program the variation of the rotation speed from one method to another method and also for carrying out an all in one "Leviçhi" type experiment.

### **Offered services:**

- electrochemical measurement;
- corrosion;
- development and characterization of metallic biomaterials;
- advanced and eco energy systems sources - Fuel Cell technology;
- protective coatings;
- electrodeposition of metals and alloys;
- batteries.





## A.2. Material processing techniques

### Plastic processing and composite materials obtaining



*Plastic Materials Laboratory Extruder  
KETSE 20/40 type*

#### **Field of applications:**

- granules of plastics composite can be prepared, having reinforcing fillers of various types: polymeric, synthetic fibers, glass fibers, natural fibers, powders (e.g. wood flour), ceramics, pigments etc.

#### **Functional parameters:**

- it has two screws in counter-rotating motion;
- ratio L/D: 40;
- maximum temperature: 450°C;
- 8 areas of temperature control.

## Samples processing from thermoplastic polymer composites



*Melt Injection Machine  
BOY 35A type*

### **Field of applications:**

- processing the thermoplastic materials, as well as PVC, elastomers, thermosetting resins, silicone fluids, obtaining different shapes depending on the mould used for injection;
- dumbbell type samples are obtained for testing the tensile strength of plastics.

### **Functional parameters:**

- screw diameter: 28 mm;
- ratio L/D: 16.6;
- closing force: 350 kN.

## Deposition and/or growth of layers and/or organic thin films



*Plasma-Enhanced Chemical Vapor Deposition (PECVD)  
for flexible organics*

### **Field of applications:**

PECVD equipment allows deposition and/or growth of thin layers and/or thin films by plasma decomposition and/or plasma polymerization of conductive and dielectric materials. The deposition of these layers is possible on different sub-layers.

The deposition takes place in a vacuum reactor, from gaseous phase in a RF activated discharge plasma, 13.56MHz, providing a better control on film properties.

The organic or inorganic layers or thin films can be obtained deposited on the various large-scale substrates (e.g. flat substrate of Ø150 mm) as follows:

1. Nanocrystalline, microcrystalline or polycrystalline silica films designed to obtain photovoltaic cells on flexible support:

- nc-Si:H nanocrystalline films having crystallites of the order 1–100nm;
- $\mu$ c-Si:H films with crystallites having the size of  $>100$  nm,  $< 10$   $\mu$ m;
- Si:H polycrystalline films having the grain size higher than 10  $\mu$ m;
- a-Si:H films n-doped with phosphorus.

It allows obtaining of the organic macromolecular structures on the substrate Kapton polyamide, polyethylene terephthalate PET, PTFE, polyester sulfone (PES), polyethylene naphthalate (PEN), or Si, SiO<sub>2</sub> substrate.

2. DLC films (DLC-diamond like-carbon) of a-C and a-C:H type, including the formation of structure type diamond films and growth of various nanostructures. These layers deposition should be possible on the metallic substrate of titanium, steel or stainless steel.

## Functional parameters:

### 1. Type of operation:

- capacitively coupled - interchangeable flexible configuration: coupled anode or cathode;
- simple and mixed, RF-LF, in terms of radio frequency fields.

### 2. Configuration for material deposition/growth

The equipment is mainly set up for deposition and/or growth of thin layers and/or organic or inorganic thin films of conductive and dielectric materials. Also, it allows the deposition and/or chemical growth from vapor phase to plasma, PECVD, of thin films at high speed and excellent uniformity of the deposited layer ( $< \pm 10\%$  - preferably  $\pm 3\%$ ), with an edge of maximum 25 mm on radius to the maximum diameter of support holding of the deposition substrate.

### 3. Processes in plasma:

- cleaning/etching (plasma etching);
- deposition of organic and inorganic layers and/or thin films as well as plasma treatment of the surfaces, including the engraftment of functional groups on the surface of the material.

### 4. The arrangement of the electrodes:

- symmetrically arranged, parallel, disc-shaped, up-down configuration.

### 5. Support electrode for the substrate (lower):

- heated disc, min.  $\varnothing$  200 mm.

### 6. Temperature of the support electrode

- controlled heating of the support electrode in the temperature range of (20 ... 400) $^{\circ}$ C.

### 7. Deposition substrate

Depositions/growth are performed on plaques with diameters of 50 mm (2 inches) and 200 mm (8 inches). The substrate for deposition and/or growth is placed in direct contact with the heated electrode (20 ... 400) $^{\circ}$ C.

### 8. Distribution of the process gases:

- 5 gas lines and 1 liquid line in which one gas line for  $\text{CH}_4$ ,  $\text{SiH}_4$ , Ar,  $\text{H}_2$  and  $\text{O}_2$ , and a liquid line for  $\text{C}_2\text{H}_5\text{-OH}$ ;
- gas and liquid lines have the possibility for calibration.

### 9. Chamber cleaning

The deposition system is provided with the possibility of cleaning the chamber to remove the residuals after using the plasma etching, or various chemical agents.

### 10. Equipment handling. Automation

The equipment is configured so that:

- to include an intended computer having installed a special software compatible with the operating system support (e.g. Windows 7 or newer);
- the software allows the control of the process parameters and individual parts (valves, space heaters, vacuum pumps etc.);
- the automation software allows the use of both automatic and manual mode.

## Services for obtaining the oxide/metal thin layers



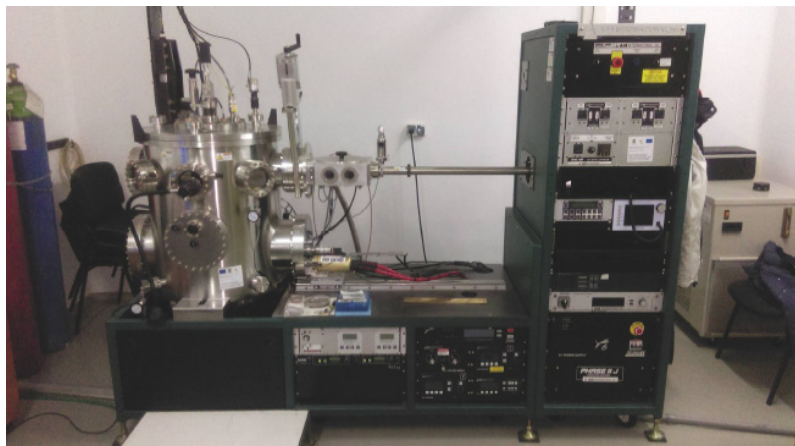
*Automated system for the thin layers depositon  
by "SPRAY" technique  
PRISM Ultra-Coat 300 type  
made by Ultrasonic Systems Inc. - USA*

### **Field of applications:**

The equipment allows thin films deposition by "spray" technique of various coatings of solid mixtures based on solvents or water-based, such as the photoresist, acrylics, adhesives, masks, and catalysts or antimicrobial coatings on almost any substrate or surface. The most common applications include: fuel cells, solar cells, circuit boards, semiconductors etc.

### **Functional parameters:**

- work surface: 450 x 450 mm;
- positioning resolution: 5 - 25  $\mu\text{m}$ ;
- platform movement on 3-axis (X, Y, Z);
- spray head speed: 1 - 500 mm/s.



*Equipment having plasma sources for the material processing under ultra-high vacuum by the magnetron sputtering and e-beam  
ATC 2200 type  
made by AJA INTERNATIONAL - USA*

### **Field of applications:**

The equipment allows to achieve the thin layers and nanostructures of: magnetic materials, conductive materials, resistive materials, oxide semiconductors, insulators, precious metals (with maximum use of cathode).

### **Functional parameters:**

- basal pressure: min.  $5 \times 10^{-8}$  torr;
- work pressure in evaporation:  $5 \times 10^{-8}$  torr;
- gage vacuum system for the whole field of vacuum: 760 -  $5 \times 10^{-9}$  torr;
- 4 sources for sputtering in DC, pulsed DC and radio frequency;
- electron beam evaporator in ultra-high vacuum (UHV) of 5 crucibles.



*Technological Equipment for Vacuum Processing of  
Titanium Nitride Thin Layers  
ETPV-SSNT type  
made by BESTEC Germany*

**Field of applications:**

- deposition of vacuum thin layers in order to achieve decorative thin coating technologies: biocompatible, optical, anticorrosive, lubricating, antiwear by standard magnetron sputtering or reactive type.

**Functional parameters:**

- technological chamber made of non-magnetic stainless steel ( $45 \pm 50$ mm and  $H = 500 \pm 50$  mm);
- rotation speed of maximum 30 rot/min for portsubstrates;
- limit pressure under  $5 \times 10^{-7}$  mbar and stable dynamically vacuum in range  $5 \times 10^{-1} - 5 \times 10^{-4}$  mbar, in technological space;
- two circular magnetrons with the spray target of 5 cm;
- 2 work gases: Ar - bombing gas and  $N_2$  - reactive gas;
- DC power supply of min. 500W for supply of the spray cathode magnetron type;
- RF power supply of min. 300W, with adaptation box of the plasma impedance for to supply the spray cathode magnetron type;
- DC pulsated power supply of min. 500W for polarization of the substrate in order to ensure the coating of reactive magnetron type;
- heat sources of substrates at temperatures of RT – 350°C.





## High precision prototyping



*3D Printer for models  
Fortus 360 mc LE type  
made by STRATASYS - USA*

### **Field of applications:**

The printer uses the Fused Deposition Modelling Technology, by printing the needed models through the layer-by-layer fusion of the molten thermoplastic materials. The unwrought material: filament.

The printer is designed for rapid prototyping applications with high accuracy, being a direct digital manufacturing system. The components are made by fusion of successive layers of extruded plastic under controlled temperature to improve accuracy.

It can be used to produce the models for the study of fluids flow (wind or hydro turbines, aircraft models), mechanics (demonstration models, molds or functional components), architecture (scale models).

The printer can be used together with three-dimensional optical scanning systems for making medical prostheses adapted to a person, without be necessary to carry out a mold.

### **Functional parameters:**

- work space capacity: 58.5 dm<sup>3</sup>;
- work space size: 406×355×406 mm;
- layer thickness: 127 μm;
- tolerance: ±0.127 mm.

### *Construction materials:*

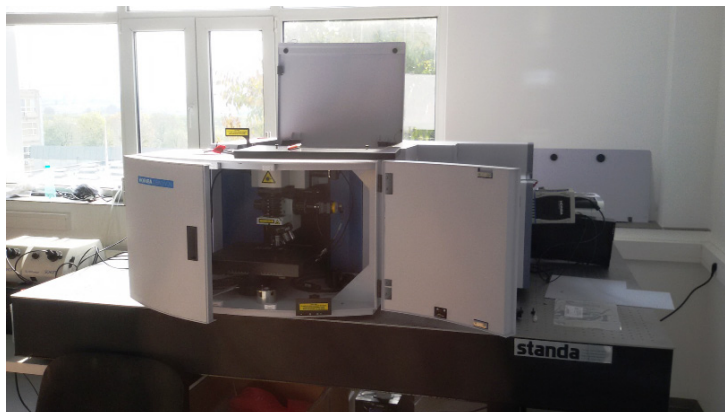
- ABS - tear strength 36 MPA, tensile elongation 4%, HDT 96°C;
- polycarbonate - tear strength 68 MPA, tensile elongation 5%, HDT 138°C;
- nylon 12 - tear strength 48 MPA, tensile elongation 30%.

### *Support materials:*

- ABS – soluble support material, dissolvable in a liquid bath;
- polycarbonate - soluble support material, dissolvable in a liquid bath;
- nylon 12 - soluble support material, dissolvable in a liquid bath.

The printing enclosure / work space of the device is closed and thermally controlled.

## Determining the structural changes by aging or composition change by optical RAMAN spectroscopy, evaluation of the stability of polymeric materials according to the stress factors



*Dispersive RAMAN Spectrometer  
LabRAM HR Evolution type  
made by HORIBA - Japan*

### Field of applications:

The equipment is designed for scientific research activities for the identification and characterization of materials structure and composition in liquid and solid phase, in the field of polymeric materials, composites and nanocomposites materials, carbon materials, magnetic materials, ceramics, metal oxides and other Raman active materials etc.

<i>Technical characteristics</i>	<i>Functional parameters</i>
Spectral range	50 - 4000 cm <sup>-1</sup>
Detector	Electron Multiplying CCD, resolution 1024x256, cooled with Peltier elements.
Lasers	<ul style="list-style-type: none"> <li>- wavelengths: 785 nm, 633 nm, 532 nm;</li> <li>- variable power;</li> <li>- safety class I;</li> <li>- self-aligning.</li> </ul>
Microscope	<ul style="list-style-type: none"> <li>- confocal (upright);</li> <li>- video camera (2MP) for viewing the samples;</li> <li>- provided with motorized mass with movement on the three axis of minimum step 0.1 microns on X, Y and 0.2 microns on Z axis;</li> <li>- possibility of working in bright and dark field;</li> <li>- objectives: 50x LWD, 50x oil immersion, 10x, 50x.</li> </ul>
2D and 3D automatic mapping and imaging	<ul style="list-style-type: none"> <li>- real 2D and 3D automatic mapping and imaging;</li> <li>- identification of all the particles of the same type in the analyzed sample according to the spectral response.</li> </ul>
Accessories	<ul style="list-style-type: none"> <li>- accessories module for liquid samples;</li> <li>- SERS kit;</li> <li>- antivibration mass;</li> <li>- heating-cooling device for samples (negative temperature: &lt;-120°C; positive temperature: minim 500°C).</li> </ul>

## Radiochemical materials processing in order to achieve new technologies for endurance test, for obtaining new materials by grafting, crosslinking and compatibilization, quality materials expertise



*Laboratory Irradiator  
Ob-Servo Sanguis type  
made by IZOTOP - Hungary*

### **Field of applications:**

This equipment is designed for radiochemical processing of materials in order to obtain products with predetermined functional characteristics. In this way it can be achieved cross-linking processes, polymerization, grafting, compatibilization. The irradiator allows testing regarding the susceptibility to degradation by accelerated aging, in order to establish the period of use safety.

The equipment can be used in radioprocessing for monocomponent systems, technological mixtures, nanocomposites. Exposure to the  $\gamma$  radiations action emitted by  $\text{Co}^{60}$  source is a fast and efficient method for characterizing the resistance to oxidative degradation of most products with lifetime limited by operating environment conditions.

### **Functional parameters:**

- self-contained dry irradiator of category I;
- irradiation source:  $\text{Co-60}$ ;
- radioactive activity: 5000 Ci (185 TBq);
- dose rate: minimum 3000 Gy/h (without attenuator);
- rotating canister: minimum 4 liters;
- external dose rate:  $< 50 \mu\text{Sv/h}$  at 5 cm;
- control of temperature in irradiation chamber;
- computerized/automatic calculation of the irradiation dose and of irradiation ending time;
- accumulator to ensure the irradiation cycle in case of power failure.



## Studies of climate degradation (stability assessment, expanding areas of use, material quality expertise), preparation of materials by UV irradiation



*Equipment for exposure to light and climatic aging  
XENOTEST 440 type  
made by ATLAS - Germany*

### **Field of applications:**

The equipment is designed for climatic degradation studies of samples subjected to aging. Action of the environmental factors, heat, humidity and ultraviolet radiations simulates the conditions under which the materials are operated in the environment. By performing of these exposures, it is tested the materials capacity to resist to the oxidative damage; these tests are necessary to characterize the polymeric electrical insulation resistance, the protective or covering materials for solar cells, for which the knowledge of the degradation level determines their operational performance setting.

### **Functional parameters:**

- air-cooled Xenon lamps: 2x2200 W;
- exposure area: 2310 cm<sup>2</sup>;
- direct setting and control of irradiance in the range 300-400 nm: 30-120 W/m<sup>2</sup>;
- direct setting and control of BST (Black Standard Temperature): 20-115°C;
- direct setting and control of the irradiation chamber temperature: 20-65°C;
- direct setting and control of relative humidity: 10-90%;
- sample rotating system for uniform exposure of samples;
- spraying system for simulating the rain conditions and for relative humidity control;
- water tank (60 liters) for humidity control and for spraying the samples.

# B. MEASUREMENT OF PHYSICAL PROPERTIES, AT LOW TEMPERATURES

## B.1. Materials

### Measurement of physical properties, at low temperatures



*Measurement system of physical properties at low temperature,  
in range 4.2 ... 350 K*

#### Field of applications:

The equipment is designed for thermal, electrical, magnetic characterization of materials in the cryogenic temperature.

#### Functional parameters:

#### Measurable physical properties:

- |    |   |   |
|----|---|---|
| 1. | Thermal properties                            | measurement error                                 |
| a. | thermal conductivity (k)                      | 5%  |
| b. | specific heat (c)                             | 2-5%  |
| c. | Seebeck coefficient (S)                       | 5%  |
| d. | thermoelectric figure of merit (Z)            | 15%   |
| 2. | Electrical properties                         | measurement error                                 |
| a. | electrical resistivity (in DC)                | 0,03%   |
| b. | electrical resistivity (in AC)                | 0,01%   |
| c. | Hall effect                                   |   |
| d. | characteristics I-V                           |   |
| e. | critical current of superconducting materials |   |
| 3. | Magnetic properties                           |   |
| a. | magnetic susceptibility (in AC)               | - sensitivity: $2 \times 10^{-11} \text{ Am}^2$   |
| b. | magnetization in DC                           | - range: $2,5 \times 10^{-5} \dots 5 \text{ emu}$ |
| c. | magnetic couple                               | - sensitivity: $10^{-7} \text{ emu}$ at 9T        |
| d. | anisotropy of magnetization                   | - torque: $1 \times 10^{-4} \text{ Nm}$           |

## Obtaining and maintaining low temperatures (4.2 - 300 K)

*Dewar recipient for the liquid helium storage  
CH 60 type*



**Field of applications:**

Storing liquid helium in purpose of suppling the liquid helium cryostat during tests on superconducting windings. Used for transporting the liquid helium from the producer at the user.

**Functional parameters:**

- capacity: 60 l;
- cryogenic agent: liquid helium;
- temperature lower limit: -269°C;
- working pressure: 1 bar;
- relief valve set pressure: 0.5 bar;
- evaporation rate: 1.5l/24h.

*Cryostat for the liquid helium storage*



**Field of applications:**

Liquid helium cryostat maintains the temperature of 4.2 K for achievement of tests and experiments on LTS superconducting materials and LTS coils.

Physical properties testing of electrical engineering materials at very low temperatures (4.2 – 300K).

Measurement of critical parameters (critical current, critical field and critical temperature) to LTS superconducting materials and LTS coils.

**Functional parameters:**

- working pressure: 0.5 bar;
- working temperature: -269°C;
- cryogenic agent: liquid helium;
- capacity: 60 l.



*Dewar recipient for the liquid nitrogen  
APOLLO 100 type*

**Field of applications:**

Storing liquid nitrogen. It is used for:

- transporting the liquid nitrogen from the producer to the user;
- supplying with liquid nitrogen the cryostat used for testing superconducting materials and windings.

**Functional parameters:**

- working pressure: 1.3 bari;
- working temperature: -196°C;
- cryogenic agent: liquid nitrogen;
- capacity: 100 l.



*Cryostat for the liquid nitrogen  
STELLA F 300/1250 type*

**Field of applications:**

Maintaining the temperature at 77 K for testing and experimenting on HTS superconductive materials and HTS coils. Testing physics properties for the electrotechnical materials at low temperatures (77-300K).

**Functional parameters:**

- working pressure: 0.5 bar;
- working temperature: -196°C;
- cryogenic agent: liquid nitrogen;
- capacity: 88 l.

*Withdrawal flexible system for liquid Helium*



**Field of applications:**

Transferring the cryogenic agent from the dewar to the cryostat.

**Functional parameters:**

- cryogenic agent flow capacity (liquid helium): min. 2l/min.





# Determining the critical parameters ( $T_c$ , $I_c$ ) to superconducting materials and determining the critical and functional parameters to superconducting coils

## Measuring and monitoring the temperature in range 4.2 - 300 K



*Temperature Monitor  
218 type*

The temperature monitor, together with Cernox sensors, are used for the temperature measuring in cryogenic field 2-300K, in the presence of magnetic fields.

### Field of applications:

They are used at superconducting coils that works at low and very low temperatures. The system has small errors induced by magnetic field, excellent resistance to ionizing radiation and excellent stability.



*Cernox Sensors  
CX-1070-SD-HT type*



*Programmable DC power supply  
XR10-600/208 type*

### Field of applications:

Power supply for the superconducting windings and superconducting electromagnets (LTS and HTS). Superconductors applications in electrical engineering.

### Functional parameters:

- input parameters: 187-229 V AC, 22 A AC, 50-400 Hz, 3 phases;
- output parameters: 0-10 V DC, 0-500 A DC, 0-6 kW.

*Nanovoltmetru  
2182A Keithley type*



### Field of applications:

Make low noise measurements at high speeds.

### Functional parameters:

- dual channels support measuring voltage, temperature, or the ratio of an unknown resistance to a reference resistor;
- built-in thermocouple linearization;
- A/D linearity: 0.8 ppm of reading + 0.5 ppm of range.

## B.2. Superconducting coils

### Measuring of magnetic field in the range of 0 - 9 T and in the temperature range of 4.2 - 300 K

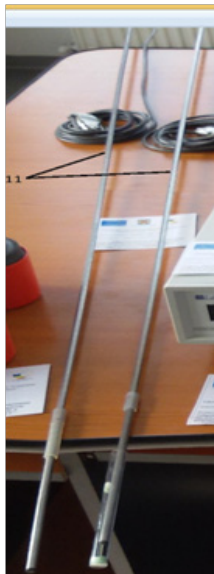


*Gaussmeter  
475 DSP type*

#### **Field of applications:**

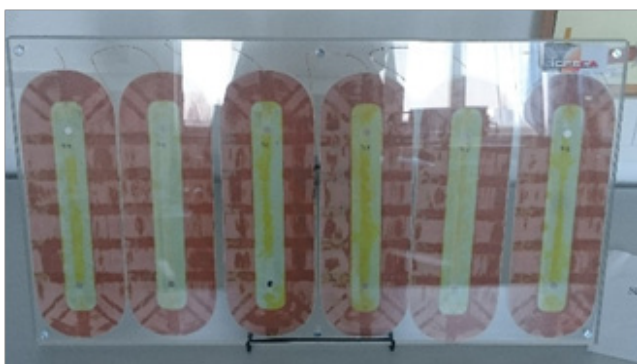
The system which consists of a gaussmeter and cryogenic Hall probes is used for magnetic fields measurements obtained with superconducting coils.

The device is used in order to measure the magnetic field in the range of 0 – 9 T.



*Cryogenic Hall probes  
HMCT-3160-WN1 and MMZ-2536-UH2 types*

## Processing and testing the superconducting coils HTS and LTS



#### **Features:**

- types of coils: dipole, quadrupole and sextupole;
- high and uniform magnetic fields;
- value of magnetic field: 0 – 8 T.

## C. MEASUREMENTS OF ELECTROMAGNETIC COMPATIBILITY

With increasing use of the integrated circuits, the problem of electromagnetic interference and susceptibility has become a priority issue in the design of the automation equipment of high reliability. Electromagnetic Interference (IMF - electromagnetic interference, or RFI - radio frequency interference) is represented by an unwanted signal that is induced due to electromagnetic field pollutant, signal which may damage the equipment or system operation. In these conditions, one major problem is to ensure a satisfactory functioning of systems / equipment / appliances in the electromagnetic environment, without producing noticeable perturbations on them or interfering with other equipment. On the other hand, a very topical issue is the action of the electromagnetic fields (produced by the operation of various communication systems or electronic) on biological structures. As an obvious conclusion, measuring the electromagnetic shielding becomes a matter of top importance for modern society, both in terms of securing electronic equipment, and in order to ensure biological protection.

The electromagnetic compatibility testing are made according to:

- o SR EN ISO/CEI 17025:2005 "Cerințe generale pentru competența laboratoarelor de calibrare și încercări" (General requirements for the competence of testing and calibration laboratories);
- o SR EN 50147-1:1999 "Camere anechoice – Partea 1: Măsurarea atenuării ecranelor" (Anechoic chambers – Part 1: Shield attenuation measurement);

ASTM D4935 "Standard Test Method for Measuring the Electromagnetic Shielding Effectiveness of Planar Materials", ASTM, 1999, IMEKO, 2007;

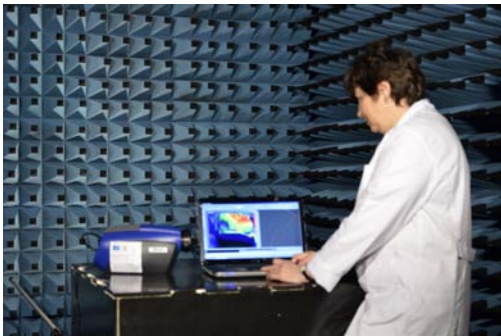
MIL-STD-285 "Method of attenuation measurement for enclosures, electromagnetic shielding, for electronic test purposes", June 25, 1956;

IEEE Std 299-1997 "IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures", IEEE, 21 April 1996.

### Offered services:

- determining the electromagnetic field (IEC 50383);
- determining the electromagnetic shield attenuation used to protect electronic devices, building and / or specialists exposed to the electromagnetic radiation (IEC 50147-1);
- measurements of the electromagnetic field emitted by electronic and electrical devices (IEC 50383).

## Laboratory equipments



### Anechoic Chamber

- frequency range: 200 MHz–18 GHz;
- shielding effectiveness: >100dB;
- size (lxLxh): 292cm x 570cm x 300cm.
- the chamber is certified according to SR EN 50147-1: 1999.



### G-TEM Cell

- frequency range DC: 1 - 18 GHz;
- field uniformity : +/-3dB to 1 GHz and +/-4dB to 18 GHz.



### Signal Generator

- frequency range: 250 kHz – 40 GHz;
- frequency resolution: 0.001 Hz;
- output power: -20 dBm – +12 dBm.



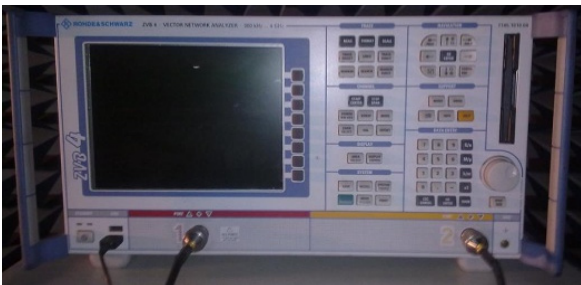
### Spectrum Analyser E7405A

- frequency range: 100 Hz - 26,5 GHz;
- resolution: 0.1 dB;
- measurement units: dBm, dBmV, dB $\mu$ V, dB $\mu$ A, A, V, W;
- maximum power supported at the input: 1 W.



### Spectrum Analyser FSP

- frequency range: 9 kHz - 4.2 GHz;
- maximum power supported at the input: 1W.



### Vectorial Network Analyzer (VNA) ZVB4

- frequency range: 300 kHz – 4 GHz;
- ports number: 2;
- ports output power:
  - up to 50 MHz: -40 dBm – +10 dBm;
  - over 50 MHz: -40 dBm – +13 dBm;
- ports input maximum level: +13 dBm.



### Power Amplifier BSA 0104-15/10D

- frequency range: 9 kHz – 4.2 GHz;
- maximum power: 15/10 W.



### Power Amplifier 20T4G18

- frequency range: 4.2 – 18 GHz;
- maximum power: 20 W.



### Power Amplifier ST181-50

- frequency range: 0.8 - 18 GHz;
- output power: 50 W;
- gain: 47 dB.



### Power Amplifier SMX50

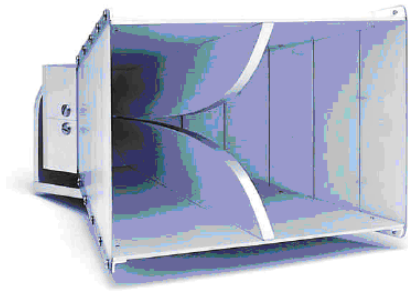
- frequency range: 10 kHz - 1000 MHz;
- output power: 50 W;
- gain: 47 dB.



### Isotropic Antenna of Electric Field

- frequency range: 30 MHz – 3 GHz;
- the intensity of the electric field in the range of: 1 mV/m - 100 V/m.





### Horn Antennas 3115

- frequency range: 1 – 18 GHz;
- continuous maximum power: 300 W;
- top power: 500 Watts;
- impedance: 50  $\Omega$ .



### Magnetic Antennas

- emission: HFRA 5149 (20 W) type;
- reception: FMZB 1513 type;
- frequency range: 9 kHz – 30 MHz;
- impedance: 50  $\Omega$ .



### Log-periodical Antennas VUSLP 9111B

- frequency range: 200 MHz – 3 GHz;
- maximum input power: 1000 W (< 300 MHz); 300W (1 GHz);
- impedance: 50  $\Omega$ .



### TEM Cell 4 GHz

- maximum frequency: 4 GHz;
- external/internal diameter: 40/8 mm.



### Coaxial Cell 20 GHz

- maximum frequency: 20 GHz;
- external/internal diameter: 6/3 mm.



### Measurement System with Horn Antennas

- distance between antennas: 40 cm.



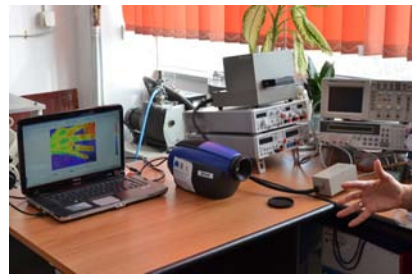
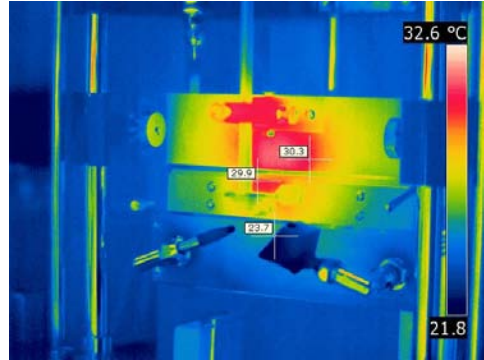
### Power-meter 5794

- frequency range: 9 kHz - 110 GHz;
- power: -50 - +44 dBm;
- 2 sensors + 2 directional couplers (0.1 MHz - 4GHz);
- 2 sensors: 1.5 MHz - 6 GHz, respectively 10 MHz - 18 GHz.

## Spectral Analysis

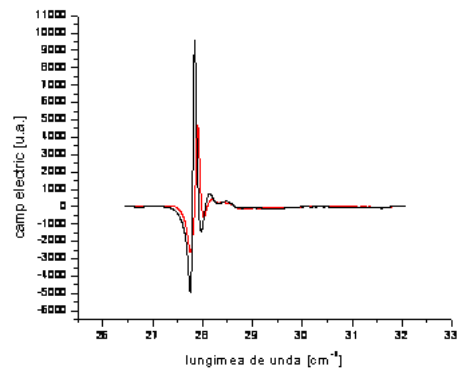
- spectral analysis in the range of THz
- spectral analysis of infrared images

- spectral analysis of infrared images for high-speed electrical circuits, printed wiring, fire prevention, electrical connections, buildings, applications in medicine, applications in biology etc.



*Thermographic Camera and spectral infrared images for an electrical circuit*

- reflection THz spectroscopy;
- transmission THz spectroscopy;
- characterization of materials in the field of THz.



*THz Spectrometer and spectral analysis*

## Impedance spectrometry

### Offered services:

- measurements of the volume and surface resistivity (IEC 60093);
- measurements of the complex magnetic permeability (IEC 60205);
- measurements of the dielectric properties (measurements of capacity, complex dielectric permeability, solid dielectric tangent (IEC 60250));
- measurement of the liquid electric properties.

### Impedance Analyser 4294A

- frequency range: 40 Hz - 110 MHz;
- measured parameters :  $|Z|-\theta$ , R-X, Ls-Rs, Ls-Q, Cs-Rs, Cs-Q, Cs-D,  $|Y|-\theta$ , G-B, Lp-G, Lp-Q, Cp-G, Cp-Q, Cp-D, Complex Z-Y,  $|Z|$ -Ls,  $|Z|$ -Cs,  $|Z|$ -Lp,  $|Z|$ -Cp,  $|Z|$ -Rs,  $|Z|$ -Q,  $|Z|$ -D, Lp-Rp, Cp-Rp;
- measuring configuration: 4 points;
- frequency resolution: 1 mHz.



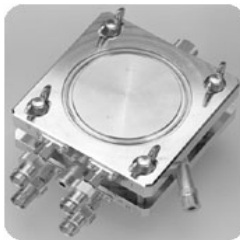
Measuring Kit SMD 16034G



Dielectric Measuring Kit 16451B,  
40 Hz to 30 MHz



Components Measuring Kit  
16047E, 40 Hz to 110 MHz



Liquid Measuring Kit 16452A,  
40 Hz to 110 MHz



Magnetic Materials  
Measuring Kit 16454A

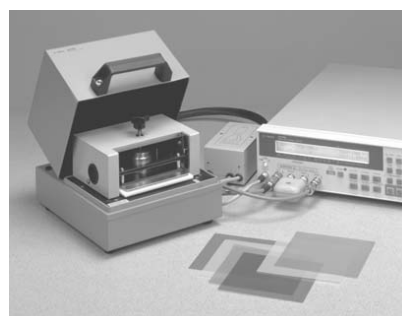


Impedance Analyser 4294A  
Measurement range: 40 Hz - 110 MHz

### Apparatus for determining the surface and volume resistivity

#### High Resistance Meter 4339B

- measured parameters: surface and volume resistivity;
- measurement area:  $10^3 - 10^{16}$  ohmi;
- work voltage: 0.1 - 1000 V;
- electrical current DC: 1 pA - 100  $\mu$ A;
- accuracy: 0.6%.







# Processing the micro and nanoelectromechanical systems

## 1. Processing by electrical erosion

- Working through wired electrical erosion - on CNC SMART DEM, manufacturer KNUTH, Germany

### Functional parameters:

Number of axes: 4 – x/y, u/v,  
Processing dimension: 250x350x200mm,  
Positioning accuracy: 0.02mm.

- Working through electrical erosion with massive electrode - on E.D.M. ZNC-210, manufacturer KNUTH, Germany

### Functional parameters:

Maximum electrode surface: 314 mm<sup>2</sup>,  
Dimension of piece: max. 200x200mm,  
Z height: 90mm.



Processing Machines by electrical erosion:  
- with wire -left  
- with electrode -right

## 2. Micromechanical Processing

- Micromechanical processing on CNC Center in 5 axis - manufacturer KERN Micro, Germany

### Functional parameters:

Processing dimension: 250x220x200mm,  
Positioning accuracy: 0.001mm,  
Repeatability: 0.001mm,  
Main axis speed: max. 50 000 rpm,  
Minimum diameter for drilling and milling: 0.03mm.

- Micromechanical processing on TMV400 CNC in 3 axis – manufacturer TOPPER, Taiwan

### Functional parameters:

Processing dimension: 400x250x250mm,  
Positioning accuracy: 0.01mm,  
Repeatability: 0.003mm,  
Main axis speed: max. 12 000 rpm,  
Maximum diameter of tool: 80 mm.



Precision Processing Center in 5 axis



Precision Processing Center in 3 axis  
TMV-400 type

- Micromechanical processing on automatic lathe CNC machine of "Swiss" DIAMOND 12 type

**Functional parameters:**

Half-finished piece diameter: max. 12 mm;  
 Working length: max.150 mm;  
 Main axis speed: 10.000 rpm;  
 Number of tools: 10.



*Automatic lathe CNC of "Swiss" DIAMOND 12 type*

**3. Outturn coils on automated machines**

- Outturn toroidal coils on SMC-1 machine, manufacturer JOVIL, USA

**Functional parameters:**

Conductor size: 0.05÷1.2mm,  
 Tor inside diameter: min. 8mm,  
 Tor outer diameter: max. 63mm,  
 Tor height: max. 50.8mm.

- Outturn cylindrical coils on TAK-01 machine, manufacturer NITTOKU, Japan

**Functional parameters:**

Conductor size: 0.01÷1.2mm,  
 Working field: longitudinal 100mm,  
 Maximum outer diameter of coil: 140mm,  
 Winding step adjustable in the range 0÷9.999mm,  
 Cross coil section: circle, square, rectangle, ellipse etc.



*Toroidal coil winding machine JOVIL SMC-1*



*Cylindrical coil winding machine NITTOKU TAK-01*



#### 4. Laser microprocessing

- Microprocessing on laser KrF Coherent Compex Pro and ISEL system in five axis

##### Functional parameters:

Wavelength: 248 nm;  
Maximum power: 25 W;  
Energy/impulse: 600 mJ;  
Impulse duration: 30 ns;  
ISEL mechanical system in 5 axis;  
Positioning accuracy :  $\pm 0.005$  mm;  
Angular displacements: B:  $-10^\circ +100^\circ$ ; C:  $360^\circ$ ;  
Precision angular: 1.5 min.



*Excimer processing laser station (KrF) of Coherent COMPex Pro 205 F type*

#### 5. Laser photolithography and removal the photoresist

- Laser photolithography on Heidelberg DWL-66fs system

##### Functional parameters:

Wavelength: 375 nm;  
Laser diode power: 18 mW;  
Minimum writing width:  $1\mu\text{m}$ ;  
Thermostatic enclosure:  $\pm 1^\circ\text{C}$ ;  
CAD-CAM transfer;  
Interferometer positioning (resolution 200 nm).

- Removal the photoresist using the microwave radicals generating system of R3T STP2020 type

STP 2020 system includes:

- Vacuum chamber (with external vacuum pump);
- Temperature control system;
- Data tracking system;
- Vacuum molecular pump A300.

##### Functional parameters:

- attack the SU8 photoresist, with rates up to  $200\mu\text{m/h}$ ;  
- do not attack metals like Ni, Ni/Fe, Au, Cu etc.;  
- attack with low rates the Si combinations ( $\text{SiO}_2$ ,  $\text{Si}_3\text{N}_4$ );  
- power up to 2000 W cont. @ 2,54GHz;  
- reactive process gases:  $\text{CF}_4$ ,  $\text{SF}_6$ ,  $\text{NF}_3$ ,  $\text{O}_2$ ,  $\text{H}_2$ ;  
- inert process gases:  $\text{N}_2$ , Ar, He.



*Laser lithography system of Heidelberg DWL 66fs type*



*Remote Microwave Plasma Etcher STP 2020 Stripping Tool for SU8, made by R3T - Germany*

## Manufacturing of mechanical parts on Numerical Controlled Processing Center for 5-axis Turning and Milling

### Field of applications:

5-axis Processing Center is a machine of the latest generation and is a very successful joint operations of 5-axis turning and milling.

This is a horizontal axis processing center fitted with a universal gripping piece that represents a rotation axis (C axis), directly driven. Besides the usual axis (X, Y, Z), the Processing Center is equipped with the 5th axis (B axis) namely an articulation that provides the support for rotation tool holder. The support tool can receive both active and passive tools, the active one being directly driven with speeds ranging up to 12 000 rpm.



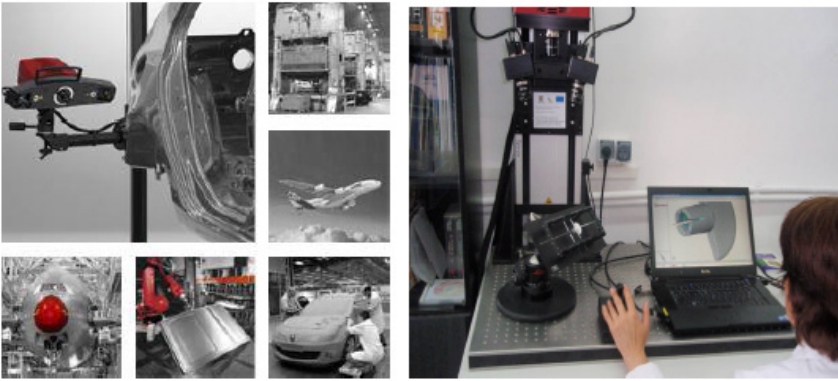
The machine is equipped with tools numerically controlled with 20 stations, all stations can be equipped with any kind of tool (both active and passive): turning, milling, drilling, threading, slotting, boring, gearing. For processing parts with small diameter relative to length, the machine was equipped both with CNC spindle and Mac Navi software which allows to obtain a high quality of processed surfaces and very good deviations of shape and position.

Machine applications: cutting of slots and pockets on curved surfaces, milling the cam profiles, milling the threads, milling the gears by many processes: milling step by step with cutter, milling by rolling with snail-milling, milling by piece rotating, filleting with special profiles by turning, realization of slots with specific profile by turning, profiling by turning, profiling by milling.

Milestones for processing: flanges, housings and shafts for electric cars, articulations, cases for sensors, wheels for chain drive, gears for wind generators, pieces for conveyors, camshafts and tappets, parts for achieving the flexible couplings.

<i>Functional parameters</i>	<i>Value</i>
Diameter of the parts	600 mm
Length of the parts	750 mm
Maximum shaft speed	5000 rot/min.
Guides with rolling systems	Yes, guides preloaded after Caged Ball technology
Encodere liniare absolute pentru axele x, y, z	Yes, for X, Y, Z axis
Number of tools	20 stations for milling, turning, drilling, threading, slotting, boring, gearing tools
Maximum speed of driven tools	12000 rot/min.
Maximum diameter of tool	90 mm
Maximum length of tool	200 mm
Number of simultaneous axes machining	5-axis simultaneously numerically controlled NC-Baxis
X-axis displacement	500 mm
Y-axis displacement	160 mm
Z-axis displacement	800 mm
C-axis rotation	360 (minimum controlled angle 0.001 degrees)
B-axis rotation	225 (-30 to 195 mm with a minimum controlled angle 0.001 grade)
Pinola rance	810 mm

## E. MEASUREMENTS BY PHOTOGRAMMETRY (IMAGING)



**Field of applications:** quality control, reverse engineering, high precision prototyping, fast milling.

*ATOS system for precision scanning and measuring for small objects*

ATOS SO systems are mainly used for measuring small and complex objects, with high requirements for data precision and quality. With point distance less than 0.02 mm can be measured even very small details.

ATOS viewer allows easy exchange of 3D measurements results and reports.

Flexible optical equipment is based on correlation of triangulations and gray tones of the images captured by two CCD cameras. 3D coordinates of each pixel are calculated with great precision and thus generate polygonal surface of the object analyzed.

ATOS 3D Digitizer can:

- accurately determine the 3D coordinate for a point;
- transmit complete dimensional information to a CAM system;
- dimensional analysis in different sections;
- complete measurement reports.

*TRITOP Measurement System*

TRITOP is a coordinate measuring equipment operating on the optical principle. Compared with the ATOS system that is used for smaller objects, the TRITOP system can scan objects with larger volumes (eg a car).

This mobile technology is designed to establish the exact 3D position of marking on a surface, providing effective measurements, of the site, for: quality control of large objects, verifying technological properties, the analysis of static deformation.

In addition to the ATOS system the TRITOP equipment measures coordinates for any mechanical feature and allows:

- comparisons for results obtained in CAD systems;
- checking the shape and tolerance positions;
- checking the design specifications.

TRITOP module for deformation measuring allows the capture for different loads and mechanical load situations.

*Dynamic Measuring System by Photogrammetry - PONTOS*



PONTOS system records analog signals for image capture which synchronize with loads situation and mechanical stresses.

It performs measurements of deformation speed (lowered or raised), of movement, and displacement of some singular points from an assembly (destructive testing, wind tunnels, ...).

It performs measurements of speeds and accelerations for singular points (directions, angles, ...).

## F. ELECTRICAL TESTING IN TRANSITIONAL REGIME INTENSE ELECTRICAL CURRENTS for the research-development of medium and high voltage protection systems



*DC Pulse Generator*

### **Field of applications:**

Producing current pulses for research / laboratory tests in the resistors and discharges with metallic oxides (ZnO), and other protective devices.

### **Functional parameters:**

- charging voltage: max. 100 kV;
- nominal pulse energy: 125 kJ;
- wave shape: 1/10  $\mu$ s, 8/20  $\mu$ s, 30/60  $\mu$ s, 4/10  $\mu$ s, 10/350  $\mu$ s and long wave 2 ms.

## G. TESTING in the field of BIOCHEMISTRY AND BIORESOURCES

- Research and development of biomass-based facilities for the energy recovery of biodegradable waste, wastewaters, agriculture residuals and industrial organic waste to biogas and biofuels;
- Chemical and microbiological analysis of organic slurries for monitoring the anaerobic digestion processes in laboratory-scale or industrial bioreactors;
- Research for stimulation the microbial activity in biochemical processes, determination the influence of process factors, such as temperature, hydrostatic pressure, organic loading rate on the biogas quality and quantity, experimental regarding increase the energetic yield in biogas systems;
- Research for enhancing the biological decomposition of lignin-cellulose based materials to be used for bio-fuels industry;
- Fat extraction in plants and oil seeds, determination of fat content in organic samples and/or fat contaminated soils;
- Laboratory analysis for assessing the environment quality: determination the quality of air, water, soils in terms of organic and inorganic pollutants.



## H. TESTING EQUIPMENT in the field of HYDRO-GAS-DYNAMICS MEASUREMENTS



*Equipment for determining the hydro-gas-dynamic performances of fine bubble generators*

**Area of use:**

The equipment determines the variation of the pressure drop on fine bubbles generators and mass transfer with the gas flow rate, allows the study of bubble columns flow stability, and visualization of bubble swarm evolution inside the tank.

**Field of applications:** establishing performance of fine bubble generators.



*Oxymeter*

**Area of use:**

Displays and transmits online the data regarding the dissolved oxygen concentration depending on temperature.

**Functional parameters:**

- operating temperature range between 0 ÷ 60°C;
- operating pressure range 0 ÷ 6 bar.

**Field of applications:** determines the oxygen transfer associated to various aeration devices and the content of dissolved oxygen in tap water or wastewater.



*Peristaltic pump*

**Area of use:**

Performs the recirculation of fluids for different flow rate, depending on the used tube size: 40 ml / min, 80 ml / min, 210 ml / min and 350 ml / min; it operates at a fixed speed of 100 rpm and is equipped with flow reverse option.

**Field of applications:** determination of the mass transfer in diffused aeration systems – performs the recirculation of water from the aeration tank into the measuring probe of the oxymeter.



*System for data acquisition, monitoring and control of pressures and flow rates on 6 channels*

**Area of use:**

Performs independent adjustment of airflow in the range of 0 ÷ 1 m<sup>3</sup>/h and of pressure in the range of 0÷1 bar.

**Field of applications:** flow and pressure control for supplying systems that generate fine bubbles.

# I. MECHANICAL and ELECTRICAL DESIGN

**Computer Aided Design Software SolidWorks**, from Dassault Systems, includes:

- SolidWorks Office Premium 2014;
- SolidCAM 2010;
- SolidWorks Simulation Premium 2014;
- SolidWorks Flow Simulation 2014;
- COSMOS EMS.

Design software with academic license NX 6, from Siemens PLM Software, includes:

- NX Model;
- NX Drawing;
- NX Manufacturing;
- NX Nastran.

**Brief description** of CAD/CAM/CAE softwares:

- SolidWorks Office Premium 2014, respectively NX Model and NX Drawing – cover the needs of CAD on 3D modeling of components and products in research and technical documentation necessary for the execution of products prototypes;
- SolidCAM and respectively NX Manufacturing – allow the import of 3D models made in CAD system, data entering necessary to process the parts (the equipment characteristics, sequence of operations, working regimes, features tools, use etc.) and development of equipment code that can be transferred to CNC equipment used in processing;
- SolidWorks Simulation Premium 2014, SolidWorks Flow Simulation 2014, COSMOS EMS and respectively NX Nastran - allow simulation of mechanical, thermal, fluid and electromagnetic phenomena which appear in operating of studied products, in order to analyse and optimize of these.

**Computer Aided Design Software**, from AUTODESK:

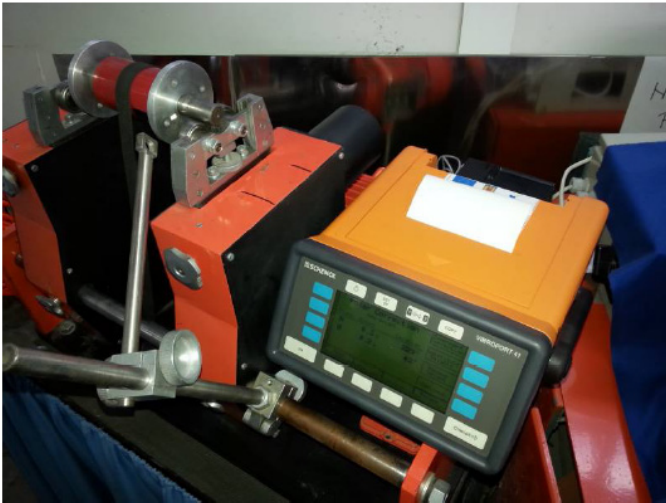
- AutoCAD Electrical 2015;
- AutoCAD LT 2015;
- Building Design Suite Premium 2015 which includes:  
AutoCAD Architecture; AutoCAD MEP; Revit.

**Simulation software COMSOL Multiphysics** is a powerful interactive environment dedicated to numerical modeling and solving a wide range of engineering problems described by systems with partial differential equations 1D, 2D, 3D elliptical type, parabolic or hyperbolic, linear or non-linear, possibly coupled together, even if describes different physical phenomena.

With the help of software simulation COMSOL Multiphysics 5.0 to which adds several optional software modules can solve gathered by: diffusion, wave propagation, acoustics, structural mechanics, electromagnetism, electrochemistry, microwave, micro electromechanical, optical, fluid dynamics, quantum mechanics, solid state chemistry, biology but also coupled problems, such as the electrokinetic and heat transfer in order to take into account the variation of conductivity with temperature.

**Numerical computation software MATLAB** (from Matrix Laboratory) is a development environment for numerical computation and statistical analysis that contains the programming language with the same name, made by MathWorks. MATLAB allows manipulation of matrices, visualization of functions, implementation of algorithms, creation of interfaces and can interact with other applications. Although it is specialized in numerical computing, there are packages [2] enabling it to interact with gender Maple symbolic computation engine. An additional package, Simulink 2014, provides the ability to perform simulations of dynamic systems and loaded using mathematical models. MATLAB is widely used in industry, in universities and it is cross-platform available, under various operating systems: Windows, GNU/Linux, UNIX and Mac OS.

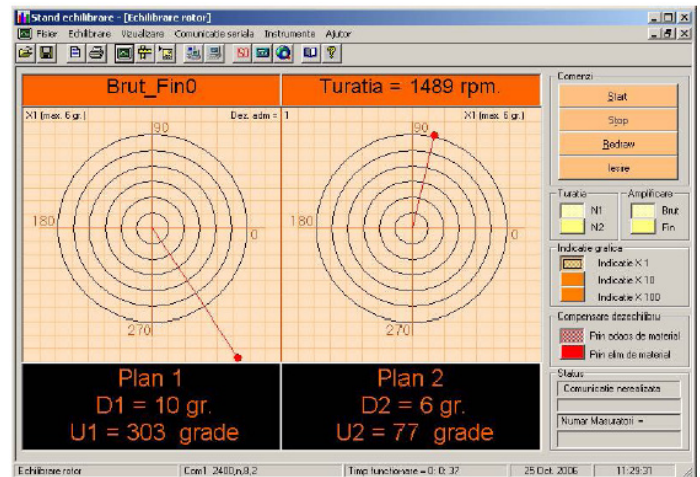
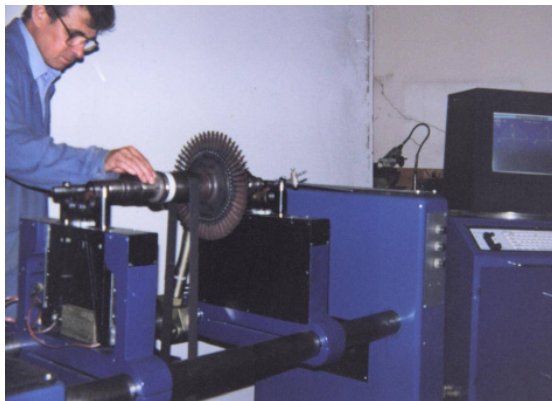
## J. DYNAMIC BALANCING TESTING; VIBRATIONS AND NOISE MEASUREMENTS



**VIBROPORT 41 (Schenck)** is a portable measurement equipment that allows:

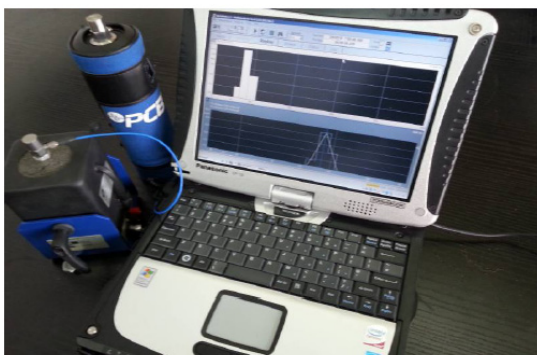
- experimental services for diagnosis of vibrations and dynamic behaviour of industrial machines and equipment;
- two-channel data acquisition;
- predictive diagnosis and maintenance of machines and equipment;
- 1-2 planes in-situ balancing with automatic determination of balancing weight and display the un-balancing value and position vector or editing the measurement document;
- measuring the level of shaft vibration;
- FFT signal analysis with 3200 points and frequencies;
- Nyquist diagrams display.

*Testing of 1-2 planes dynamic un-balancing (rotors for electrical machines, clutches discs, cardanic shafts, crankshafts, ventilators)*



### Features:

- it displays the un-balancing on a monitor, both graphical and numerical;
- working speed: 750 - 6000 rpm;
- weight of balancing pieces: 100 g - 100 kg.



*Vibroacoustical Analyzer  
Panasonic Soundbook type*

### Features:

- analysis of vibration monitoring (accelerations, speeds, displacements) on four channels simultaneously;
- Fourier analysis of signal spectrum in frequency;
- noise monitoring;
- can measure any mechanical vibration induced by an industrial equipment;
- possibility to storage spectrum values / aquisitions;
- CF19 operating system compatible with Windows XP;
- number of channels: 4;
- simulator of mechanical vibrations.



## K. ELECTROMAGNETIC MEASUREMENTS with HALL PROBE



### Field applications:

The magnetic characterization equipment is designed for execution of automated complex magnetic measurements, all devices being able to be controlled by a computer. Associated equipment are intended for a magnetic measurement system with Hall probe (with measurements in space) and a system with rotating coils.

### Functional parameters:

Hall probe calibration system with linear magnetometer Metrolab PT2025 + options:

- magnetic field in the range 0-2T;
- voltage: 220 VAC  $\pm$  10%;
- power: about 50 VA;
- frequency: 50 Hz;
- IEEE 488 interface (option included IEEE488);
- resolution 10<sup>-7</sup>T;
- sensitivity (voltage error) 160 mV/ $\mu$ T;
- 5 probes in the range 0-2T (1062-1-10M, 1062-2-10M, 1062-3-10M, 1062-4-10M, 1062-5-10M);
- gradient compensation coils – 3;
- 20 G/cm – 40 G/cm (1100-20, 1100-40 compensation coil) and 100 G/cm (ACC-1060 compensation coil);
- control oven in the range -25°C – 70°C (2060-High Stability Frequency Counter);
- standard permanent magnets with nmr homogeneity;
- (Nominal Field 0.01T, Nominal Field 0.05T, Nominal Field 0.10T, Nominal Field 0.30T, Nominal Field 0.50T  $\pm$  10%) (products: PM-1055-001F, PM-1055-005F, PM-1055-010F, PM-1055-027S, PM-1055-050N).

## L. TESTING in the field of FLUID MECHANICS

### *Wind tunnel for testing wind turbine experimental models*



#### **Field of applications:**

The wind tunnel for testing models of wind turbines is an aerodynamics testing stand operating at subsonic speeds which can be used for: wind microturbines with axis wind horizontal and vertical, scale models of wind turbines with horizontal and vertical axis, active aerodynamically subassemblies for wind micro turbines and scale models wind turbine, various aerodynamic testing for specific parts and subassemblies.

#### **Functional parameters:**

- test section: 1m x 1 m;
- test length: 1 m;
- working speed range: 2 - 30 m/s;
- total length of the testing stand: 10 m;
- loading system using a mechanical load for the wind rotors and for the wind rotor models in order to determine their mechanical and power characteristics;
- wind regime characterization: aerodynamic scale with maximum force of 50 N and maximum measured torque: 10 Nm;
- mechanical and energy parameters characterization: the stand is equipped with transducers to determine the rotational speed (the speed will be measured in the range between 10 - 3000 rpm) and torque to a turbine shaft in the range of 0.2 - 10 Nm;
- visualization system of the airflow and turbulence;
- acquisition system, analysis and display of the data from measuring equipment modules.

### *Testing stand for scale models of axial water turbines*



#### **Field of applications:**

The testing stand is designed for testing scale models of hydraulic turbine with horizontally and vertically shafts. The hydraulic stand operates in closed circuit and has a testing/visualization area for the flow within the channel.

The stand is a hydraulic aggregate that is built in a modular construction is sealed and has detachable components, which circulates clean water in a closed circuit. The main modules of the stand are: flowing section, testing section, water tank, pumps and variable-speed electric motors with frequency converters.

#### **Functional parameters:**

The stand is equipped with:

- a test/view area (transparent material) respectively the testing section with: 375 x 300 x 1000 mm;
- flow rate of the water in the test / view section adjustable between 0.05 m / s - 1 m / s;
- system for measuring and control of the water velocity and flow rate in the test/view section;
- system for simulating a mechanical load using Eddy current adjustable brake;
- system for measurement of the mechanical braking torque (0.1 to 1 Nm) and speed ranging from 40 to 400 RPM;
- system for acquisition analysis and data processing: rotational speed, torque and flow rate;
- system for plotting the stationary characteristics: mechanical power, mechanical torque depending on the speed (flow) of water for different speeds.

## *Waves channel*

### **Field of applications:**

It allows of adjusting the wave frequency by a drive mechanism with electric motor and a mechanism consisting of connecting rod – crank.



### **Functional parameters:**

size of channel: 0.3 x 0.4 x 3 m.

## *Installation for two-phase mixture studies*

### **Field of applications:**

This equipment has been designed to study the concepts concerning the mixing of liquids and it consists of a transparent cylindrical vessel equipped with a variable speed stirrer, electronic speed control, torque and speed measurement system.

### **Functional parameters:**

- vessel of transparent plastic material, with capacity of 25 liters, including removable baffles and drain valve;
- stirring shaft of AISI 304 stainless steel with interchangeable stirrer
- 8 stirrers of AISI 304 stainless steel with different design:
  - Rushton turbine;
  - 4 impellers with 2 flat blades;
  - impeller with 4 flat blades;
  - impeller with 4 pitched blades;
  - impeller with 6 flat blades;
- variable speed motor with digital indicator of r.p.m. and torque.



*Ultrasound measurement system for water flow and speed SonTek Flow*

**Field of applications:**

- measurement liquid speed in the range of 0.001 - 4.5 m/sec , in flow with free surface.



*Acoustic Doppler Velocimeter 3D*

**Field of applications:**

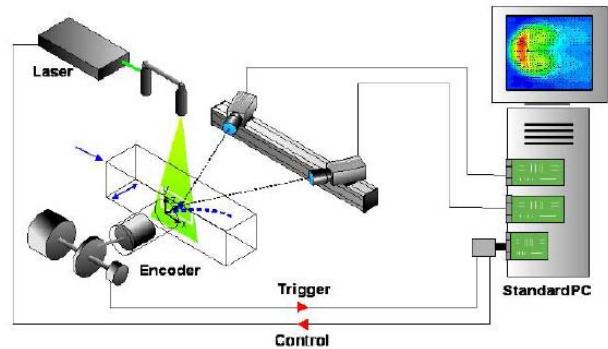
- measurement of liquid speed in the range of 1 mm/s ÷ 2.5 m/sec., in flow with free surface.



## *Fluid water velocity measurement equipment - Particle Image Velocimetry 3D (PIV 3D) -*

### **Domeniu de utilizare:**

3D - PIV measurement system is used for a series of scientific research and application related to 3D flows in fluid media: air and water, and air-water two-phase flow. It is used to determine the instantaneous velocity field and flow lines.



### **Functional parameters:**

- 3D PIV system enables non-intrusive measurement of instantaneous velocities by optical means;
- stereoscopic measurement method allows the evaluation of the 3 components of velocity simultaneously in a plan to give instantaneous speed fields;
- minimum speed range of operation: air 0-50 m/s; water and biphasic environment: 0-20 m/s, allowing phase separation.

### **Reference components:**

- **Pulsed laser source** with two cavities, minimum energy 2 x 200 mJ, and the minimum operating frequency of 15 Hz;
- **Optical system** for generating laser light plane is equipped with:
  - a base module for generating light plane,
  - a module for focusing the widest range possible (eg. 100-5000 mm),
  - optical modules that allows varying the angle of light plane between 5° and 60°.
- **a synchronization unit** between the various hardware components;
- **the software acquisition package** for control and data processing compatible with the operating systems Microsoft Windows 7 and 8, 64 bit allowing total control of all devices that compose 3D PIV system (laser source, cameras etc.);
- **two fast CCD cameras**, encoding 12 bits gray level, with image acquisition rate of at least 30 Hz at a resolution of 4 megapixels;
- **special stereoscopic Mira:** for 3D PIV system calibration;
- **synchronization:** synchronization electronic unit between cameras and laser source - autonomous system;
- **software acquisition package, control and data processing:** acquisition module and control module of the instantaneous velocity fields; module for advanced calculation correlation; module for generating the adaptive correlation grid for computing; stereoscopic PIV measurements module;
- **atomizer** for air dispersion of tracer particles.

## M. TESTS of CELLS, MODULES and INVERTORS for applications with PHOTOVOLTAIC PANNELS

### *Solar array simulator power supply*

#### **Field of applications:**

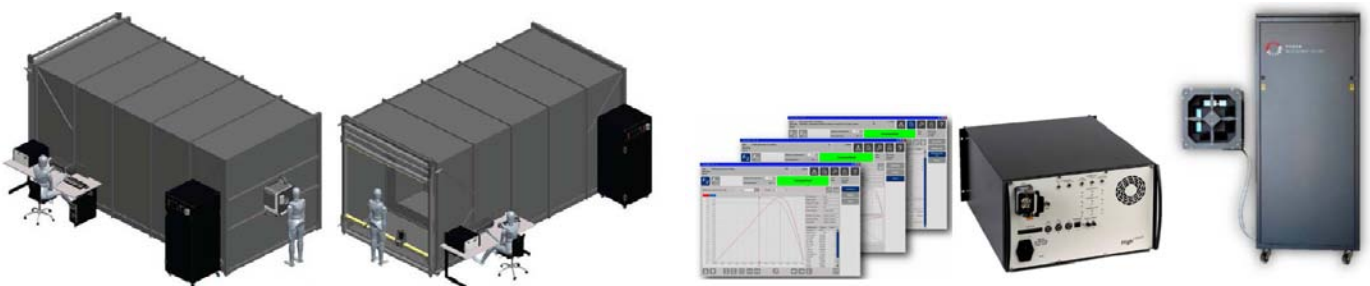
The programmable solar array simulator power supply 62150H-600S & 1000S released by Chroma provides simulation of Voc (open circuit voltage) up to 1000V and Isc (short circuit current) up to 50 A and 30kW maximum power. It can simulate the I-V curve from the early morning to nightfall for PV inverter testing or dynamic I-V curve transient testing.



62150H-600S/1000S model  
600V/1000V/15kW

A620027/A620028 model  
Slave Unit  
600V/1000V/15kW

### *Solar power simulator for PV modules tests*



#### **Functional parameters:**

The accuracy of the power measurement is set by the quality and reliability of the sun simulator in compliance with the IEC Standard 60904-9.

The PASAN Mayer Burger SunSim 3c could be rated class AA – AA – AA (or A+ according to TÜV).

Non-uniformity of irradiance  $\leq 1.0 \%$ ;

Pulse instability (long term)  $\leq 1.0 \%$ ;

Spectral irradiance distribution  $\leq \pm 12.5 \%$ .

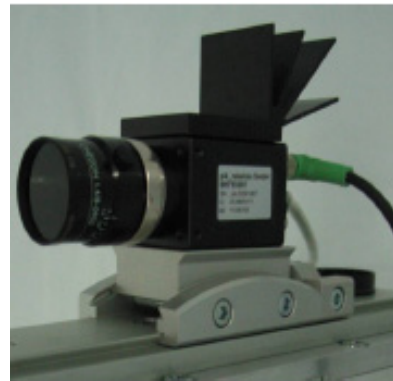
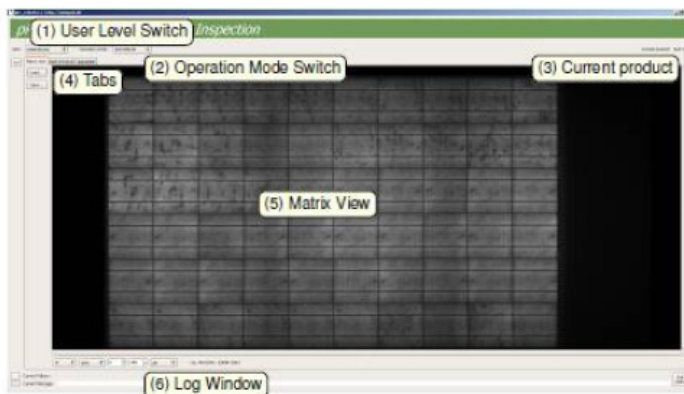
### *Testing at high potential for PV modules*



#### **Field of applications:**

Potential Induced Degradation (PID) is a phenomenon which affects some PV modules with crystalline Si cells and leads to gradual deterioration of performance, reaching up to 30 percent and more after a few years. The compact tester of series LG 1800 combines protective wire, insulation, high voltage, leakage current, function and continuity test in one device allowing tests according to many standards (IEC, EN, UL, VDE etc.). The tester is optimally suited for manual workstation and for production line and laboratory.

### *Electroluminescence inspection system for PV modules*



#### **Field of applications:**

*Elporti pi4 SOLAR* is an electroluminescence inspection system for PV modules, developed for mobile use. It is characterized by excellent image quality because of the use of high-quality industrial camera. Visualize concealed damage in PV modules locally.

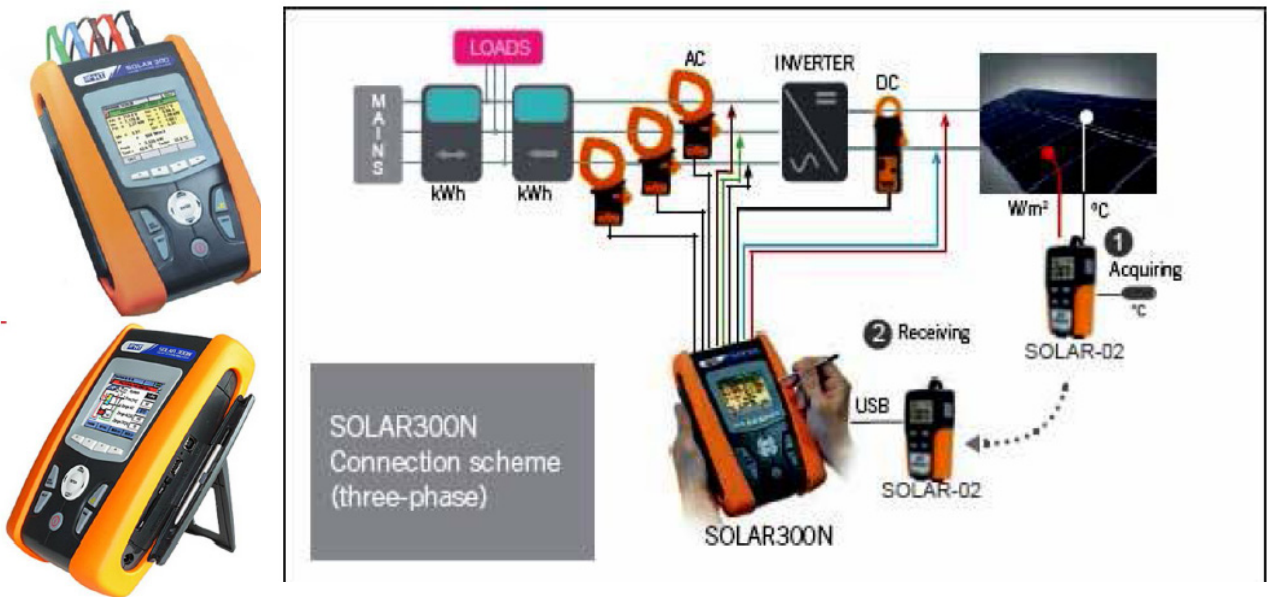


## *In-situ System for testing and monitoring of PV modules and systems*

**The SOLAR 1000** is an automated data acquisition system specifically designed for solar monitoring applications. The standard package is designed to meet CaISO standards. Typical applications include pre-construction phase solar resource assessment, baseline data collection, and performance monitoring. The Solar1000 simplifies the process of collecting system data by acting as the single point data gateway for environmental, inverter, and meter data.

**Solar 300 N** allows carrying out all tests required for the verification of the efficiency of single-phase and three-phase photovoltaic systems. Testing photovoltaic systems requires contemporarily measuring environmental parameters (incident irradiation of modules, temperature of environment and modules) and electric parameters (continuous power, alternating power). Measures on PV modules in compliance with IEC/EN60891 and IEC60904-5.

It is also a powerful instrument for the complete analysis of mains quality in compliance with standard EN50160 (harmonic analysis, analysis of voltage anomalies, flicker, unbalance).



Another equipment is the multifunction instrument PVCHECK which allows prompt and safe electrical checks required for a PV system (section DC) as well as controls on working of modules / strings in accordance with IEC/EN62446 guidelines. PVCHECK verifies the continuity of the protective conductors (and the associated connections) and executes insulation resistance measurement of the active conductors on a module, a string or a photovoltaic field in accordance with the requirements of IEC/EN62446, without the need of short-circuiting the positive and negative terminals. PVCHECK allows verification of a PV string's working in accordance with the requirements of IEC/EN62446 by measuring the open circuit voltage and short-circuit current under operating conditions and reporting the results to STC (by means of radiation measurement).

It provides an immediate outcome for both absolute measurements and for measurements compared with the previously tested PV strings.

PVCHECK also allows carrying out performance analysis of PV array (DC) under operating conditions (connected to the inverter) providing an indication of the power generated and the efficiency of the field as specified by IEC/EN62446.

*Test kit  
PVCECK*



## SOFTWARE for SYSTEMS PHOTOVOLTAIC PV Syst, PV Sol, METEONORM

### **Field of applications:**

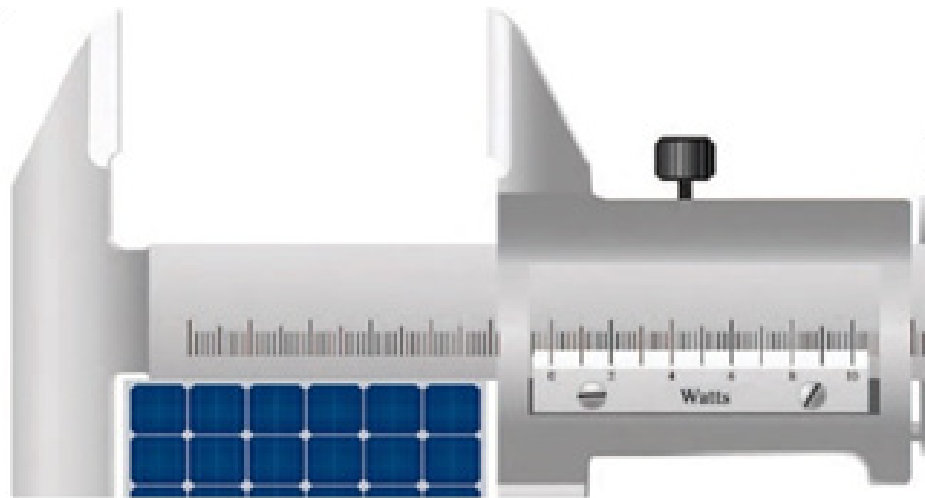
This software is used by the *Laboratory for research and testing of photovoltaic panels* for testing the photovoltaic models in real conditions.

## SOFTWARE for SYSTEMS PHOTOVOLTAIC AUTOCAD electric 3D+, 4Autocad

### **Field of applications:**

This software is used by *Laboratory for research and testing of photovoltaic panels* for modeling and simulating the current electrical and thermal phenomena of photovoltaic cells and panel and for designing of energy structures based on photovoltaic panels.

## MAINTENANCE SERVICES FOR PHOTOVOLTAIC POWER PLANTS



### General description:

The Department of Efficiency in Energy Conversion and Consumption from ICPE-CA presents a general proposal for maintenance services related to operating or in ongoing commissioning PV power plants and systems. The maintenance services are addressed to PV power plants owners, operators and contractors of Operating and Maintenance services (O&M).

The PV electric current - voltage characteristic and modules' power can be measured with a precision of 0.5%. Also, PV modules can be tested by using field electroluminescence or at the customer's location.

ICPE-CA provides technical expertise and turnkey power solutions for both photovoltaic power plants which are building integrated (BIPV - Building Integrated Photovoltaic) or ground mounted.

A photovoltaic (PV) plant is essentially an electrical power system with very few elements impacted by regular ageing and damage. However, overstraining due to high temperatures and electrical overloads may be substantial in the case of inverters, switches and other system components. In addition, the components exposed to weather fluctuations require continuous supervision in order to avoid premature damage.

*Preventive Maintenance* (PM) represents the service which, by scheduled system interventions, avoids the accidental fall of the essential components related to the photovoltaic system. Constant monitoring, associated to a *Condition-based maintenance* (CBM) program, is indispensable to providing a high **PR** (*Performance Ratio*).

In the frame of maintenance contracts, intensive monitoring of the operating parameters and technical conditions regarding the photovoltaic installation is carried out. All the gathered data is stored in the monitored system database and is used as a constant resource for periodic reports on the performance of the photovoltaic system. Each maintenance activity is recorded in the operating and maintenance report of the supervised PV plant and transmitted to the customer monthly. In addition, all the warranty claims towards the suppliers are technically handled by ICPE-CA along with the PV system operator. All the activities focus on cost efficiency and safety regarding the operation of photovoltaic installations.



**Preventive** (or planned) **maintenance**, abbreviated as **PM**, includes routine inspections and equipment maintenance, defined by technical specifications, with a fixed frequency established by equipment type, environmental conditions and warranty terms. The purpose of PM maintenance is to prevent unnecessary damage and production losses (power losses).

This approach is becoming increasingly popular due to the fact that it significantly reduces the probability of unplanned withdrawing from service of the PV power plant. Optimization and moderate costs associated to PM activity comparing to the total cost will always be considered, thus avoiding unnecessary activities.

The intervention usually begins with the visual inspection of the equipment, in particular of the PV modules. There are searched the hotspots which are visible to the naked eye in case they were caused by bird droppings or glass breakage of one or more modules (as a result of vandalism or rainfall) or visible only by using the thermal camera in case the connection between the cells is interrupted, a protective diode in the panel connection box is short-circuited, one of the PV cells is broken or the encapsulation film is frosted.

**Corrective maintenance** is the intervention that is typically performed following Preventive Maintenance (PM) finding when an inappropriate operation of an inverter is detected (for example, entering limiting / protection mode, with or without real justification, or entering thermal protection due to inadequate ventilation) or when relatively low power produced by a series of modules is encountered (one of the string's modules is provided by power losses). It is usually solved by adjusting / repairing (in case of inverters) or replacing / repairing the faulty module. The Corrective Maintenance is different from Reactive Maintenance. The latter involves interfering with a PV system or equipment when it is already out of service. In general, preventive maintenance (scheduled according to the contract) associated with the corrective maintenance which is described above apply where the monitoring equipment does not provide sufficient information to allow a Condition-based maintenance program.



**Condition-based maintenance**, abbreviated as **CBM**, uses real-time data from PV power plants in order to anticipate faults and/or lower performance and prioritize activities maintenance and resource allocation. Intervention is performed if one or more indicators show that the equipment will fail or the performance of the equipment deteriorates.

For the most part, PV power plants are equipped with hardware and software equipment which offer real-time data on the state of the PV system such as: DC and AC (active and reactive) power, electric current and voltage at the inverters' input and output of, **PR** (Performance Ratio), weather data (temperature, humidity, wind speed and solar irradiation) and other data depending on the complexity of the monitoring equipment. Such a system determines the state of a PV power plant (PV panels, inverters, connection boxes, cables, connectors, etc.), intervening when necessary (Example: decrease of PR, the current /power of an inverter drops inappropriately compared to the other inverters etc.). The intervention consists in performing specific parameter measurements in the area where a disturbance has been identified, on the DC side comprising the area of PV panels along with cables, connectors and **Stringer Boxes** or the alternating AC side with inverters, cables and connection boxes. Both universal instruments (voltmeter, ammeter and ohmmeter) as well as equipment specific to PV system measurements are used. The measurements that determine the status of PV panels must be performed according to the SR EN 61829:2016 Standard – “*Photovoltaic (PV) array. On-site measurement of current-voltage (IV) characteristics*”, according to the SR EN 60904-1 Standard, Art. 5 – “*Measurement of the current-voltage of photovoltaic devices in natural light*” and according to SR EN 60904-1 Standard, Art. 7 – “*Measuring the current-voltage of photovoltaic devices in pulsed solar light*”.

Following the interpretation of the IV characteristics, there are determined the following: the degradation state of a PV panel (by comparison to the initial parameters), the failure of a cell, an interrupted or degraded connection of the connectors or cables, or, more seriously, the effect of PID (Potential Degradation Induced). A complete analysis of a PV module also involves electroluminescence (field test) for crack detection or PID (the most serious) effect..



**Reactive maintenance** is performed after the equipment has ceased to work. It is opposed to the *Preventive Maintenance (PM)*, which faces a pre-established program. *Reactive Maintenance* (also known as "*Maintenance of Malfunction*") is limited to bringing the equipment to its normal operating condition after being defective. Faulty equipment is replaced or repaired by replacing defective parts / components in accordance to the service contract specifications.

Emergency repairs cost 3 to 9 times more than the planned repair, so maintenance plans that are based on Reactive Maintenance are generally the most expensive. This type of maintenance is expensive due to the fact that failures occur accidentally during production (instead of pre-programmed maintenance interruptions) while the period and cost of spare parts supply is relatively high. Special transport is needed and also the maintenance personnel are often needed to work overtime in order to complete the equipment repair.

### Cost of maintenance services

<i>Crt. No.</i>	<i>Budget article</i>	<i>Comments</i>
1,	Total Budget	It is determined depending on the area's climatic conditions, the extension of the guarantee, the access to public roads, the access to water supply, the distance to the first urban area etc.
2,	General maintenance of the PV power plant	It is determined by the size of the PV power plant, by its location (if the winter seasons are characterised by heavy snow which needs to be removed), by the planned interventions frequency.
3.	Verification and analysis of wiring and the DC and AC electrical components	It includes the verification of cables, junction boxes, connection boxes, AC / DC switches, PV panels and strings. The price depends on the coverage level of the park's surface. If the inspection is achieved on 10% of the surface, a minimum price is imposed. If the inspection is achieved on the entire surface, the maximum price is established. There are achieved two inspections per year or when a fault is occurring during the daily monitoring of the plant.
4.	Washing the PV panels	The price is based on the washing technology, the location salary levels (the cost mostly covers the labour). It also can be appreciated depending on the surface of the panels.
5.	Vegetation cleaning	The cost is based on the grassed surface (the nature of vegetation) and the number of necessary interventions.
6.	Maintenance of inverters	The cost covers filter cleaning, thermal imaging analysis, small repairs (replacement of internal components), and periodic efficiency verifications.
7.	Replacement of inverters	It consists of replacing the inverter once after the warranty period. Depends on the characteristics of the inverter.
8.	Spare parts	Implies the existence of a stock of materials, fuses, contacts, connectors, cables, circuit boards, filters, fans and PV modules. It includes both the price of the components and their storage in the PV plant location.

## N. ELECTRIC MOTORS TESTING

### Testing the electric motors with maximum power of 130 kW



#### Functional parameters:

Maximum testing speed: 1500 rot/min.;  
Digital oscilloscope TPS 2024 including current probes A 622, A 621;  
Megohmmeter HT 7051;  
Digital multimeter DMM4050;  
Equipment for measuring the filed magnetic parameters with power options 230V, OPT.CABLU RS 232, OPT. software;  
Hydraulic platform MARCO -MO-020080-D2;  
Hydraulic workshop crane of MK S 750 DW type;  
Measurement and acquisition system of DTS-160 type;  
Portable computing system of DELL VOSTRO type;  
Converter SP 7411-F1 1600 kW.

### Testing the electric generators with maximum power of 7.5 kW

#### Functional parameters:

Maximum speed of use : 800 rot/min;

The stand has the servomotor of AC-M2n2000 type and driving of SSD-637f type;

Aquisition module Spider8 has 4 aquisition channels with resolution of 16 bites up to 9600 samples/s on all channels simultaneously;

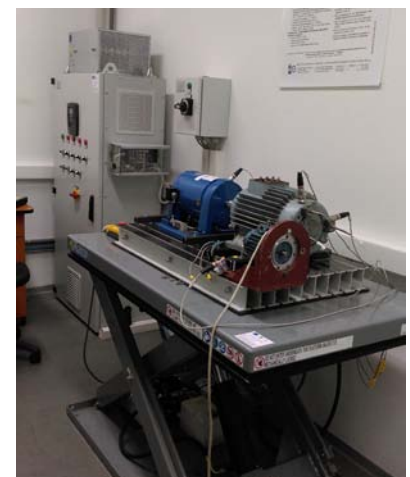
Transducer for measuring the torque T4WA-S3/200Nm, made by HBM, has the following features:

- rated torque 200 Nm at nominal positive/negative value of  $\pm 10V$ ;
- 360 of pulses with 5 V to one rotation;
- measured speed in the range [0, 3000] rot/min., measuring the torque in both directions.

### Testing stand for high speed electric motors

#### Field of applications:

Test stand designed for high speed electric motors is equipped and used for electromechanical testing. These electric machines are generally used for driving tools used for finishing surfaces. The test stand is capable of making measurements of characteristic parameters of electric machines (winding electric resistance in cold conditions, idle and short-circuit operating parameters, mechanical characteristics, heating test and characterization during in load operation).



#### Functional parameters:

Electric machines that are intended to be tested should have the following characteristic values:

- maximum rated power: 17 kW;
- maximum speed: 50 000 rot/min.;
- maximum supply voltage of electric machine: 400 V;
- the measurable frequency range of the supply voltage of the electrical machines: 0 - 1700 Hz.

## O. SERVICES of INTEGRATED MANAGEMENT of QUALITY-ENVIRONMENT

### Consulting:

- alignment of the internal environmental legislative framework at the national and international law requirements;
- certification and implementation of the Integrated Management System of Quality-Environment according to ISO 9001 and ISO 14001;
- management and conservation of natural resources based on ecological principles, paying special attention to materials recycling;
- obtaining of clean and lower polluting technologies to protect the natural capital and to reduce / to eliminate the pollution effects;

### Studies:

- assessment of the occupational disease risks with appreciation of work safety and environment protection;
- scientific justification and development of the sustainable strategy at the economic entity;
- improve the quality of the environment by implementing technical-economical, juridical and administrative measures at the economic entity.

### Equipment:



*Portable Sound Level Meter  
12 model, made by Pulsar Instruments Ltd.*

### Functional parameters:

- measuring range:  $35 \div 130$  dB(A);
- operating temperature:  $-10 \div + 50^{\circ}\text{C}$ ;
- size:  $L=120$  mm,  $l = 70$  mm;
- acoustic calibrated using an external reference.



*Emission Gas Analyzer  
A97PRO type, made by WTW GmbH*

### Functional parameters:

- compact analyzer of burning gas to make all necessary measurements and calculations to assess the heating systems with a preparation system for gas and data management;
- portable equipment;
- measures and displays:  $\text{O}_2$  concentration (0.1 – 20.9%), CO (0 – 4000 ppm), NO (0 – 2000 ppm), NO<sub>2</sub> (0 – 500 ppm), combustion air temperature ( $-20$  –  $125^{\circ}\text{C}$ ), stog temperature (0 –  $850^{\circ}\text{C}$ ), Pr;
- it determines and includes: CO<sub>2</sub> (in %), NO<sub>x</sub> (0 – 2500 ppm), fuel efficiency (0 – 100%), air excess (0 – 250%), stog loss (0 – 100%), dew point in  $^{\circ}\text{F}$  or  $^{\circ}\text{C}$ ;
- built-in memory for 890 individual records for fuel tests.





*Portable Laboratory Photometer  
PHOTOLAB S 12 type, made by WTW GmbH*

**Functional parameters:**

- measurements for the whole reactivities domain, from Al to Zn;
- portable version;
- 12 filters and photodiodes network;
- simultaneous measurements for the turbidity correction;
- optical system without usable mechanical components;
- memory for 1000 data;
- software "Multi/ACHAT II" to transfer the stored data to the PC.

## P. MOBILE ENVIRONMENTAL LABORATORY



Many research activities have been held and are still ongoing in INCDIE ICPE - CA for environmental protection and renewable energies sectors. Evaluation of pollution level referring to different environmental factors (water, air and soil) as well as of noise level, can only be achieved by using high performance equipments to monitor pollution on the site and to allow a real time intervention if there are registered some non-compliance with environmental legal requirements.

Persistent Organic Pollutants, transformer oils, CFCs, volatile organic compounds, pesticides and polycyclic aromatic hydrocarbons are only few of many very harmful pollutants that exist in the environment and those concerns is regulated by EU and national legislation. Also, monitoring of biochemical processes that occur in plants for conversion of organic materials into biofuels such as ethanol, biogas, is very important for obtaining valuable products with a minimum of energy and materials need.

The noise produced by cars and industrial equipments is also an environmental factor to be monitored both to ensure optimal working conditions for operators and to identify any damages in order to remedy them in a proper time.

Meteorological parameters like wind speed and direction, air temperature and humidity, atmospheric pressure are essential for monitoring of emissions and imissions in the environment, but also for evaluating the real potential of renewable resources.

Due to the multiple research needs within the existing research projects, and also to the environmental protection and energy sector regulations which are becoming more and more stringent, it was considered absolutely necessary to supplement the INCDIE ICPE-CA research equipments with a mobile environmental laboratory to provide environmental analysis services for determination of different environment pollutants at a high level of quality.



*Portable Spectrophotometer  
WTW PHOTOLAB S 12 type*

**Field of applications:**

The determination of the inorganic and organic compounds in:

- drinking water;
- natural water;
- municipal and industrial wastewater;
- sludge from sewage plants;
- fermentation sludge;
- other laboratory applications.

**Functional parameters:**

- portable and laboratory photometer with 12 filters and photodiodes network;
- simultaneous measurements of turbidity correction;
- LCD display for operation and measurements instructions;
- 2 compartments with reaction containers of 10, 16, 20 and 50 mm;
- automatically selects the working method by container code;
- extended memory to store 500 data sets;
- keyboard to insert the code or value;
- software data processing and transfer to PC.



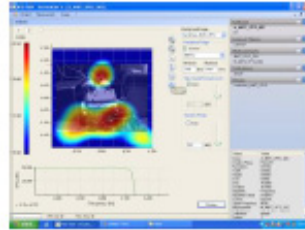
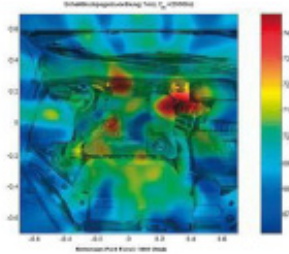
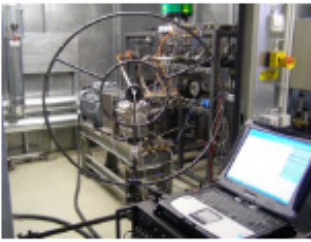
*Portable Oxygen Meter  
OXI 315i type*

**Field of applications:**

Determination of the oxygen concentration and temperature in natural waters (rivers, lakes), drinking water, wastewaters, aquariums and fish ponds etc.

**Functional parameters:**

- portable and laboratory equipment;
- automatic temperature display;
- compensation of pressure and salinity;
- it includes calibration system, exchange membranes, cleaning solution, electrolyte solution, abrasive film;
- data saving.



*Noise Level Measuring Equipment - ACOUSTI CAM*

**Field of applications:**

Determination of the ambient and industrial noise.

**Functional parameters:**

- designed for drawing minimum 2D noise maps;
- the system will allow measurements of noise in indoor applications for laboratory applications (anechoic room) and outdoor applications;
- based on Acoustic Camera method (video camera + 30 measuring microphones);
- frequency range: 200Hz - 12kHz;
- measurement distance: 0.4 - 150m;
- the system allows development by programming own custom application using data post-processing software (MatLab type) and includes the source code of the data recording system (data acquisition);
- the software for analysis and evaluation of noise includes minimum 3 algorithms: the time domain, frequency domain and orthogonal beam-forming (to detect high-level noise sources);
- portable system which allows both DC (12-24 V) and AC (200-240 V).



*Weather Station*

**Field of applications:**

Determination of the weather parameters.

It is fitted with the following sensors for analysis of the weather parameters:

- **Ultrasonic Anemometer**

WindSonic type



- Sensor for wind direction and speed (direction 0-360°; speed 0-60 m/s).

- **Temperature and humidity sensor**



- temperature sensor in the range of  $-40^{\circ}\text{C}$  ...  $+60^{\circ}\text{C}$  and relative humidity sensor in the range of 0...100%;
- fitted with solar rays protection case.

- **Pressure sensor**



- designed for air pressure in the range of 825 – 1050hPa.

Equipped with telescopic pneumatic mast, extension height up to 10 meters.

## Chemical and microbiological analysis



*SGas Chromatograph/ Mass Spectrometer  
VARIAN GC450/MS240 type*

### Field of applications:

Designed for a wide range of applications in the research, industry, environment analysis, biofuels monitoring processes. Qualitative and quantitative chemical analysis of organic compounds in liquid and gaseous samples with application to biofuels and environment protection.

Monitoring the biochemical processes in bigas units, characterisation of biomass, biogas and other organic products.

Fitted with FID, ECD and TCD detectors, mass spectrometer. It includes software for chromatograph control, acquisition and data transfer components, printer etc.



*Chemical Oxygen Demand Analyzer  
GERHARDT type, Kjeldatherm model*

### Field of applications:

Determination of the organic loading in wastewaters, organic slurries for assessing the pollution level in terms of total organic compounds.

For wet digestion of various samples of biomass and wastewaters.

The analyzer is a compact heating system with 8 positions, electronic control of temperature and protection against overheating. It is based on CCOCr method.

The required heating up phase of the samples to around 148°C is reached in less than 10 minutes.



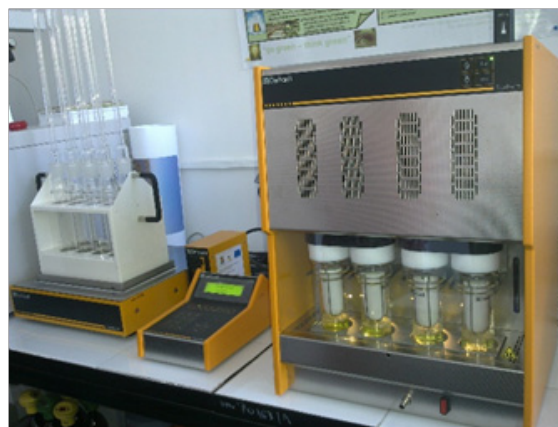
*Biochemical Oxygen Demand Analyzer,  
WTW OxiTop - IS 6 type*

### Field of applications:

Determination of microbial loading in waters, wastewaters and organic slurries by determination of microbiologically decomposition of organic compounds.

It can be used also for determination of the anaerobic digestion effectiveness in anaerobic digesters.

It is fitted with a specific system for pressure control and a 6 bottles device for measurement of dissolved oxygen.



*Fat/Oils Extraction System,  
Gerhardt type, Soxtherm model*

### Field of applications:

Determination of fat/oils content in various samples such as contaminated soils, oilseeds, food etc.

Extraction of plant components in organic solvents, quantitative separation of oil phase in liquid mixtures.



*Total Organic Carbon/Total Nitrogen (TOC/TN) Analyzer,  
ELEMENTAR type, VarioTOC CUBE model*

**Field of applications:**

Determination of TOC and TN in biomass, wastewaters, organic slurries.

Assessment the biomass feedstock to be used in bioreactors for biogas production.

Measurement range for TOC: 0 – 60.000 ppm (mg/l) with no dilution;

Measurement range for TNb: 0 – 700 ppm (mg/l).



*Spectrophotometer  
WTW Photolab S12 type*

**Field of applications:**

Determination of the physical-chemical parameters in wastewaters and fresh waters: anions, cations, turbidity, residual hardness etc.

It is a high-precision, laboratory photometer. It features easy operation, simultaneous turbidity measurement and compensation. Automatic check of the optical system and zeroing on action. Graphic display with instructions. The AutoSelect function recognizes cuvettes via barcode; all necessary settings automatically of more than 150 methods.



*A Magnetic Stirrer Hotplate,  
HEIDOLPH type, MR Hei-Tec model*

**Field of applications:**

Preparing of mixtures, broths, solvent evaporation etc.

Heating power: 800W;

Temperature range: 20 – 300 °C;

Stirring speed: 100 – 1400 rpm;

It is provided with a contact thermometer and provides overheating protection.



*Oven/Incubator/Sterilizer,  
Mettmert type*

**Field of applications:**

Sterilization of laboratory materials, incubation of biological samples.



*Vertical Autoclave,  
Systec V-150 type*

**Field of applications:**

Sterilization of broth, materials, laboratory vessels, decontamination of biological waste.



*Biological Cabinet Astec Microflow,  
ABS 1000 model*

**Field of applications:**

Preparing of biological samples in aseptic environments. It protects the operator against any microbiological contamination.



*Inversed Optical Microscope,  
Nikon Eclipse Ti-E type,  
fitted with confocal system Eclipse C1si*

**Field of applications:**

Microscopically analysis of biological samples, wastewaters, study of ecosystems in wastewaters.



*Thermostatic Water Bath  
RAYPA type, BAC-1 model*

**Field of applications:**

Heating/ solving of solutions/components, preparing of broths, laboratory vessels cleaning etc.

It is completely made of stainless steel with mechanical temperature adjustment, tank capacity 2.5l. Temperature range ambient +5°C up to 105°C.





*pH-meter, Hanna Instruments type, PH 211 model*

**Field of applications:**

Determination of the acidity/alkalinity of liquid and semi-liquid samples (biomass, slurries, aquatic solutions).

It is a microprocessor-based pH and temperature bench meter. The pH measurements are compensated for temperature effect manually or automatically.



*Pressure vessels for 0, 2, 4, 6 bar, KRAUTZYBERGER type*

**Field of applications:**

Anaerobic digestion tests under different hydrostatic pressures and mesophilic temperature range, for assessment the behavior of anaerobic microorganisms in large bioreactors applications.

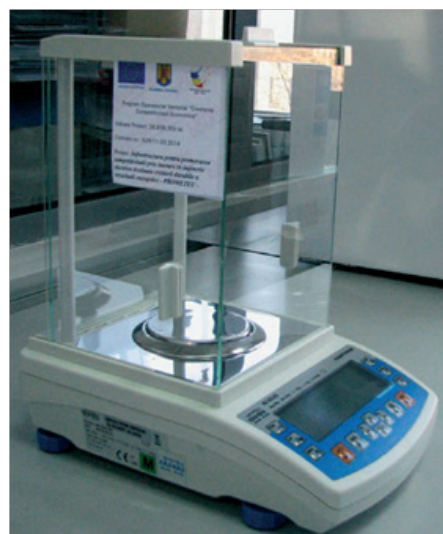


*Vacuum Drying Oven  
SELECTA type, Vaciotem-T model*

**Field of applications:**

For laboratory activities, the equipment serves for drying the wet samples, removing the organic solvent after fat extraction.

It is fitted with vacuum pump and set of vacuum connection from pump to the oven. It is designed for drying at adjustable temperatures from 35°C up to 200°C with a temperature fluctuation of  $\pm 1^\circ\text{C}$ .



*Analytical Balance  
AS 220R2 type*

**Field of applications:**

Samples weighing for laboratory analysis.



*BOD Thermostatic Box,  
WTW type, OxiTop Box model*



*Laboratory Refrigerator,  
Candy type, ML CFO050 model*

**Field of applications:**

The device serves to regulate the temperature of the measuring instruments for the biochemical oxygen demand according to the self-regulation procedure.

It is especially suitable for the Biochemical Oxygen Demand Analyzer, model WTW OxiTop – IS 6 and to incubate samples for BOD analyzes.

The box is heat insulated and is set to  $20^{\circ}\text{C} \pm 1\text{K}$ .

A blower provides permanent air circulation.

The refrigeration cycle is hermetically sealed and contains evaporator, condenser and an automatically ventilated refrigerating unit.

**Field of applications:**

Conditioning and preserving of water, wastewater, slurry and biomass samples before laboratory analysis.

Capacity: 46 l;

Power consumption: 108 kWh/an.

## **R. SERVICES offered by *the INCDIE ICPE-CA Sfântu Gheorghe BRANCH***

### **Activity domains:**

- research and development in other natural sciences and engineering;
- consultancy in business and innovation.

### **Offered services:**

- research and development services;
- assistance and consultancy to obtain experimental models and prototypes;
- consultancy for protection of the intellectual property;
- assistance in finding the international business partners;
- tehnology transfer;
- consultancy in accessing the European funding programs;
- consultancy in innovation management;
- contact point for Enterprise Europe Network.



*Servicii de consultanță la dispoziția  
intreprinderii dumneavoastră*

### **Contact:**

INCDIE ICPE-CA Sfântu Gheorghe Branch  
4 Presei Street, 520064 Sfântu Gheorghe  
Covasna County  
Phone / fax: 0040-026 732 73 95  
email: ecomat@icpe-ca.ro

## **S. SERVICES offered by *the Technological and Business Incubator ITA ECOMAT ICPE-CA Avrig***

### **Offered services:**

- physical incubation of SMEs;
- assistance for the establishment of start-ups and spin-offs;
- research and development services;
- assistance in finding the international business partners;
- tehnology transfer;
- consultancy in financing the research projects.

### **Contact:**

Work point INCDIE ICPE-CA, Avrig-Mârșă  
1 C. Coposu Street, Avrig-Mârșă  
Sibiu County  
email: ecomat@icpe-ca.ro

## **T. SERVICES offered by the Technology Transfer Center ICPE-CA (CTT ICPE-CA) Intellectual Property**

- specialized activities for technology transfer, including the development of models and prototypes, consultancy for the implementation of the technology transfer;
- promoting the use of patents owned by ICPE-CA and of other R&D activity results of ICPE-CA by licensing, know-how transfer and setting up of spin-offs;
- consultancy / assistance in negotiation of contracts of licensing or know-how transfer;
- consultancy in preparing the documentation for protection of the intellectual property and exploitation of the property rights;
- information and consultancy in identifying the financial support schemes for the implementation of research results in SMEs;
- facilitating SMEs' access to technological services and research infrastructure of INCDIE ICPE CA.

## **U. MARKETING**

- classical and electronic (internet) marketing for the institute;
- development of the laboratories interconnection for communication, informing, collaboration and dissemination of information;
- development of the interconnections with other institutes, research networks, consortia for establishing of partnerships, regional programs, databases;
- developing the personnel informing frame by acquiring specialized books and subscriptions to scientific journals;
- organizing scientific events; participation in fairs and exhibitions;
- marketing in promoting and valuing the patents, products, equipments and services developed by the institute.

## **V. BIBLIOGRAPHIC INFORMATION**

### **offered by the BUREAU OF MANAGEMENT OF KNOWLEDGE AND INFORMATIONS / PUBLIC RELATIONS**

- public relations;
- development of the information by purchasing specialized books and subscriptions to scientific journals.
- publicizing the ICPE-CA products and services;
- management of ICPE-CA knowledge and informations;
- technical library of ICPE-CA.



INCDIE ICPE-CA  
313 Splaiul Unirii Street,  
District 3, Bucharest  
Postal code 030138  
Phone: +40-021-346.72.31  
Fax: +40-021-346.82.99  
E-mail: office@icpe-ca.ro, marketing@icpe-ca.ro  
www.icpe-ca.ro

