New technologies – discover Poland
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We are living in the age of remarkable technological change that is pushing us to take a closer look at the connections between technology and economic development. The harder we think about it, the more we realize that technological innovation is key to long-term economic growth. Although market economy has a great deal to do with innovation, it is not purely a market-driven phenomenon. Innovation is science based. Therefore the quality of higher education is fundamental to the success of the national innovation strategy.

The bondage between science and economy is obvious. However, we have to put greater emphasis on promotion and exchange of fresh ideas, new scientific discoveries and their economic application. This not only streamlines efforts focused on finding new scientific partners and markets all over the world, but also helps making the innovation process work more effectively.

This publication is dedicated to the latest achievements of Polish science. The reader will find a representative collection of Polish scientific and technological discoveries in selected research areas. This booklet is only an introduction to the Polish scientific potential. It confirms that Poland is a creative and reliable scientific and business partner.

I am proud to present you this informative publication entitled “New technologies – discover Poland”. I hope it will encourage you to discover it also personally, through visits and direct business contacts.

Beata Stelmach
Undersecretary of State
Ministry of Foreign Affairs

Showcasing the newest works by innovative Polish scientists is the perfect occasion to recall the Polish scientific tradition, whose achievements have gone down in the annals of European and global science for many centuries. The first member of this Pantheon is without a doubt Mikołaj Kopernik – alumnus of the University of Bologna, one of the most recognizable figures in the history of science, and the author of what is perhaps the most significant revolutionary discovery in modern scientific research. Let us also recall Maria Skłodowska-Curie, the great physicist and chemist who, first with her husband and then through independent research, led to a breakthrough in physics and chemistry. This list would not be complete without Jan Czochralski, whose discoveries in crystallography constitute the foundation of global innovations in computer technology. It is also worth mentioning Ernest Malinowski – the great constructor of the trans-Andean railway; Ralph Modejski – the creator of unique urban engineering projects; our mathematicians and logicians: Stefan Banach, Stanisław Ulam or Alfred Tarski; as well as the benefactor of children all over the world – Hilary Koprowski, who invented the polio vaccine.

With great appreciation we should recall the activities of Polish physicists: Stefan Pienkowski, Leonard Sosnowski, Leopold Infeld, Szczepan Szczęsniewski, Andrzej Soltan, Henryk Niewodniczański and Włodzimierz Trzebiatowski, the founders of world-wide schools dealing with problems of physics of low temperatures, molecular physics, high-pressure research, theoretical and nuclear physics.

For a dozen or so years after World War Two – an inauspicious time for Polish science due to economic, demographic, and political reasons – ties and dialogue between Polish researchers and the global scientific community suffered considerably. After the political transition in the 1980s, however, Poles set about modernizing the economy and research sector with enthusiasm. It is with great satisfaction that we present the achievements of these last years in the field of innovative technologies created by Polish researchers and research teams. Our satisfaction is all the greater as we open the exhibition of Polish technological achievements in a country with which we enjoy systematic, centuries-old scientific ties. One example of our joint research tradition is the many years of operation of the Polish Academy of Sciences Research Centre in Rome, cooperation between Polish and Italian archaeologists, the use of Polish inventions to preserve monuments in Florence, or – last but not least – Polish-Italian cooperation in the automotive industry since the 1930s, the fact that cannot be left unmentioned in Turin.

I would like to extend my best wishes to the exhibition’s organizers and audience. May the exhibition fulfil all your expectations and ambitions, and may it contribute to continuing the beautiful and age-old tradition of Polish-Italian scientific and technological cooperation.

Professor Michał Kleiber
President of the Polish Academy of Sciences
Independence is important for everyone. Unfortunately, for a person with such insignificant disability as the lack of thumb seems to be, life is not easy at all. We learn how to write in the earliest years of our life and it becomes an inherent element of our everyday life. When somebody is suddenly deprived of the opportunity to ordinarily use a writing tool, the disability starts to be inconvenient, it deprives of the independence.

The product is the result of the thesis project titled “Product – a Result of Ergonomic Analysis of a Hand” It is a response to the problems of writing tools’ users, and what is more, it changes the image of a strongly “exploited” form of these tools. We have been using the tool, the form of which practically has not changed for ages. All these years of use have made its advantages and disadvantages evident. JustPen’s form results in ca. 90% from ergonomic analyses. Every curve and distance is justified, being directly linked to the anatomy of the human hand. The product is structured in such a way so as to enable writing with just one finger. The product solves the problems of users with such hand dysfunctions as the lack of a thumb or remaining fingers and all these people with limited hand motility (rheumatoid arthritis, cerebral palsy, tetraplegia, etc.), who are often excluded from the possibility to use standard writing tools.

Only in Poland, in accordance with the information of the State Institute of Hygiene of the National Institute of Public Health, approximately 4 000 people a year suffer an injury the result of which is the amputation of a thumb or fingers. Many more suffer injuries resulting in permanent thumb or fingers paresis.

Writing with a ‘finger’ seems to be the simplest and the most intuitive writing method, therefore it has become the subject of my research. Tension of tendons is definitely weaker while writing with a ‘finger’ than using conventional methods, where holding a pen in writing position requires the use of both, a finger and a thumb.

This tool uses standard writing cartridges making it more available, cheap in operation and less complicated in production.

In order to provide the highest possible accommodation of the tool to the human hand, the product will be manufactured in 4 sizes: large, medium, small, and extra small.

The invention has a wide scope of use - its structure can be also applied as a computer mouse, cutlery holder or other tools.
VIBROTHERMOGRAPHY BASED SYSTEM FOR AIRCRAFT SKIN ELEMENTS EXAMINATION

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The method monitors heat produced by damage under vibration and/or ultrasonic excitation

Vibrothermographic damage detection method is based on temperature measurements on a surface of tested component with the use of a highly sensitive infrared camera. Observed temperature increase in the structure is caused by a conversion of elastic wave energy that is delivered to the structure into heat. Energy conversion takes place mainly in the locations of structural defects and carries valuable diagnostic information. Damage characteristics are extracted from a series of infrared images by dedicated software package and summarized in a convenient form for the operator.

The diagnostic system based on vibrothermography has been developed at AGH-UST within the scope of the research project MONIT – Monitoring of Technical State of Construction and Evaluation of its Lifespan. The complete diagnostic system has been developed and built in two versions: stationary system for laboratory tests and handheld system for field measurements. The stationary measurement system is equipped with pneumatic press system which allows controlling clamping force between the excitation device and the structure. Supporting frame is fully customizable, depending on the type of components to be tested, it can be designed to meet the requirements. Handheld version of the ultrasonic excitation device comprises a holder that has been designed to allow easy operation and mobility.

The main fields of application:
• Detection of cracks in metallic materials and composite structures
• Detection of delaminations in composite materials
• Testing bolt connections and riveted

The main advantages of vibrothermography:
• Nondestructive and noncontact measurement
• Short measurement time – few seconds
• Detection, localization and sizing of damage
• Defects are visualized on the structure for easy interpretation
• It is feasible to perform Virtual Testing with explicit finite elements to optimize measurement setup

System components:
• Infrared camera – FLIR high performance series, cooled InSb detector, 320x240 resolution;
• Spectral range 2.5-5 μm, frame rate up to 380 Hz, NETD <20mK;
• Excitation source – high power narrowband ultrasonic system or flash lamp;
• Ultrasonic generator – 10-50kHz frequency range, 2kW output power, built in signal generator, TTL trigger, amplitude modulation.

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Family of modular special vehicles for recon and mine sweeping of roads codenamed SHIBA. The family of modular special vehicles for recon and mine sweeping of roads codenamed SHIBA was developed by Military University of Technology, AMZ Kutno and Military Institute of Engineer Technology. Presented solution is an answer to growing threat from improvised explosive devices (IEDs) to soldiers during peacekeeping missions. Due to great variety of explosive types and sizes, it is crucial to develop solution allowing recognition, evaluation and neutralization of potential threats. The family consists of three vehicles:

- with ground penetrating radar and metal detector for recon,
- with mine flail for mine clearance and path marking,
- technical vehicle with interrogation arm.

One of the most important goals was to ensure operator’s safety. For that reason, both numerical analyzes and experimental results were used to develop hull with enhanced blast resistance. New materials and special manufacturing techniques were used. As well as that, the hull is also bullet resistant according to NATO STANAG 4569 standardisation. Providing proper safety level allows the platoon to operate in hostile areas such as in Iraq and Afghanistan.

One of possible vehicle’s configuration is recon vehicle with ground-penetrating radar and metal detector. These devices allow proper recognition and identification of potential underground threats. Special software was developed to process signals from sensors and identify real threats with minimum number of false alarms. The recon system is linked with braking system that stops the vehicle as soon as potential threat is spotted. Software’s implemented threats database covers most of the modern mines, duds and grenades.

For the time being, all three vehicles were build and equipped with devices according to their function. The capabilities and performance of each device was evaluated during laboratory and field tests. During field tests, standard threat simulators were used to check the performance of both ground-penetrating radar and metal detector. The results show that both devices and entire system integrated with the vehicle work properly.

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**SHIBA SPECIAL VEHICLE WITH GROUND-PENETRATING RADAR (GPR) FOR RECOGNITION AND NEUTRALIZATION OF IED THREATS**

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METHODS OF MANUFACTURE
COMPOSITE CHITOSAN FIBERS

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A novel technology for the manufacture of a multi-filament chitosan yarn with addition of nanoparticles of tri-calcium phosphate (β-TCP), hydroxyapatite (HAp) or the complex HAp/β-TCP has been prepared in the Institute of Biopolymers and Chemical Fibres. A homogeneous suspension of hydroxyapatite and/or tri-calcium phosphate added to the chitosan solution allows to prepare a spinning solution from which fibers can be spun in form of yarn of 150 - 300 filaments. The linear mass of a single filament is in the range of 1,5 – 8,0 dtex. Staple fibers can be prepared from the yarn. Addition of calcium phosphate nanoparticles to the spinning solution has a positive impact upon its quality and eases the fibre forming process. It enables the spinning in a coagulation bath with a lower content of sodium hydroxide which, in turn, accelerates the washing of the fibers. Introduction of sodium carbonate to the coagulation bath along with a lower content of sodium hydroxide enables the fibre be drawn by up to 70% and spun at speed up to 35m/min. The prepared yarn is characterized by good mechanical properties and tailored bioactivity and biodegradability. By the addition of nano-hydroxyapatite (HAp) or nano-tri-calcium phosphate, an adequate functionality can be conferred upon the the chitosan fibers.

In the use of chitosan yarn in the preparation of textile scaffolds the addition of calcium phosphate nanoparticles is required which are normally used in biomaterials for bone and cartilage implants. Chitosan fibers prepared in the Institute in the form of multi-filament yarn have found application in partly resorbable surgery meshes, nerve prostheses, textile scaffolds, knitwear and nonwoven.
Glass and Building Materials Division in Cracow developed the technology of Roman cement production in a rotary kiln. Produced cement faithfully reproduces the features and color of the historical material. The application recipes and ready-mixes based on Roman cement have been developed at the Division to fulfill the needs of the conservation market.

Modern Roman cement produced by the Division is an excellent product for conservation and restoration of stucco elements preserved on facades: plasters, run moulds, as well as cast elements. It can also be successfully used for finishing facades of modern buildings and for production of different types of decorative elements.

Roman cement was a natural hydraulic binder commonly used for decoration of facades in XIXth and in the beginning of XXth century, in a period of Historicism and Art Nouveau. Many European cities at this time experienced rapid growth due to industrialization and they changed their former appearance, turning themselves into modern urban organisms, adapted to the requirements of the era. To the present day these facades create unique character of historical centers of most of the European cities. After the First World War Roman cement production was discontinued and its application techniques were almost completely forgotten.

Many facades of buildings across Europe were restored recently with modern Roman cement and ready-mixes based on this binder. Most of them are located in Cracow, for example:

- Former Trade Academy Building at the corner of Florian Straszewski and Kapucyńska Street
- Łoziński House on Józef Piłsudski Street
- the apartment house on Józefińska Street
- the apartment house on M. Skłodowska-Curie Street
- the apartment house on Jana Street
- Helclów Social Welfare House
- the apartment house on Szczepańska Street

Those buildings were restored correctly and once more became the pride of Cracow.

Patent Application:
- P 392495, 24/09/2010
- P 393960, 18/02/2011
The defense against the invasion of pathogenic microorganisms such as bacteria, fungi, yeasts and algae has been a serious problem for a long time. These microbes attack humans and animals causing serious infections. Among the materials exposed to the adverse action of microbes are silicone elastomers, which are broadly used as gaskets and sealants in bathrooms and other sanitary equipment in bathrooms, such as toilets, hospital rooms and medical offices. Our studies yielded new antimicrobial polysiloxane materials. Linear polydimethylsiloxanes terminated by silanol functions at both chain ends having 20% siloxane units substituted at silicon by 3(dimethyl-n-octylammonio)propyl chloride or 3(dimethyl-n-hexadecylammonio)propyl chloride were synthesized. They were crosslinked and also incorporated by co-crosslinking into an room temperature vulcanized (RTV) silicone elastomer. A strong enhancement of QAS presence on the surface was observed when it was in contact with water or water vapor. Therefore, antimicrobial properties of this material develop in moist environment. Hydrophobicity of the elastomer surface was little affected by the incorporated biocidal QAS-containing polysiloxane when the elastomer was kept in air. This material showed little ability to adsorb proteins from its aqueous solution. Bacteriocidal activities of surfaces of the crosslinked biocidal polysiloxanes and of the elastomers having incorporated these polymers were determined by the colony count method. Thousand-fold reduction of Staphylococcus aureus in contact with the dimethyl-noctylammonio substituted polymer was achieved in 2 min and in contact with the elastomer containing 20 wt% of this polymer in 15 min. Antimicrobial properties of crosslinked polysiloxanes containing polysiloxanes with QAS groups may be sensitive to the presence of bacteria on their surface. Bacterial walls induce migration of polymer segments with pending QAS groups towards the surface.
In many cases it is necessary to know the weight of luggage we take with us for instance on plane’s board. The only way we can avoid the stressful situation during check-in is to know a mass of luggage earlier.

The invention is a travel bag equipped with a total weight measuring system. The proposed solution could be used in travel bags designed with wheels as well as legs. The suitcase is composed of aluminum profiles that stiffen the whole construction. The measuring units are mounted to these profiles and wires are placed inside them. The whole suitcase may be covered with plastic or textile.

The total weight measurement system consists in four measuring units. The measurement system has also: a user panel, a microprocessor system and a battery. The idea of total weight measurement of suitcase is to measure ground reaction forces that are transmitted on horizontal ground, contacted to the ground only by wheels and legs. Information about normal forces received from measuring units is sent to the microprocessor system. Subsequently, the microprocessor system estimates the total weight, based on measured forces and known weight of wheels and legs. The user panel shows on the screen estimated total weight of suitcase. It also allows to change display units of weight and to set the maximum weight of a travel bag. The excess can be signaled by a beep. The user panel includes: the screen, the button on/off warning tone, the button changing the unit of weight, and two buttons changing the desired maximum total weight of bag, i.e.: increasing and decreasing it. Switching on the warning tone is symbolized on the screen as a symbol of the speaker. The screen shows also the selected unit of mass.
The present invention relates to the method of applying the antibacterial coatings on the textile materials. The antibacterial layer is composed of one-dimensional nanostructures of zinc oxide. Nanomaterials were being deposited directly on the surface of textiles using a Chemical Bath Deposition (CBD) method. Deposited nanoparticles of zinc oxide showed a good adhesion to the textile materials. Consequently, they are resistant to washing and other activities which are associated with daily use. Moreover, nanostructures deposited on fabric did not become detached from the surface, even though the material was subjected the ultrasonic rinsing. The biological activity of materials coated with zinc oxide nanoparticles was examined for the two bacteria: Escherichia coli and Staphylococcus aureus. Microbiological studies showed that covered materials have good bactericidal properties which is maintained for about 2 years. Furthermore, zinc oxide is cheap, nontoxic, biocompatible and has a white colour which allows to obtain a safe textile product of any colour. Antibacterial one-dimensional zinc oxide structures have been also introduced inside the fibres and modified fibres with excellent properties both antibacterial and mechanical were achieved. The use of zinc oxide as an antimicrobial agent has many advantages in comparison to currently used in the industry antibacterial agents such as silver nanoparticles. The main advantages of presented invention are low costs of process (the use of cheap and widely available chemical reagents) and simple synthesis method which does not require the use of advanced equipment. In addition, white colour of zinc oxide allows to get any colour of the finished textile product which is not impossible using nanosilver. Such modified materials are competitive on the market, among other antibacterial materials. Modified textile materials may be used in medicine for the production of antimicrobial bandages and protective clothing and in clothing industry for the production of beddings and sportswear which greatly stay fresh for longer.

Patent:
P 395710
(WIPO ST 10/C PL395710)
The Wiz2D enables construction deflection measurement using digital SLR cameras for remote image acquisition and provides image processing algorithms to calculate the displacement field. The software implementation has been developed in the C++/C# programming environment. ED-SDK libraries provided by Canon have been used to control one or more cameras in the system. Two modes of operation are available: on-line and off-line. In the first case, the user specifies the date and number of measurements and then the system works fully automatically carrying out the image acquisition and deflection measurement. The off-line mode provides analysis of the images stored on hard disk.

There are two methods of deflection calculation implemented in the software. In the first one, the user can specify points in which the measurement will be carried out. The displacement field is computed in these sets of points only. However, one can use the dense measurement method in which one specifies N - the number of points between the selected ones. The program automatically divides the structure between the user specified points into N equally spaced measurement locations. The result browser module carries out the visualization of calculated curves of deflection and report generation in popular formats, like PDF, XML, CSV and TXT. An additional feature of the software is detection of exceeding the allowed level of a deflection and the sending of alerts to a client by an e-mail.

An important element of the system is also a suitable calibration pattern that allows determination of the scale of the object. In addition to measuring the vibration passes in selected points of the design of the system allows the reconstruction of three-dimensional structure of the object, and select the frequency visualization mode of use.

Application areas:
- In plane displacement measurements during load tests for new structure: bridges, footbridges, pipelines etc.
- Measurement of 2D/3D deformation of the structure or its regions eg. deformation after welding

Main advantages:
- Measurement simplicity: acquisition of two images of a structure is sufficient for deformation analysis;
- Global deformation measurement without a dense sensor network;
- Increased measurement accuracy with image registration techniques, possibility to measure very large objects
- Deflection curve can be calculated from images of structure taken before and after loading from two distinct points in space
- Application of commonly available SLR digital cameras
- Easy analysis and interpretation of results
A Method of Increasing Heat Exchange Surfaces and Active Surfaces of Metal Elements Including, in Particular, Heat Exchange Surfaces

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The Laser Centre for Technologies of Metals conducts research into the applications of laser technologies for developing passive methods of heat transfer enhancement. Research comes as a response to global growing demand for new technologies which reduce energy consumption by industrial devices.

The fundamentals of laser-vibration technology for heat transfer enhancement in metal elements by increasing their surface roughness were developed. The technology employs laser melting of metal elements that are, at the same time, subjected to vibrations to produce on their surfaces solidified structures characterised by increased roughness when compared with the roughness of a technically smooth surface. Thermal investigations showed high efficiency of the rough structures obtained with the technology for heat transfer enhancement. For OH18N9 stainless steel subjected to laser-vibration melting, the heat transfer coefficient for water nucleate boiling was found to increase 3.5 times when compared with a technically smooth surface. The possible applications include the cooling of electronic components and computers.

Patent:
PL 207358
PL 210889

SILVER MEDAL, IWIS International Exhibition of Inventions, Warsaw 2010
SILVER MEDAL, iENA International Trade Fair, Nuremberg 2010
SILVER MEDAL, Concours Lepine, Paris 2011

Surface topography of an aluminium alloy treated by laser-vibration melting
Surface topography of a stainless steel element treated by laser-vibration melting
The idea of the invention is to replace the main constitutive part of the cell, i.e., the cast-lead current collector grids, by lightweight porous glassy carbon grids. Porous glassy carbon is characterized by a low density, ca. 10 times lower than pure lead’s. Since the mass of the classic cast-lead grids represents from 20 to 30% of the total mass of the battery, depending on construction, the use of porous glassy carbon material significantly lowers the total mass of the lead-acid cell. This results in an increase of the specific energy of the improved battery by ca. 40-50% to the level of 50Wh/kg. Consequently, the battery can have the same power, but will be lighter.

Our improvements to the lead-acid battery will be highly advantageous for the existing technology because of:

- A simple manufacturing process
- A low production cost
- Excellent cyclic work parameters

The main advantages of the modification:

- The new batteries mass will be significantly reduced compared to the conventional ones. For example a new 45Ah battery will be 3 to 3.5 kg lighter, and a stationary 200Ah battery will be 15 kg lighter than the batteries employing conventional technology.
- The specific capacity and the specific energy will be higher by 40-50% compared with the standard lead-acid batteries
- The specific energy of our new system is at the same level as for Ni-Cd
- The cost of 1Wh in our battery is ten times lower than for the Ni-Cd and twenty times lower than for the Li-ion batteries
- Environmental friendly due to less amount of Pb than standard lead acid batteries
- Recycling efficiency of lead is 100%
- Alternative for harmful Ni-Cd battery system.

Applications of the new lead-acid batteries:

- An alternative for the old Ni-Cd system
- Electric vehicles/hybrid vehicles
- Cordless power tools
- Industrial portable electronics
- Backup power systems
- Energy storage for renewable power systems

• The specific energy of our new system is at the same level as for Ni-Cd

Due to the significant difference in the grid masses it is possible to fill the battery with greater amount of electrochemically active materials. This results in increasing the capacity of battery based on porous carbon (left) up to 50% compared to standard battery type (right).
The subject of this invention (Patent Application No. PCT/PL2011/000120 of 28.11.2011 priority PL 29.11.2010/ P 393076) is the method of obtaining innovative textile barrier materials against UV radiation and microbes, which are moreover characterised by very high photocatalytic activity. Such materials made of polyester fibres after low-temperature plasma pre-treatment include in their structure micronized titanium dioxide (TiO2) in the crystalline form of anatase, which absorbs UV radiation and catalyzes the degradation of organic compounds to simple products. Before the application process, the surface of micronized TiO2 particles was modified with selected alkoxysilanes: 3-methacryloxypropyltrimethoxysilane, vinyltrimethoxysilane or N-2-(aminoethyl)-3-aminopropyltrimethoxysilane in order to improve morphological and dispersion properties. Then the textiles were subjected to a superficial pre-treatment with cold plasma or alcali-scouring to improve their adhesive properties. Micronised and modified TiO2 particles were incorporated into the textiles' structure by means of conventional methods: dip-coating with water dispersion or coating with the paste containing acrylic resin.

Advantages:
- Ecological pre-treatment process by low-temperature plasma.
- Obtained textile materials are characterised by:
  - good barrier properties against UV radiation, expressed as reduction of spectral transmittance value in the whole range of UV radiation and Ultraviolet Protection Factor (UPF) coefficient value above 40,
  - very high photooxidative activity, which enables to clean indoor air from toxic organic compounds by their decomposition to simple inorganic compounds (efficiency of formaldehyde decomposition to simple unorganic compounds amounts to 90-98%),
  - inhibition of microbes development, especially bacteria present in the air: Micrococcus flavus, Bacillus subtilis and other Pseudomonas aeruginosa, Escherichia coli.

Fields of application:
- Products with such properties can be used for the special applications:
  - as elements of furnishing, covers of art and book collections to protect them against the destructive effects of UV radiation,
  - as personal protection equipment protecting employees exposed to dangerous diseases (including cancer), against harmful effects of UV radiation emitted by natural and artificial sources.

Production of such innovative materials is a complex technological process that can be implemented in chemical and/or textile enterprises.
Textile barrier materials protecting against electromagnetic field (EMF) have been developed at Textile Research Institute (IW) and are obtained according to innovative technology of continuous deposit by magnetron sputtering of thin (nanometer) conductive coatings on the textile background. The subject of patent application (P 387977 dated 2.02.2012) is the method of producing such materials and the production equipment. Innovative step is the application of magnetron sputtering method for textile materials covering. Conductive „net” of sputtered fibres is formed by a specially constructed magnetron equipment and proper process parameters in such a way not only to achieve high electrical conductivity but to create good shielding properties. In this method – according to the invention – the substrate material is textile fabric of properly selected structure, while the coating constitute: metals, alloys, metal oxides or layer systems formed depending on the required shielding efficiency. Advantages of the technology:

- ecological - waste-free, no sewage
- coating formation rate μ/min
- layer thickness in nm range
- good adhesion to background textile material
- high production efficiency – 0.3 cm³ of metal are sufficient to cover a few hundred square meters of textile substrate

Patent Application: P 387977

Examples of possible applications of barrier materials:

- To reduce interferences of electronic devices operation in the following sites: computer centres, banks, stock-exchange facilities, data banks, telephone, operation centres, hospitals, offices and meeting rooms
- To reduce human exposure to outside/external electromagnetic fields in: hospitals, schools, office buildings, residential houses
The invention is a composite biomaterial containing metal and ceramic nanoparticles. Hydroxyapatite materials are considered one of the leading materials in bone surgery because of the high degree of biocompatibility, osteoconductivity and the ability to create chemical connections with living tissues. In the new generation of composite materials for biomedical applications hydroxyapatite of animal origin with a structure similar to human bone obtained by an innovative method has been used. Hydroxyapatite used in the composites have been obtained with a novel method using pig bones, which allows a significant cost reduction in obtaining this type of material in comparison with traditional methods and produces a material with given parameters. This method is innovative on a global scale in ecological aspects. It eliminates aggressive hydrolyzing agents, which generate significant quantities of hazardous waste that need to be disposed of in a special way. In the developed method the hydrolyzing agent is lactic acid, which provides a mild process conditions. The technology is waste-free with protein hydrolyzate as byproduct of high purity, for food use. Silver nanoparticles operate not only antimicrobial against bacteria, viruses and fungi, but also stimulates the number of living cells such as lymphocytes, fibroblasts, osteoblasts to increased activity. Due to unique combination of a polymer matrix with hydroxyapatite and nanoparticles the obtained biomaterial exhibits bioactivity and capacity to stimulate bone tissue reconstruction. The presence of nanoparticles provides bactericidal properties of composites which significantly reduces the risk of postoperative infection.
THE MODERN WOUND DRESSING POLYMERIC MATERIALS
MODIFIED PLANT EXTRACTS

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GOLD MEDAL, IWIS International Warsaw Invention Show, Warsaw 2012
SILVER MEDAL, KIWIE Korea International Women’s Invention Exposition, Seoul 2012
BRONZE MEDAL, INST International Invention Show & Technomart, Taipei 2012
BRONZE MEDAL, Concourse Lepine, 2012
Diploma of the Polish Minister of Science and Higher Education for promoting Polish
inventions abroad, Warsaw 2013

The dressing polymeric materials modified plant extracts
are the subject of the invention. The proposed synthesis
of the polymer matrix using microwave radiation is
a modern and waste-free method of "green chemistry". The
technology is simple, fast and very efficient. The
developed method uses the energy to initiate the polym-
erization reaction, and the sterilization of biomedical
products. Innovation of the invention is primarily a
modification of the polymer matrix under microwave
irradiation by introducing active substances into the
system - natural origin, plant and approducts, which will
provide additional healing properties. They characterize
several biological properties such as antiseptic, antibac-
terial, anti-inflammatory and stimulate regeneration of
the epidermis, and accelerate epithelization.

The proposed bioactive dressings not only protect the
wound against the influence of external environment,
but also due to its characteristics directly interact with
the processes of healing. They belong to the most modern third-generation
of interactive dressing materials. Innovative dressing
polymeric materials are applied in the treatment of
wounds with medium exudates, slow-healing (decubitus
ulcers, venous ulcers, diabetic foot ulcers), which are
in the phase of granulation and epithelization and also
in case of post-operative wounds. The new generation
dressings fulfill the most important requirements and
ensure an optimal environment for the natural processes
taking place in the healing of the wound through
a proper termoregulation and moisture, gaseous
exchange and pH (slightly acidic pH, bacteriostatic
activity).
The robot PIAP GRYF is a remote controlled device dedicated for the speedy reconnaissance of terrain and locations which are difficult to access. It was created to meet the needs of the Polish Army for small sapper robots. These devices are intended to support the operations of soldiers in missions abroad. The use of small sapper robots on such operations is dictated by the tasks the soldiers are undertaking in the regions of armed conflicts. The small sapper robots are used in such locations for the tasks of searching vehicles, culvers and ditches, searching buildings, neutralizing detected, improvised explosive devices, mines, munitions and incendiary devices.

The robot has been designed in such a way as to effectively replace a human in dangerous situations thereby decreasing the treat levels to their life and safety. The robot’s construction has been designed with maximum flexibility and usefulness to the army and other agencies. The robot PIAP GRYF robot consists of a mobile base and additional equipment.

The mobile base possesses a wheel-track drive system, which allows it to move in all types of terrain including sand and rocky surfaces. The drive system may be improved by installing additional adjustable approach angle front track. This solution increases the robot’s stability as well as giving it the capability of overcoming of larger obstacles and rougher terrain. The mobile base has been designed with dimensions allowing it to perform inspections of vehicle undercarriages — the height of an appropriately configured robot is 190 mm. In instances where an even lower height is required, it is possible to remove the wheels from the power transmission system. The robot then rides solely on tracks, giving it a total height of 160mm. The true testament to the robot’s usefulness is its array of additional equipment which may be mounted on it. Aside from such accessories as the manipulating arm or a camera on a rotating head, several other accessories have been developed for the GRYF robot which make it an invaluable tool when performing tasks connected with the recognition and neutralization of explosive charges. These additions may include: an X-ray device along with the equipment remotely transferring images of the X-rayed element, a pyrotechnical disruptor, additional cameras including night-vision and thermal-vision options, additional halogen lamps, a reel for a cable for remote detonation of explosive charges, an automatic winding reel with a fibre-optic cable for controlling the robot, electro-hydraulic shears for cutting, a chemical and radiological detection sensors and many more.
The fast method for determination of concentration (or titer) of proteins (antigens/antibodies) is described. The quantitative method of antigens/antibodies determination is based on measurement of electrophoretic mobility in an electric field of particles with immobilized biomolecules (antigens/antibodies) after incubation with an analyzed blood serum sample. In the presence of specific antibodies/antigens in the analyzed liquid the mobility of complex particles-antigens-specific antibodies is changed. The change of mobility corresponds to concentration of aimed biomolecule in analyzed biological liquid.

The method is complementary to the commonly used ELISA test (Enzyme Linked Immunosorbent Assay) allowing determination of antigens/antibodies in blood serum, but in contrary to this method, the measurement of electrophoretic mobility of analyzed sample is fast, because it may take a few minutes. Moreover, it does not require time consuming sample preparation and long lasting analytical procedure which is needed necessary for ELISA. The method is especially suitable for monitoring of antigen-specific antibodies interactions, for which the methods based on particles aggregation kinetics in regard to the presence of analyte in a investigated liquid failed.

In the method polymer hydrophilic microspheres carrying covalently bound specific antigens/antibodies to the corresponding partners in serum are involved. The particles are not commercially available, the method of their synthesis was developed in our laboratory (Pat. nr 192172 from 21.05.1999 (BP/3379/831/06)).

The polymer core-shell microspheres are very uniform, with a diameter ca. 200-300 nm, contain hydrophilic shell, composed from hydrophilic polyglycidol. Moreover, the hydrophilic (water swollen) interfacial layer protects the particles against spontaneous physical adsorption of proteins from biological liquid (i.e. blood serum, urine).

The calibration of the dependence of electrophoretic mobility of complexes obtained after specific binding of antibodies (antigens) from biological liquid with interacting antigens (antibodies) immobilized on microspheres versus the concentration (or titer in physiological range) of analyte is required.

The method based on electrophoretic mobility measurements was already successfully applied for determination of concentration of Helicobacter pylori antibodies in patients sera suffering from diseases of digestive tract and the results were very consistent with the ELISA tests.

Determination of H. pylori antibodies concentration in patients blood sera by P(S/PGL)-H. pylori with bound antigens

The process of surface remelting of non-conductive oxide coatings and other materials characterized by very low electrical conductivity may be successfully conducted using welding sources of heat provided that the standard welding station is previously redesigned and additionally equipped. The methodological and apparatus-related work undertaken led to the development and construction of a welding set with a free independent arc, in which the active participation of the oxide coating in the creation of the electric arc and its stabilisation has been eliminated. Two modifications of the GTAW (Gas Tungsten Arc Welding) method have been elaborated, one of which was the so-called dual nozzle-dual electrode variant (DN-DE), and the second modification was a single nozzle-dual electrode set (SN-DE). In the case of the DN-DE solution, the welding set was equipped in at least a pair of torches with at least one electrode in each torch, where an electrode or electrodes of a single torch from each pair were connected to the negative pole of the welding power source. In the case of the SN-DE variant, both electrodes operated in the area of one gas nozzle. In both proposed solutions the modified material is a “passive” consumer of heat that is released from the electric arc that is generated between two infusible electrodes, in which, in this way, the processing of the material does not depend on the electric properties of the respective material. The application of the aforementioned unit, e.g. for remelting of the plasma sprayed coatings (e.g. non-conducting oxide coatings) makes it possible to reduce the coating porosity, eliminate the laminarity of the coating structure and reduce the inhomogeneity of the chemical and phase composition, in which, as a result, it thereby improves the operating properties of such coatings (hardness, wear and corrosion resistance, adhesion to the substrate). The modification of the surface layer of non-conductive oxide plasma-sprayed coatings prepared with the application of the modified GTAW welding technique may constitute an alternative solution in comparison to currently predominant laser technologies, and by virtue of its price competitiveness, treatment simplicity, and the availability of welding heat sources, this solution seems to be especially interesting.
First polish biomimetic underwater vehicle (BUV) called CyberFish is a prototype of mobile underwater robot that resembles carp fish in the way it looks and moves. The only principal of robots motion is by means of undulation of an artificial tail with a tail fin and pectoral fins as well. Mechanical part of the robot consists of four rigid segments connected with each other by means of sealed rotary kinematic pairs thus the biggest segment represent the head of a fish-robot whereas the other three represents the tail. Each segment is driven by separate servomechanism and can be deflected at a desired angle. Proper synchronization of deflection of each segment causes the tail undulates fish-like. Changing servo control parameters gives the robot the ability to perform different maneuvers which with combination of water filling buoyancy tank causes great maneuverability and agility of the robot under the water surface. Mechanical parts of the fish-robot where designed in CAD software additionally its exterior shape was designed with the help of a 3D scan of a real fish. Robot’s control system is composed of a low-level microcontroller based inner control board and high-level PC application. Currently the CyberFish is manually controlled via two way radio communication link using laptop with self-written PC application. However scientific research on autonomy of CyberFish are still in progress and it is expected the robot will gain the ability to navigate in water environment by itself and performing assigned tasks. Potential field of application of CyberFish is for military defensive tasks as intelligence, surveillance, reconnaissance, especially in areas where classical screw propelled underwater vehicles are unusable because of its noise, vortices formation, size and shape. CyberFish can be covered by silicon coating which makes it undistinguishable from its real counterpart and gives major advantage in stealth reconnaissance. In such a case CyberFish of even a swarm of CyberFishes will be equipped with video cameras, sonars, hydrophones, inertial navigation and preform for instance harbor monitoring for dangerous loads or suspicious vehicles mooring the jetty.

Based on experiences connected with building 5 versions of CyberFish, Polish Naval Academy, Cracow University of Technology and Industrial Institute of Automatics and Measurements proposed project in European Defence Agency within framework of Unmanned Maritime Systems programme. The main objective of the project is to build a swarm of heterogenous Biomimetic Underwater Vehicles (with undulating propulsion) capable of carrying out common task of underwater ISR. Two European countries (Germany and France) would like to participate in the project. Expected date of starting project is 2014.
The majority of USB flash drive users see a great inconvenience in inserting the device into the computer, because very often they try to insert it with the wrong side of the device. The aim of the invention is to eliminate that problem through the modification of USB slot located on the computer.

The change consists in the use of a flexible structure of slot board which will adjust to the location of the USB slot of the connected device. What is important, this modification will allow to maintain the standard dimensions of the slot, as well as it will be compatible with all generations of the USB slots.

The change of slot structure could for instance be made when introducing a new USB standard (e.g.: 4.0). Hence, the target place of the use of the device would be the new series of computers, laptops or USB hubs.
Many bioactive compounds used in therapy could properly fulfill their function only when they are safely transported to selected tissue, cells, or subcellular compartments, and are released only when they reach their targets. On the way these compounds should be protected inside of the patient’s organism. Typical administration routes (e.g. oral and intravenous) result in exposure of drugs either to a very low or high pH conditions, leading to particle decomposition, or to components of the patients defense system, recognizing them as a threat and that must be eliminated. In particular nucleic acids must be transported protected by the properly designed carriers.

The presentation will show new synthetic routes leading to copolymers combining polylactide, poly(ethylene oxide) and polyglycidol derivative blocks, allowing to produce nano- and microparticulate carriers with tailored size, hydrophobic/hydrophilic balance as well as with the cationic/cationogenic character. Produced nanoparticles with diameters from 25 to 50 nm were found to be stable in pH ranging from 3 to 10. They were not toxic to a variety of cell lines. Formation of nanoparticles in presence of dissolved nucleic acids resulted in nucleic acid loaded objects. Transfection ability in cell cultures are under investigations, however first results are promising. Partners specialized in gene delivery studies in animal models would be highly welcomed with purpose to prepare an EU funded project.
Recent literature data suggest that in the marrow reside progenitors with a potential to regenerate not only hematopoietic system but also different damaged tissues. Cells of the latter potential may belong to Mesenchymal Stem Cell population (MSC). In years 2003 – 2005 twelve patients suffering from atherosclerotic lesions entered the cohort 1 and 10 patients with similar symptoms were recruited in years 2009 - 2011 to the cohort 2 for autotransplantation of marrow mononuclear cells to the affected limbs. Marrow cells population (harvested from the iliac posterior crest) enriched in mononuclear (MMC) cells was implanted to the affected limbs. The patients suffered from atherosclerosis and all appropriate surgical procedures were exaggerated prior to the cellular therapy.

This one day procedure consisted of the following steps: (i) bone marrow harvest from posterior iliac crest in a volume of 500 mL, (ii) mononuclear cells enrichment with the use of a Cobe Spectra separator which ended with a volume of 100 mL, (iii) 70 mL of the cell suspension were injected in 0.5 mL portions to calf muscles of the affected limb.

Autotransplantation inoculum consisted of (mean ± SEM):
- hematopoietic progenitors CD34+, CD45+: 1.29% ± 0.19,
- mesenchymal stem cells on the ground of the presence of CD45-CD34: 10.3% ± 0.93, CD45-CD34-CD90+: 0.1% ± 0.02, CD45-CD34-CD105+: 2.4% ± 0.33, CD45-CD34-CD73+: 0.08% ± 0.01, cells forming fibroblast-like colony: 24.4 ± 4.5 CFU-F/10x10^6 WBC.

The outcome of the procedure - 22 patients were treated and benefited from: pain reduction in 83%, 67% and 28% cases; wound healing in 25%, 42% and 50% cases while assessed 1, 3 and 12 months post transplantation, respectively. Two cases had to have the affected limb amputated.

Our 10 yrs experience in the improving of vascularization of the ischemic legs prompted us to use mononuclear bone marrow cells implantation in patients with osteonecrosis of the femoral head.

In the procedure 4 holes were drilled through the affected femur head to have them filled with an inoculum composed of CD34-CD45-CD90+ cells and also those CD73+ and VEGFR-2+ After 3 months the improvement in Harris hip score was seen in 3 out of 5 hips which received autologous MMC transplant.

The presented study results document that implantation of MMC benefits patients with legs ischemia and infarcted femur. The laboratory and clinical protocols have been completed to be used in the clinic.
Imaging by EPR (Electron Paramagnetic Resonance) can provide data on the pharmacokinetics of free radicals and on oxygen partial pressure (concentration) in tissues. The determination of oxygen concentration in tissues supplies valuable information in the detection and treatment for tumors in oncological therapy. It turns out that oncological therapy fails when oxygen concentration falls below a certain level. EPR technique is one of the most sensitive methods of measuring oxygen concentration allowing very precise determination of oxygen concentration in living organisms. However, the long duration of the measurement constitutes a serious impediment to practical application of EPR tomography. The proposed solution allows reducing the duration of the measurement of one projection — information about the distribution of oxygen concentration in a given direction — from about a minute to a fraction of a second. This results in the reduction of the duration of the experiment from a couple of dozens of minutes to a few seconds. The invention consists in determining the projection of oxygen concentration from a single EPR spectrum measurement by measuring the ratio of the amplitudes of recorded signals in various directions of sweeping, whereas at present at least 8-16 additional projections are required. A decrease in the measurement time of one projection to 200μs theoretically allows performing 3D imaging within 10 ms, which is a time unavailable with other EPR imaging techniques. In practice the necessary accumulation of signal prolongs this time to a few seconds. The presented solution is a foundation for fast EPR imaging techniques. It helped create other inventions allowing high-resolution imaging of free radicals and oxygen concentrations. Nowadays there does not exist a commercially available EPR tomograph enabling fast oxygen concentration imaging to be performed in clinical practice. The application of this invention will make it possible to introduce a new product connected with medical techniques, allowing both the localization of tumors and tissue oxygen concentration level imaging. The prototype of EPR tomography was constructed and underwent preliminary tests successfully. The estimated cost of producing the tomograph is within range of $1000 to $100000 depending on the size of the examined object and on equipment. The production of the first small tomographs for oxygen concentration imaging in small living organisms may be launched at the beginning of 2014. The launching of the production of big EPR tomographs requires a maximum of three additional years of research.
Hair and fur are composed of complicated mixture of structural proteins with different resistance to biological degradation, immunogenicity and structural flexibility. Keratin associated proteins (KAPs) are the most rigid part of the hair and fur. These proteins express very low immunogenicity even in xenotransplantations. Isolated KAPs are natural skeleton proteins of hair and fur that forms microtubules. We developed KAPs preparation method from natural materials and applied them as active components of nutracosmetics (bioactive cosmetics). These tubules could be loaded with active components. We developed technological application of KAPs for isolation of bioactive substances from natural sources. KAPs microstructures, loaded with bioactive components could be used for preparation of nutracosmetics. Thus KAPs with active components deliver active components into deep layer of the skin where they are slowly released. The skin regeneration and healing are the most fruitful applications of the products. This invention presents new bioactive preparations in which KAPs microtubules have been used for isolation of natural polyphenols isolated from red wine or green tea. The KAPs loaded with polyphenols penetrate epidermis and transport active components directly to the site where they are needed.
Mechanical and thermal protection of the body is believed to be the major function of hair and fur that cover mammalian skin. Proteins that construct hair are characterized by extremely high resistance for degradation. However, it should be taken into account that even such environmentally resistant material may be also slowly broken down by mechanical wiping or biodegradation due to skin endogenous enzymes or hosting of numerous microbes. Similar processes may take place not only in skin, but also in stomach due to well-known phenomena of fur skin swallowed by animals.

We hypothesized, that biodegradation products of hair or fur may possess bioprotective properties which are supplementary to the physical hair protective features. The evolutionary process resulted in a reduced hair-covered space on human body, but it may be assumed that bioprotective effects of hair degradation products persist. We applied the process of partial enzymatic digestion of hair and fur. Enzymatic digestive water soluble lysate consists of mixture of peptides, including fragments of keratins and keratin associated proteins. Human skin is exposed to various environmental cancerogenic factors. Therefore, we hypothesized that bioprotective mechanisms of hair lysate, if any, could affect proliferation of melanoma cells. Indeed, we found out that mixtures of soluble peptides originated from human hair inhibited proliferation of human melanoma cells in vitro. Moreover, these peptides express some additional active conditioning properties. Therefore, we proposed to use peptides obtained from hair proteins as components of everyday skin lotion. The proposed lotion should be particularly beneficiary for face skin that is constantly exposed to sunlight.

Viable cell yield in 7-day melanoma MeW186 cultures set after 3 passages at 5x10³ cells/well without or in the presence of the hair lysates (A)

A comparison of the proliferation indices showing that both the AWL lysate (B) and the AT lysate (C) inhibited the proliferation of various melanoma lines generated from different patients. The proliferation index was calculated as the proportion of the mean viable cell count following culture to the viable cell number at the beginning of the culture.
The vision-feedback hybrid robot for in-vitro biological cell manipulation consists of a 4 DOF parallel manipulator attached to its platform: a 3 DOF serial, flexure based, piezoelectric-actuator driven micromanipulator carrying tools, and a camera with a high-magnification macroscopic optical system. Three-dimensional shape reconstruction using a unique image processing algorithm allows for reliable tool movement in vicinity and inside of a cell, and long-term stabilization of the cell and the tool relative position. The parallel robot with a novel kinematic structure, for which analytic closed form of forward and inverse kinematic equations exist, exhibits high positioning resolution and accuracy, low-level of electromagnetic interference, and good vibration damping. The micro-robot provides high movement precision in comparatively large workspace and very good vibration damping. Both robots are equipped with a trajectory generator and a controller, which ensure required positioning and trajectory tracking performance. Information of the cell and the tool relative position is provided by a vision system, consisting of a macroscopic optical system with controlled parameters, a high-resolution camera, an illumination system, and image processing and analysis algorithms. The Depth From Focus (DFF) algorithm is used for recovering of third dimension (z-coordinate) for 3D shape reconstruction of microsized biological objects. Potential applications include neurophysiology patch-clamp in-vitro research, injection or extraction of substances or objects into/from a living cell etc.

Patent: P 387229
An object of the invention is fabrication of the abrasion resistant coatings with the powder pressureless forming method, retaining the relatively high ductility of the coated tool’s core. The pressureless powder forming is an alternative technique of coatings deposition, compared with the PVD and CVD ones, and to the laser alloyed and plasma sprayed ones. This method does not require using the expensive coating deposition equipment, and the only investment expenditures are connected with acquiring the typical heating device used in the powder sintering process. Coating thickness may be easily regulated by applying the powder-binder slurry once or several times on the prepared substrate surface. Moreover, the substrate surface does not require finishing grinding, polishing, and degreasing as in case of the PVD and CVD coatings. The polymer-powder slurry was made by mixing of powder and binder (parafin wax or laquer). Next the substrate was covered by polymer-powder slurry. It was found based on experimental research carried out of the binder agent portion effect on structure of the deposited coating that its optimum volume portion is about 50-70%. In case of the polymer-powder mixtures in which the binding agent volume portion was less than 50% the high viscosity of the slurry made it impossible to put it down onto the surface of the investigated materials. However, numerous cracks and cavities that originated during its thermal degradation were revealed on the sintered coating in which the binding agent portion exceeded 70%. The coating was sintered and heat treated together with the substrate. The retained carbon coming from binder after incomplet debinding decrease the sintering temperature and initiates the sintering process. Single or multi layers with the growing portions of the hard carbide phases were put down onto the prepared test pieces to obtain the gradient structure in the coating. The binder agent thermal degradation process occurred during heating up to the sintering temperature or with the isothermic stop at the temperature of 300 oC for 30 min. Further the test pieces were heat treated. The sintered and heat treated materials were prepared in the form of the metallographic microsections to make evaluation possible of structure of the coating and of the zone between the substrate material and coating, as well as of the substrate structure.
Technical state monitoring system of rail vehicle is a modern, complex solution for monitoring the technical condition of main vehicle mechanical systems and components as well as for the qualitative assessment of the rail infrastructure. The system is based on a dispersed network of smart sensors installed on the vehicle along with the data acquisition unit and a data server with the application of analysis and management of diagnostic data.

The system architecture is open and scalable, based on the idea of smart sensor network. The main features of the monitoring system are simplicity and low cost of implementation in operation. The system is designed for use on all vehicles (classic and light rail) and in the future can become a standard feature of every new vehicle.

In the case of a vehicle, the presented system allows:

• assessment of the wear of running gear elements
• immediate detection of faults in the vehicle suspension elements
• dynamic adjustment of the vehicle maintenance to the actual condition of the vehicle
• complex fleet management including the current condition of the vehicles
• monitoring of ride safety and comfort

• life cycle assessment of vehicles including a history of events and trends in vehicle wear
• in the case of the rail infrastructure, the system allows:
  • monitoring the main sections of infrastructure, increasing operational safety of the whole transportation system
  • immediate detection of faults (cracks, weaken, flats, etc.)
  • dynamic adjustment of speed limits depending on the current technical state of the given track section
  • life cycle costs assessment of the selected track section.
• user-friendly software allows an on-line monitoring of the technical state of rail vehicles and track, making the fleet management easier and enabling dynamic scoping repair and optimal planning of infrastructure repairs.

The complete monitoring system was build and passed in normal operation by the following clients:

• Miejskie Przedsiębiorstwo Komunikacyjne w Poznaniu (two tramways)
• Tramwaje Warszawskie (three tramways)
• PESA Bydgoszcz (one electric multiple unit)

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Central production and distribution of water for a city creates a complex research problem related to water network control and management. The IT system presented is meant to assure a right balance assuming the use of several water uptake stations and energy saving and reliable functioning of the water network. This is a multi-criteria optimization and control problem, with a high number of variables influencing the operation of waterworks. The IT system includes in its programmable structure some optimization and control algorithms, a monitoring system (SCADA), a numerical map of the water net (GIS), a customer information system (CIS), hydraulic models of the water network and some modules supporting the water network management. Implementation of the IT system in municipal waterworks brought multiple benefits, namely reduction of the operational costs, decrease of emergency rate, increase of operational dependability, and ensuring high quality of water produced.

The IT system is of innovative character, providing for automated and comprehensive manner of control and management of the municipal waterworks. For a couple of years the IT system is under development at the Systems Research Institute of the Polish Academy of Sciences (SRI PAS) with close cooperation with Intergraph Polska. The complete IT system shall be of interest to all municipal waterworks that want to introduce modern solutions improving organization of their functioning and management of their water networks. Application of the strategic and pro-ecological control of water network using the IT system ensures water saving rationalization regarding the use of surface water and also of the hardly renewable underground water in cases when the waterworks use the underground water uptake stations. Application of the operational predictive control of water network to save the energy used by the zonal pumping stations will result in reduction of air pollution.
Two cutting edge antennas have been developed and installed at the outside European Space Laboratory Columbus - the first European territory in space and the main European contribution to the International Space Station (ISS). The antennas have been developed by Prof. Pawel Kabacik’s team at Wroclaw University of Technology. The application of these antennas is broadcasting of digital TV educational programs and still frames. This broadcast is to strengthen popularity of space programs. In antenna development closely cooperated Thalesaleniaspace in Torino. Kayser Italia in Livorno developed the digital TV transmitter. Delivery of the transmitter is scheduled onboard ATV Albert Einstein (2013). The main organization responsible for TV program production is ARISS – Amateur Radio on the International Space Station.

All this started in 2002, when the ARISS-Europe chairman presented the initiative to The European Space Agency Director of Manned Spaceflight and Microgravity. The development of needed low-profile antennas was a great technical challenge. It was agreed to work on L- and S-band antennas accommodated on the MDP panels which protect Columbus. Dr Pawel Kabacik of Wroclaw University of Technology, accepted the development of the antennas. In June 2005 a contract was signed bearing development and construction of antennas. The mechanical vibration tests were very severe with regard to extreme vibrations produced by the Shuttle boosters. In September 2007 antennas were successfully submitted to vibrations tests in Germany and ESA decided their installation. In October 2007, antennas were installed at NASA Kennedy Space Center. A few month later, Columbus was delivered to the ISS with NASA Space Shuttle Atlantis in 2008.

Dual polarized RHCP/LHCP X-band antenna array, manufactured with a high scale of integration, is made with integrated multi-layer laminate panel. Antenna models are landmarks of the unique antenna technology developed in-house at Faculty of Electronics, Wroclaw University of Technology. The technology is on the space qualification path. The extreme challenge is to ensure antenna bandwidth against several antenna parameters. The antennas developed by Prof. Kabacik’s team are thin profile and reveal excellent characteristics of which superior quality have demonstrated both circular polarizations and high value of isolation between them.
At present, there is no simple method of obtaining upconverting nanopowder based on zinc and gadolinium oxide possessing superparamagnetic properties at room temperature. The nanopowders, when excited by near infrared light (NIR) (980 nm), possess the ability of effective upconversion (UC) to the visible emission. Bioimaging is an essential tool applied in clinical diagnostics. In particular, the use of fluorescence imaging allows to examine the molecular events and the structures in living cells. The method allows to obtain superparamagnetic (at room temperature) nanopowder which possesses and has at least three orders of magnitude higher luminescence intensity than other known ternary oxide nanopowders (spinel). In addition, PVP (polyvinylpyrrolidone) passivation renders the material hydrophilic.

The Figure 1 depicts the photoluminescence intensity of the synthesized nanopowder doped with erbium and ytterbium with photoluminescence of the zinc-aluminum spinel (ZnAl2O4). The properties of nanopowders are useful for cells visualization in the living animals.

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Moon Light is a high performance continuous speech recognition decoder, using the grammar of Speech Recognition Grammar Specification (SRGS). The system is based on dynamic programming using Hidden Markov Models (HMM). The Moon Light decoder is used to convert continuous speech into text by comparing the speech to the dialogue structure contained in the grammar of the SRGS, providing the best matching sequence of spoken words. The recognition results can be used to control applications.

An Interactive Voice Response system (IVR) is a good example of using the Moon Light speech recognition system which allows a person to communicate with a computer. Developers can create applications that use Moon Light speech recognition system thanks to Application Programming Interface (API), which enables the decoder to communicate with the application. The API interface assures easy, practical use of speech technology, such as in: voice control of an Internet kiosk, a mobile application or a website.

The Moon Light decoder can operate in Software-as-a-Service mode (SaaS), using VOICE LAB’s Speech Data Center that makes prototyping, testing and running applications simple and quick. The hardware requirements for the Moon Light decoder depend on the type of application, the size of the recognized dictionary and the amount of simultaneous telecommunication channels supported by the system. For applications in telecommunications we recommend servers with a 64-bit Linux system, memory of 6GB and 4-8 CPU. Moon Light operates on platforms with a 64 or 32 bit Linux system and meets the W3C standards in SRGS specifications. The solution is speaker independent.
Micro-Bioreactors and Nano-Modified Substrates for Cell Culturing

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In vitro cells culturing is a method commonly used in biological and clinical research, bioengineering and biotechnology. Progress in microfabrication technology enabled development of microfluidic platform resulting in reduction of amount of used reagents and total costs of experiments. Automatic perfusion of bioreactors with cell culture media enhances mass transfer and eliminates the need for periodic media exchange causing variation of concentration of key metabolites when traditional microplate cell culture technique is used. Then, due to the continuous supply of nutrients and oxygen, and transporting metabolites away, perfusion enables maintain homeostasis.

We present a novel microreactor designed for hepatocyte culture. The device was made in polydimethylsiloxane (PDMS) - a biocompatible, transparent elastomer, easy to pattern using soft lithography technique. The collagen-coated bioreactor was tested with hepatoma-derived C3A cell line. Moreover, nano-modification of PDMS by diamond like carbon (DLC) layer deposition* was investigated.

Critical aspects of bioreactor design include optimal mass transfer and shear stress. The effectiveness of mass transfer in cell culture depends on the geometry of bioreactors, mainly high aspect ratio, and uniform distribution of medium in the growth chamber. Thanks to implementation of a mixing section, homogenous distribution of culture media in the growth chamber was obtained. The high aspect ratio criteria was met by a particular geometry of the growth chamber: surface area - 2 cm² and height - 100 µm. Due to high oxygen consumption rate of hepatocytes, culture oxygenation is particularly important. Since O₂ solubility in the culture medium is low, enhancement of its delivery to cells in microfluidic systems can be obtained by increase of medium flow rate. It induces the shear stress, which may lead to cells detachment and loss. We applied an alternative approach consisting in implementation of a gas permeable membrane, to allow diffusion of oxygen to the cell growth chamber. Microscopic observations revealed that C3A cells were able to attach, spread and divide in the collagen-coated bioreactor at the low medium flow rate (0.1 µl/min). There were no significant differences between the morphology of cells cultured in the bioreactor and polystyrene culture dish. Successful growth of C3A cells in our membrane-based bioreactor positively validates its design for hepatic culturing.

*The DLC layers were deposited by the project partners from Institute of Turbomachinery, Technical University of Łódź: A. Karczemska, W. Kaczorowski, D. Batory

Research was financed by the EU (European Regional Development Found) within the POIG Programme: MNS-DIAG “Micro- and Nano- System for Chemistry and Biomedical Diagnostics (POIG 01.03.01-00-014/08-02).
Carbon nanotubes are the material made from the graphene planes scrolled into a roll whose diameter is from a fraction of a nanometre to several dozen nanometres, while their length may reach as much as several micrometres. The requirement for practical use of the potential applicational possibilities of carbon nanotubes on a big scale is the capability to make from them in the planned and controlled way the bigger structures and to join them with other materials. Experiments are very important in the area of coating the surface of carbon nanotubes with nanoparticles of metals and semiconductors. Nanocomposites of the carbon nanotubes - nanoparticles type, obtained in this process may feature the valuable materials due to combination of their unique physical and chemical properties of their components. Both components are characteristic of the big specific surface and high electrical conductance. Carbon nanotubes with density of about 1.33-1.40 g/cm³ are lightweight and have high bending-, tensile- and torsional strength. Obtained nanocomposites having their unique electrical, mechanical and heat properties, may be applied in the future as an active sensor elements when analysed signal can’t be recorded directly by human senses or when it works as a part of equipment automatically reacting on new signal and also when it is desirable that signal is recorded without human activity. An advantages of sensors with carbon nanotubes coated with platinum nanocrystals are small size and possibility to detect multiple gases at the same time. They can also be exploited in: biomedicine, medicine, the automotive industry, the food industry, agriculture, nature conservation as well as gas installations.

Own research made using the scanning- and transmission electron microscopes confirmed efficiency and performance of the employed method of decorating the carbon nanotubes. The fabricated nanocomposites are characteristic of the homogenous distribution of the platinum nanoparticles on surface of carbon nanotubes, and no non-settled platinum nanoparticles were observed in the vicinity of the nanotubes, which attests the properly made deposition process. Microscope examinations made observation possible of the cylindrical platinum nanoparticles with the diameter of 3-4 nm with clearly discernible crystallographic planes.
The number of different heart and lung support systems and devices like ventricular assist devices (VAD) and respirators, is continually increasing but the problem how to assess and compare their features is still valid.

We solved this problem at the Nałęcz Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences (IBBE PAS) in collaboration with the Institute of Clinical Physiology of the National Research Council (IFC CNR) by developing novel (patents and patent pending), hybrid simulators in which numerical models of the cardiovascular and respiratory systems are connected with mechanical assist devices (VAD, respirators) by means of impedance converters. These impedance converters are electro-hydraulic (for VAD) and electro-pneumatic (for respirators) interfaces, containing electrically controlled flow and/or pressure sources. This solution enables to replace a chosen section of the cardiovascular (or respiratory) system numerical model by an equivalent physical section (hydraulic or pneumatic) of the same impedance and to test a particular, mechanical assist device connected.

Two applications of the mentioned above simulators have been presented as examples: nonpulsatile VAD interaction with lumped parameters cardiovascular system numerical model and respirator interacting the DuBois numerical model of lungs with obstructive disease. The results of simulations showed how the tested assist devices change their characteristics in the course of heart or lungs diseases and how it influences pressure and flow in a particular point of cardiovascular or respiratory system numerical model.

Tests of the hybrid simulators performance and simulations of their interaction with heart and lung assist devices proved that they are reliable and accurate tools to test these devices and help to optimize their applications in different cases of heart and lungs pathology (as decision support systems). The simulators have been used in Poland: Foundation of Cardiac Surgery Development in Zabrze, Interfaculty Centre of New Medical Technologies (Tadeusz Kosciuszko Cracow University of Technology, Jagiellonian University Medical College, AGH University of Science and Technology, Cracow) and Warsaw University of Technology as well as in Italy (Institute of Clinical Physiology CNR).

The research has partially received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement No. 248763 (SensorART Project).
TERMET CAE – THERMAL ANALYSIS METHODS FOR DESIGN OF HIGH CONDUCTIVITY COMPOSITE MATERIALS

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TERMET CAE is a software tool for thermal Analysis & Design of various composite material structures, represented by a unit volume in the form of a cuboid. It helps material engineers analyse unique composites and turn design process into a key competitive advantage. Flexible combination of analytical and numerical methods, material database and workflow services of TERMET CAE translates into an outstanding tool for composite material studies. The direct design of composite materials with predefined thermal parameters is a difficult process, which requires ability to work with complex mathematical models and numerical methods. In order to simplify this procedure, TERMET project proposes an innovative interactive approach, which is based on computational modelling method. The key component of TERMET software is user-friendly analysis module, which evaluates thermal conductivity in various types of composite materials. We consider three main types of geometrical interpretation of composite materials: multi-layered structure, particles reinforced and fibres reinforced.

TERMET software realises several useful features, which make it flexible and very helpful tool for designing specific composite materials, like:

- it is built on classical client-server architecture for supporting multi-user and multi-project collaborative work;
- distributed material database, which allows simultaneous collective work of several designers;
- flexible graphical interface, based on synchronous graphic-mathematic kernel with enhanced productivity;
- various service functions, which provide users with real-time information during the design process;
- data conversion procedures, which allows easy combining and comparing designed composites with other known commercial CAD/CAE tools.

It may be used by materials engineers for complete design and preproduction estimation of thermal parameters in new composite materials or as an auxiliary tool for design of different thermal mechanical details of structures with complex geometry. It is also an important tool for education, training and visual presentation for materials engineers.

GOLD MEDAL in the Category “Education”, Invention and New Product Exposition INPEX, Pittsburgh, 2013
GOLD MEDAL, iENA International Ideas, Inventions and Innovation Trade Fair, Nürnberg 2012
GOLD MEDAL, IWIS Innovation Fairs, Warsaw 2012
GOLD MEDAL, Innovation Fairs, Katowice 2012
GOLD MEDAL, INST International Invention Show and Technomart, Taipei 2012
The subject of this invention is a wax microemulsion and a method of producing a stable wax microemulsion designed for waterproofing and coating various materials, particularly natural ones, to protect them from moisture, weather and biological factors. The main components of this emulsion are macro- and micro-crystalline petroleum waxes, including petroleum slack waxes of low oil content, as well as natural waxes (e.g. the Carnauba plant wax, the montan wax) and synthetic waxes, mainly oxidised polyethylene ones, in a micronised or non-micronised form, whose addition contributes to the useful properties of the microemulsion, and particularly of improving its barrier effect against moisture as well as producing a protective coating of a greater mechanical strength on the surface of materials. As a result selecting the appropriate system of nonionic and anionic emulsifiers contributing to the effective reduction of the surface tension on the wax/water phase boundary, and also of the appropriate pH regulators, and by selecting the best technological parameters of the emulsification process, with an effective dispergation of wax particles using high-pressure or ultrasound homogenisation or mechanical homogenisation, i.e. the effective mixing with a rotor/stator head, wax microemulsions of a perfect homogeneity and stability were obtained. Depending on the emulsifiers, pH regulators and the homogenisation type used, the average size of wax particles in the microemulsions produced ranges from 0.1 to 0.5 micrometres. The microemulsions produced have low dynamic viscosity, which contributes to their ability to penetrate into the structure of the material being waterproofed. Main areas of application: chipboard, wood, fibers and woven fabrics impregnation, coating of natural materials and plastics surface, including paper and cardboard, applications demanding high chemical cleanliness of products, i.e. in cosmetics and pharmaceutical industries, as well as in contact with food stuff.
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