

development opportunities

an overview of the latest technologies
developed at the Jožef Stefan Institute





// Table of Contents

4	Introduction
5	Jožef Stefan Institute
5	Center for Technology Transfer and Innovation
6	Technologies
7	Electronics, IT and Telecommunications
29	Nanotechnology and New Materials
42	Biological Sciences
45	Physical Sciences

// Introduction

In front of you is a collection of the latest technologies developed at the Jožef Stefan Institute. The presented technologies solve various problems from the fields of nanotechnology, ceramics, information technology, biotechnology, new energy sources, new materials, environmental technologies, etc. With the knowledge we have gained and by cooperating with economy and education, we wish to encourage the progress of Slovenian companies and society in general.

The technologies are available for licensing and/or research collaboration with industry or other research institutes. Due to their inventiveness and novelty, most of the presented technologies are protected by patents.

To promote our technologies in a clear and comprehensive manner, we have prepared a brief description of each of the technologies, including key information on the main field of application, problem that is being solved, main advantages of the technology and the status of intellectual property protection. We strongly believe that promotion of research and development can help establish better connections between the spheres of research and economy.

If you would like to collaborate with us by using the presented technologies in the course of your entrepreneurial endeavours or by working with us on their further development, do not hesitate to contact us.



photo: M. Smerke

// Jožef Stefan Institute

Jožef Stefan Institute is the largest and leading Slovenian scientific research institute covering a very broad spectrum of basic and applied research. It was established in 1949 and is named after the distinguished 19th century physicist Jožef Stefan, most famous for his work on the Stefan-Boltzmann law of black-body radiation. The staff of more than 950 specializes in natural sciences, life sciences and engineering.

The mission of Jožef Stefan Institute is accumulation - and dissemination - of knowledge at the frontiers of natural science and technology to the benefit of society at large through the pursuit of education, learning, research, and development of high technology at the highest international levels of excellence. The subjects concern production and control technologies, communication and computer technologies, knowledge technologies, biotechnologies, new materials, environmental technologies, nanotechnologies, and nuclear engineering. After more than 60 years of scientific achievement, the Institute has become part of the image of Slovenia.

Jožef Stefan Institute is financed through national projects of ministries of the Republic of Slovenia and the Slovenian Research Agency, international bilateral and multilateral projects and industrial projects in Slovenia and abroad. An important part of institute's revenues is derived from international contracts and industry.

// Center for Technology Transfer and Innovation





Center for Technology Transfer and Innovation at the Jožef Stefan Institute (CTT) acts as a financially independent unit within the Jožef Stefan Institute. It was established in 2011 and has since become the largest and most successful technology transfer office in Slovenia. Its task is to enable and facilitate the transfer of technologies and innovations developed at the Jožef Stefan Institute into economy, especially by initiating new industrial cooperation, establishing new spin-out companies, creating market analyses and helping protect and market intellectual property.

CTT employs twelve professionals from various professional and scientific backgrounds, who help individuals with acquiring intellectual property rights, concluding contracts with business entities, establishing spin-out companies and their market penetration, patent applications and business plans. They offer advice on optimization of intellectual property protection and actively market intellectual property, provide professional legal assistance, especially in the field of IP law, identify possibilities of IP rights exploitation (technology assessment and market evaluation), seek for suitable partners for IP transfer, carry out negotiations and prepare high quality licensing and sales contracts.

// Technologies

Technologies, described on the following pages, are divided into 4 categories:

- Electronics, IT and Telecommunications;
- Nanotechnology and New Materials;
- Biological Sciences;
- Physical Sciences.

Each category is indicated using specific background colours:  for Electronics, IT and Telecommunications,  for Nanotechnology and New Materials,  for Biological Sciences and  for Physical Sciences.

// Detection of Phoning While Driving

Summary

A solution for detecting whether a person is driving a vehicle while using a mobile computing device by making use of sensor data provided by these mobile computing devices.

Keywords

Artificial Intelligence (AI), Smart Appliances, System and Transportation

Applications

- Mobile computing industry and telecommunication service providers;
- Governmental road safety organizations;
- Insurance companies;
- Automotive industry.

Department

E9 - Department of Intelligent Systems

Stage of Development

Concept stage



IPR Status

Patent applied for but not yet granted

Description

The solution aims at helping governments and interested private organizations in restricting mobile phone use while driving, which is a well know road safety concern.

The system is based on the detection of movement patterns being attributable to the movement of a vehicle and movement patterns being attributable to the person using a mobile computing device. A relation is established between both movement patterns, based on this relation it is determined whether a person is driving a vehicle while using a mobile computing device.

The inventors are internationally recognized experts in the fields of ambient intelligence, machine learning and data mining, language and speech technologies, computational intelligence and agent and multiagent systems.

Advantages

- Completely autonomous solution (only a smart phone is needed);
- Employment of context-based reasoning methods enables more reliable and more robust detection whether a person is driving a vehicle while using a mobile computing device;
- Observing a relation of vehicle movement patterns and movement patterns of a person using a smart phone is a novel approach.

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// 3D Micro-Laser for a New Generation of Photonic Micro-Systems

Summary

The world's first practical omnidirectional micro-laser. The micro-droplet shaped laser resonator is formed spontaneously in a fraction of a second from special liquid-crystal in a carrier fluid. The laser is tunable, its production is simple and inexpensive. It can be used in optical devices, photonic devices and communication systems, displays and medical imaging instrumentation.

Keywords

Microengineering, Laser Technology, Nanotechnologies Related to Electronics and Microelectronics, Optical Networks and Systems

Applications

- Optical and photonic devices;
- Displays;
- Imaging instruments;
- Medical imaging instrumentation;
- Optical communication systems.

Department

F5 - Department of Condensed Matter Physics

Stage of Development

Under development/lab tested

IPR Status

Patents granted



Description

Conventional lasers emit coherent and monochromatic light in only one direction. The presented laser is emitting coherent light in all directions and is the world's first 3D laser ever demonstrated. Such a laser cannot be made from solid state, because of the spherical shape of the laser resonator. Spherical resonators with a series of nested shells of a dielectric material with different refractive indices are very difficult, if not impossible to produce by deposition, lithography and etching.

The invented laser is a micrometer-sized source that emits coherent and monochromatic light in all directions. The liquid-crystal 3D micro-laser is simple, robust and its production is inexpensive. The core of invention is a micro-droplet of a dye-doped, cholesteric liquid-crystal in a carrier fluid. The cholesteric forms a Bragg-onion optical micro-cavity and the omnidirectional 3D lasing is due to the stimulated emission of light from the dye molecules in the liquid crystal. The lasing wavelength depends solely on the natural helical period of the cholesteric and can be tuned by chemical composition of liquid crystals, temperature, electric field or light. Therefore, millions of identical micro-lasers can be produced simply by mixing a liquid crystal, a laser dye and a carrier fluid, thus providing micro-lasers for soft-matter

photonic devices. The laser can also be polymerized into a mechanically robust structure and integrated into optical circuits controlling the optical signals. It can be used for illuminating small objects in microscopy with coherent light, full-angle coherent illumination in holography and display technology. The micro-laser can be used as a truly point source of coherent light for calibration and testing of optical instruments. The inventors are world experts in liquid crystals.

Advantages

- World's first 3D laser that can be practically used;
- Emission of coherent light uniformly in all directions;
- The production is very simple and inexpensive;
- Self-assembly of millions of identical micro-lasers in a fraction of a second;
- Simplicity and robustness of the device.

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// Non-Invasive Real-Time Control of Inner Body Temperature Variables During Therapeutic Cooling or Heating

Summary

A new method and a device for non-invasive real-time control of inner (hidden) body temperature variables during therapeutic cooling or heating, which is not possible with today's classical cryotherapeutic devices. The solution allows for personalization of the thermal therapy process to meet the demands of a specific patient and different therapeutic protocols.

Keywords

Artificial Intelligence (AI), Applications for Health, Embedded Systems and Real Time Systems, Medical Technology / Biomedical Engineering

Applications

- Rehabilitation and medical equipment manufacturing, especially in the field of thermal therapy.

Department

EG - Department of Communication Systems

Stage of Development

Under development/lab tested



IPR Status

Patent applied for but not yet granted

Description

The method and device enable real-time control of inner body temperatures during therapeutic cooling or heating without the need of invasive temperature measurements. The solution is an upgrade of the existing computer-controlled cryotherapy devices with pre-programmed protocols in terms of heat extraction intensity and treatment time, which is already in use for the purpose of thermal therapeutic treatments. The device upgrade includes small thermo sensors (thermistors) and a support mini on-board computer with very little additional cost.

The conventional control systems are based on simple feedback loop using the difference between measured and reference values. Depending on the obtained differences, a corrective action is taken. During thermal therapy, we cannot measure the inner (hidden) body temperature (e.g., head, knee, elbow, etc.) that we want to control, but only the temperature on the body surface and the temperature of the cooling/heating media.

Therapeutic cooling or warming nowadays is a standard medical procedure after injury or surgery. Known complications during the therapeutic treatment are mostly hypo or hyperthermia. Computer-supported cryotherapy devices are becoming more often and are replacing the classical passive therapies based on ice. These growing trends are stimulated by higher efficiency and controllability of the heat extraction or

heat supply, treatment time, and pressure on the injured body part provided by computer-supported cryotherapy devices. More comparative clinical studies are expected in the future, which will extend the knowledge about the importance of the thermal therapy. The above listed potentials will contribute to market growth of thermal therapeutic devices.

The potential beneficiary is the state health insurance system and other health insurance beneficiaries because of the lower costs for medical services, less complications, and the benefit for the patient from more comfortable, more reliable and more efficient health services in the cases of postoperative or post injury thermal therapeutic treatment.

Advantages

- Non-invasive control of inner body temperature during thermal therapy;
- Temperature measurements on body surface;
- Personalisation of thermal therapy to achieve maximal efficiency for each individual patient;
- Simple implementation;
- Easy to use;
- Cost effective upgrade of existing thermal therapy devices.

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// An Intelligent Door Surveillance System

Summary

An electronic intelligent door security system able to recognize the users, detect unusual entry/exit, break-in and break-in attempts, predict user presence and offer personalized services and remote control using intuitive graphical user interface (GUI) or virtual assistant that understands natural language.

Keywords

Artificial Intelligence (AI), Building Automation Software, Smart Appliances, Smart Cards and Access Systems

Applications

- Building construction industry;
- Security system integrators;
- Architecture companies.

Department

E9 - Department of Intelligent Systems

Stage of Development

Prototype available for demonstration



IPR Status

Patent applied for but not yet granted

Description

The intelligent door surveillance system is an innovative and cost effective autonomous security and surveillance solution for private homes, apartments and holiday apartments. In addition, it can be effectively used for offices and hotels. Even though the system is a stand alone solution, primarily aimed at integration into existing doors, it can be adjusted and integrated into existing security and surveillance systems, such as access control, anti burglar systems, smart home applications and other automated home subsystems which need an additional level of functionality.

This is an intelligent system able to recognize the users, detect unusual entry/exit, break-in and break-in attempts, predict user presence and offer personalized services (customizable notifications and alarms, relevant information, voice messages, greetings and tips) and remote control using intuitive graphical user interface (GUI) or virtual assistant that understands natural language.

The solution is based on a door with an electro-mechanic lock, a tablet PC, a micro-controller and an array of sensors that offers services similar to a human doorman, improves security and increases user comfort. The sensors gather data about events related to the door, which are used for context based reasoning and awareness achieved by artificial intelligence methods running on the tablet.

The system has been awarded for innovation and has been already promoted in

several innovation fairs in Slovenia.

The researchers have developed a minimum mobile version of the system that transforms a tablet personal computer (PC) into a video surveillance device. It uses state-of-the-art machine vision algorithm to detect motion in real-time. When motion is detected, it stores pictures of the moving object to secure digital (SD) card and sends alarms via SMS to desired phone numbers and/or e-mail with attached pictures to desired e-mail addresses. The app can also be controlled remotely via SMS using a free complementary app. When surveillance is turned on, the app works in stealth mode, monitors power supply and sends warning when power is lost or low, and automatically accepts incoming calls from selected phone numbers to allow remote listen in function.

The authors of the system are internationally recognized experts in the fields of ambient intelligence, machine learning and data mining, language and speech technologies, computational intelligence and agent and multiagent systems.

Advantages

- Automated user recognition;
- Detection of unusual user behavior (entry/exit);
- Detection of break-in attempts;
- Prediction of user presence;
- Personalized services such as customizable notifications and alarms, relevant information, voice messages, greetings and tips;
- Remote control using intuitive graphical user interface (GUI) or virtual assistant that understands natural language.

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// Personalized Trip Planner – Virtual Tourist Guide

Summary

An intelligent access control system that learns from experience to distinguish authentic entries from the impostor ones and to detect an unusual behaviour of the regular users. The system improves efficiency of an arbitrary access control in surveillance and security demanding applications.

Keywords

Artificial Intelligence (AI), Knowledge Management, Process Management, Applications for Tourism, Applications for Transport and Logistics

Applications

- Hotels and resorts;
- Travel agencies and services;
- Advertising and public relations;
- Databases and on-line information services.

Department

E9 - Department of Intelligent Systems

Stage of Development

Prototype available for demonstration

IPR Status

Secret Know-how



Description

The personalized trip planner brings value to the tourists who need a carefully designed itinerary, to tourist information providers who want to offer their information effectively, and to tourist service providers to get more customers for their services.

A tourist who wants to make the most of his trip needs a carefully designed itinerary. However, many travelers do not have the knack or time for that. This is where the e-Tourist service comes in – the tourist only needs to provide it with his interests (culture, nature ...) and time constraints (start on Thursday at 13:00, finish on Friday at 17:00), and the service prepares a personalized itinerary that maximizes his sightseeing enjoyment in the time available. It achieves this by learning his preferences from his past trips and trips of similar users, using intelligent recommendation and planning methods. Since almost all tourists use the Internet to plan their trip, and increasingly many use it on their smart phone during the trip, the number of potential users is huge. Despite that, such services are currently scarce and technologically less advanced than ours.

The obvious beneficiaries of the system are tourists who get itineraries tailored to their wishes. Satisfied tourists of course also benefit tourist information and service providers, such as tourist agencies, municipalities, restaurants, museums, entertainment parks and other stakeholders, because such tourists see more,

spend more money doing so, and are more likely to return.

The service also makes it possible to subtly steer tourists towards specific sights, which can help manage the crowding of main attractions and expose less known sights. The service can reduce the need for human resources, such as employees in tourist information offices. And finally, since it can be integrated with most existing tourist information, it allows providers of such information to quickly gain a competitive advantage.

Advantages

- Use of data from various public databases and social networks for better learning of user preferences and creating better itineraries;
- Spoken human-like communication for better user experience;
- Modular architecture allows the use of the whole system or only parts, enabling various business models;
- Innovative business models enabled by the technical solution bring value to the various stakeholders (e.g. tourist agencies, municipalities, restaurants, museums, entertainment parks).

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// Ubiquitous Care System to Support Independent Living

Summary

Care system for the detection of abnormal short-term events (such as falls), mid- and long-term events, such as unexpected behaviour, that may be related to a health problem in elderly.

Keywords

Artificial Intelligence (AI), Data Processing / Data Interchange, Middleware, Smart Appliances, Environmental and Biometrics Sensors, Actuators, Applications for Health, Safety for Elderly

Applications

- Elderly care institutions;
- Hospitals;
- Rehabilitation centres.

Department

E9 - Department of Intelligent Systems

Stage of Development

Prototype available for demonstration

IPR Status

Secret Know-how



Description

The main function of the care system is the detection of short-term abnormal events (such as falls), mid- and long-term events, such as unexpected behaviour, that may be related to a health problem in the elderly.

Nowadays, most of the care systems in the market are limited to detecting falls. The innovation of the system developed is that it will not only detect falls, but also identify mid- and long-term unexpected behaviour that could indicate health problems. Thanks to these features, the elderly people can gain the confidence and independence. The system is cost effective, non-intrusive and reliable, increasing the quality of life and security of the elderly and, thus, prolonging their personal autonomy and participation in society. Not only could the elderly profit from the system, but also their families and caregivers, since the burden on them could be substantially reduced. The system aims to decrease the need of institutionalisation of the elderly.

The system works indoors. Information about the user's location and acceleration are analysed to decide whether to trigger the alarm. The system is easy to use and does not constrain the user's daily life. The user keeps control of the system and can customise the alarm protocol. In case of an abnormal situation, such as a fall or an accident, the system permits a rapid actuation of the health services, which decreases the negative consequences of the accident (worsening of injuries, psychological impact of being alone and injured, etc...).

In case a mid- or long-term abnormal situation is detected, an alert is triggered which informs the user that visit to the medical specialist might be needed.

The system is a result of multidisciplinary research with the involvement of the end-users who co-defined the specifications. Involvement of users in an early stage of the project contributed to meeting their requirements and increased the acceptability of the system to the target group.

Advantages

- **Reliability.** This aspect is essential to increase the quality of life of the elderly. The system has low false alarm rates compared to other similar systems.
- **Self-learning;** that is, the system "learns" from previous situations.
- **Non-intrusive,** in order to preserve the user's privacy. Moreover, the user keeps control of the alarm protocol and the collected location data is only processed with the users consent and for the necessary duration for the provision of a value added service. Thus, system follows the Directive 95/46/EC on the protection of personal data in the electronic communication sector.
- **Ease of use.** The system is easy to use. Since it is a portable system it is easy to wear, so that it does not constrain the user's daily life at home.

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// Bringing Context to Your Emails

Summary

A platform for searching, managing and tagging email and contacts from one or more email accounts. It can be used on a personal or on an enterprise level. Advanced search features can be used to find relevant information which can be visualized using social networks, timeline and tag cloud.

Keywords

Computer Software, Knowledge Management, Process Management

Applications

- Computer software providers;
- Early case assesment solution providers.

Department

E3 - Artificial Intelligence Laboratory

Stage of Development

Available for demonstration



IPR Status

Secret Know-how

Description

Emails are extensively used by companies and by individuals for personal use. Despite the popularity of social networks, recent studies show that the number of exchanged emails is still increasing. For active email users, finding an email or a group of emails in an inbox containing thousands of emails can be a challenging task. The solution in question makes this task easier and more efficient by providing advanced search functionalities and by showing the results in context.

The program allows the user to search for emails by specifying one or more search conditions. Conditions can include people, keywords and tags. After specifying the search conditions, the program finds all emails that match the conditions. Results are typically displayed as a list that, for each email, shows the sender, recipients, subject and a short content. Additionally, a social network is also extracted and displayed based on the people who participate in the results. Two people are connected in the graph in case in at least one result, one person was sender and the other recipient of the email. Displaying the social graph enables users to quickly detect clusters of people and to add additional search conditions. The results are also aggregated and displayed in a timeline which enables seeing periods in time with high or low activity. The visualization is also interactive and allows the user to add additional search conditions based on time. Additional summary of the results is also provided based on the content of the results. Text mining methods are used to extract from the resulting emails the most relevant keywords which are then displayed in a form of a tag cloud. The size of the keywords in the cloud corresponds to their relevance.

The program can be used as an add-in in Microsoft Outlook or as a standalone application. The application brings the most value to knowledge workers who receive tens of emails per day and typically work concurrently on several projects with different groups of people. The program is highly scalable and can store and search hundreds of thousands of emails. If used as a standalone application, it can import emails from multiple email accounts.

Advantages

- Search is not based only on keywords but features such as people names, groups, tags and time;
- The results are summarized and visualized in different ways;
- Summaries of results include social network visualization, timeline visualization and a tag cloud;
- All visualizations are interactive;
- The application can be configured to work in the cloud and the data importing can be automatically performed on the server side, while one or more clients can perform the search.

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// Fast Temperature Simulation and Optimization of Cooling Appliances and Heat Pumps

Summary

A solution for fast temperature simulation and optimization for the development of household appliances, heat pumps, heat exchangers, ventilation and air-condition (HVAC) systems. While the simulator replaces time consuming measurements, the optimization tool allows quick and optimal design of the new appliance and shorter development times of the product.

Keywords

Household Goods & Appliances, Cooling Technologies, Heating, Ventilation

Applications

- Manufacturing of domestic appliances;
- Manufacturing of HVAC systems;
- Heat pump manufacturing.

Department

E7 - Department of Computer Systems

Stage of Development

Available for demonstration



IPR Status

Secret Know-how

Description

The solution enables fast temperature simulation and optimization of the control parameters during the development process of cooling or heating appliances such as refrigerators, heat pumps, heating, ventilation and air-condition (HVAC) systems and other compressor-driven air conditioners and freezers.

The solution consists of two parts: first part is the temperature simulator and the second part is the design optimization tool (optimizer). While the simulator replaces time consuming measurements of the slow thermal processes within appliances, the optimization tool automatically finds the optimal control parameters of an appliance and provides quick and optimal design of the new appliance. Therefore the complete solution shortens the development time of the product for at least of an order of magnitude.

Usually, during the cooling or heating appliances production, each new type of appliance has to be measured to determine its optimal performance with the lowest possible energy consumption. Thermal processes in the cooling systems are, by their nature, very slow. Thus, to determine the energy consumption it may take several days of measurements. In order to speed up the process of finding an optimal set of control parameters, a simulator operates on a minimum set of specific short measurements. In the case of changes in the cooling appliance design (geometric dimensions, embedded components, method of regulation) the limited set of

measurements is repeated, and measures are entered into the simulator again. This means that the simulator can be improved without significant effort and investments. Simulation software (SW) requires only minimum computer skills of the user.

The optimizer uses a heuristic search approach to find the optimal solutions iteratively over evolving generations. The evolutionary approach is based on probabilistic methods to decide on changes and the direction of search; while the used parameter-less algorithm is able to find optimal, or at least very good solutions, relatively quick, and without the need for a parameter-setting specialist.

The fast temperature simulator is needed in development departments of household appliances and HVAC systems producers as a replacement of long-lasting measurements of temperature processes, which are slowing down the development process.

Advantages

For optimal performance of a cooling appliance the lowest possible energy consumption is needed to cool the cabinets to the desired temperature. To optimize the performance of a cooling appliance, it usually requires a lot of long-term measurements and detailed theoretical analysis of the cooling system and the construction of complex mathematical model for simulation. This requires a lot of time and specific knowledge on expensive simulation tools. As opposed to time consuming, knowledge demanding and expensive simulation tools, the proposed simulator is designed as a simple standalone program. The simulation of 48 hours of operating time takes less than 1 second. There are some simulators with similar properties on the market, but they are not designed to easily and quickly adapt to new product. This replaces a large part of the development measurements and thus reduces the development costs.

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// Intelligent High-Security Physical Access Control

Summary

An intelligent access control system that learns from experience to distinguish authentic entries from the impostor ones and to detect an unusual behaviour of the regular users. The system improves efficiency of an arbitrary access control in surveillance and security demanding applications.

Keywords

Artificial Intelligence (AI), Computer Software, Knowledge Management, Process Management, Building Automation Software, Smart Cards and Access Systems

Applications

- Building construction industry;
- Security system integrators;
- Architecture companies.

Department

E9 - Department of Intelligent Systems

Stage of Development

Field tested/evaluated



IPR Status

Patent applied for but not yet granted

Description

The aim of the arbitrary automated physical access control system is to restrict entrance to a certain room, building or a wider perimeter to authorized persons. Various access control systems include different types of credentials for the authorization, such as PIN, access cards or biometrics (e.g. fingerprint). Different types of credentials have different levels of security and are suitable for different purposes. However, any of the known credentials (including biometrics) are prone to security vulnerabilities and can be breached quite easily once the security mechanism is figured out. For example, an arbitrary card based access control system does not recognize the obvious misuse of the credential of the unauthorized person (e.g. in case somebody uses the entry access card which belongs to other person or in case of a false verification of the identity by a biometric device such as fingerprint reader.

Intelligent High-Security Physical Access Control system learns from usual behaviour of the users and detects unusual (incorrect) entry or exit attempts. The used attributes for learning are for example, the time in the day, the specific day of the week, the specific date in relation to the month (e.g. each first Monday in a month) etc. Each date also relates to a specific user in a specific way – e.g. normal working days, vacations, reported sick leaves etc. The third relation deals with previous entries in a specific time period, e.g. the last hour or on each Monday. The data features include timing of entries of the person himself or in relation to any other access of any other person. For example, appropriate input data features and examples enable finding patterns such as person #1 and person #2 always enter at

the same door inside a one minute interval. Also the combination of entries at different doors (e.g. use of different access points) gives the system more information and therefore facilitates the verification of users.

In short: in contrast to an ordinary access control system, the system in question differentiates between "proper" access of "fit" employees and all other attempts of access, e.g. due to fake card, stolen identity or other security vulnerabilities of an arbitrary access control system.

The system can be used as a stand alone application or as an add-on to an arbitrary physical access control system or time attendance system (e.g. RFID card or biometric based) in surveillance and security demanding applications. The system can be easily integrated with video surveillance systems. The system adds another level of security and functionality to arbitrary existing access control systems.

Advantages

- Detection of unusual user behaviour (entry/exit) by applying machine learning methods;
- Distinguishing of regular entries from faulty or fake ones (e.g. due to identity theft or security breach of a system);
- The system can be used as a stand-alone application or as an add-on to an arbitrary access control system in surveillance and security demanding applications;
- Easy integration with existing security systems;
- Graphical representation of the results of unusual behaviour help security personnel to understand and efficiently fine tune the detection of an unusual behaviour;
- Easy integration with video surveillance systems in order to improve the efficiency and analysis of the captured events, e.g. each event can be easily analysed and properly treated;
- Possible implementation in time attendance systems (e.g. for detection of false evidence of working hours).

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// Smart Kitchen Scale for People With Special Nutritional Needs

Summary

A light, pocket-sized, wireless kitchen scale that is used for assisting people with special nutritional needs by analysing the content of any food portions. The main advantage of the technology is that is smart and adaptable to personal needs. A prototype in a form of a smart phone has been developed and it can be used in hospitals and elderly homes.

Keywords

Smart Appliances, Applications for Health, Household Goods & Appliances, Nutrition and Health

Applications

- Health-care institutions (hospitals, clinics, elderly-care institutions);
- Sport nutrition experts .

Department

E7 - Department of Computer Systems

Stage of Development

Field tested/evaluated



IPR Status

Secret Know-how

Description

The technology enables simple and economically-priced wireless connection of a kitchen scale with a mobile phone, a tablet or a personal computer. In this way, the scale can be a lite, pocket-sized device that is used in a connection with a mobile phone. A user can carry the scale out of home and use it as a reliable source of food composition data (FCD). The complementary mobile/web application provides complex FCD as well as tools for individual recipe calculation, barcode recognition etc. FCD are not limited to nutrients but may be also other constituents, like toxins, E-numbers etc. Such a portable kitchen scale is aimed for people with special nutritional needs, i.e., chronic patients, people with food allergies or intolerances, as well as athletes, and pregnant and lactating women. It can be used not only by an individual but also by hospitals and elderly homes, where patients need nutritional treatment.

The core of the invention is a small communication module that fits into any kitchen scale and makes it wireless, while still being economically priced. Wireless connection of the Smart kitchen scale with a mobile phone, a tablet or a personal computer is inventive. To enable cheap and efficient wireless connection of the scale with a mobile phone, a tablet or a personal computer, a new technology has been developed.

The inventors have been involved in several national projects on clinical nutrition, in which they have developed a web application for personalized diet menu planning

based on evolutionary computation and food composition data from various national and European resources.

Advantages

- It is portable and enables weighing of realistic food portions;
- Provides up-to-date food composition data (FCD) and allows FCD for any dish with known recipe;
- User can select data he is interested in and adapt the system to his personal needs;
- FCD may include also other constituents (toxins, E-numbers etc.);
- The scale can have a form of a smart phone, a plate, or even a wristband.

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// Digital Processor for Scintillation Detection Systems

Summary

A digital processor for scintillation detection system. The system can be used for medical imaging, radiation therapy dosimetry, in the field of high-energy physics etc. The main advantage of the proposed technology is significantly lowered costs for industrial installations.

Keywords

Digital Systems, Digital Representation, Specialised Turnkey Systems, Diagnostics, Medical Imaging

Applications

- Producers of medical devices;
- Radiation therapy;
- Dosimetry;
- High-energy physics.

Department

F2 - Department of Low and Medium Energy Physics

Stage of Development

Field tested/evaluated

IPR Status

Secret Know-how



Description

The technology includes a digital processor which acquires and analyses signals from industrial scintillation detectors, based on a combination of digital pulse analysis and a robust computational approach to compensate for the temperature dependency to scintillation response.

The method has been successfully experimentally tested on NaI(Tl) detector in a climate chamber; the computational convergence is guaranteed mathematically, and the transfer of the algorithm into front-end electronics is a matter of routine engineering.

Advantages

Pronounced temperature dependence of the sensor response in many scintillation detectors calls for cumbersome on-site calibrations that require trained personnel and prevent boxed turnkey solutions from working well under common environmental temperature fluctuations. The offered solution enables nearly plug-and-play installations of various industrial probes (flux, density, container level) based on gamma-ray beams and many scintillation tomographs; thus reducing significantly the cost of installation and calibration.

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// Intelligent Virtual Assistant for Natural Language Conversation

Summary

A virtual assistant platform that answers questions textually and orally in a natural language on a web site.

Keywords

Artificial Intelligence (AI), Speech Processing/Technology, User Interfaces, Usability

Applications

- Municipalities, governmental organizations, ministries and agencies that extensively communicate with their clients, citizens, that are interested in their services, specific information etc.;
- Private companies with an extensive customer demand for specialized information about their products, customer support, also by employment of call centres;
- ICT and marketing companies with access to market for virtual assistants.

Department

E9 - Department of Intelligent Systems

Stage of Development

Already on the market



IPR Status

Secret Know-how

Description

The platform provides web and mobile users of the service with an intelligent assistant who can answer questions textually and orally in a natural language, and offer a range of additional services specific to the needs of the user, enable interactive communication with a user through comments and entering remarks, and give the client the chance to review interactions. The platform is available also for mobile application via four mobile platforms (Android, iOS, BlackBerry, Windows Phone). The intelligent assistant contains elements of virtual assistants, intelligent agents, web and mobile services, social networks, speech technologies and artificial intelligence. The virtual assistant platform is currently adapted to the municipalities and associations of senior citizens with the possibility of rapid transmission to other areas. Furthermore, in addition to the assistant, the innovation also offers a knowledge base for municipalities or senior citizens, and editor tools.

Advantages

- Cost effective and competitive price performance ratio;
- Unique features (TTX, feedback, context, etc.) that improve user experience and reduce the costs of maintenance of the knowledge database;
- Available for integration in mobile applications and services;
- Fast and easy implementation of the system – no highly specialized experts

- needed for local support and customization;
- Expose specific client services, application or topic with added advantage of narrowing the context of question answering which results in more relevant answers for users;
- Better user experience in comparison to looking for information on the web site manually or with search engines, frequently asked questions (FAQ) lists (faster answering for the domain specific topics);
- Less investment needed for call centres.

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// Bioactive and Antibacterial Coating for Dental Implants

Summary

A process for coating titanium or any titanium-based alloy bone implants with a protective and bioactive coating that can be also produced in a form with antibacterial properties. The powder itself has high specific surface area and is therefore highly soluble in liquid media. The coating is useful especially for dental implants.

Keywords

Coatings, Medical Biomaterials, Dentistry / Odontology, Stomatology

Applications

- Ti or Ti alloy implants, especially for dental implants to stimulate bone ingrowth and to improve implants' longer-term behaviour.

Department

K7 - Department for Nanostructured Materials

Stage of Development

Under development/lab tested

IPR Status

Secret Know-how



Description

The low-temperature process for coating of titanium or titanium-based alloy with the coating is simple and can be performed in a single step. The formed crystalline oxide coating is strongly attached to the substrate, provides more favourable surface properties to the implant than the state-of-art as it is hydrophilic, promotes hydroxyapatite formation and cell attachment and it hinders release of alloying metal ions into the surrounding tissue. In addition, it may acquire antibacterial effect.

Advantages

- Coated metal implants are hydrophilic, thus providing more favourable surface for cells;
- Its bioactive properties accelerate bone formation;
- Leaching of harmful metal ions is reduced;
- Antibacterial properties lower the probability of infection.

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// Photocatalytic Material with Superior Properties Suitable for Water and Air Purification Applications and a Method for its Preparation

Summary

A new photocatalytic material and a method for its preparation. The material is based on thin layer of zirconia. The measurements of photocatalytic activity show up to four-times higher photocatalytic activity compared to common titania photocatalysts. The technology is suitable for air, gas and water purification.

Keywords

Surface treatment, Anorganic Substances, Indoor/Outdoor Air Pollution/Treatment

Applications

- Chemical industry;
- Industrial filters production;
- Parts and/or catalysts in automotive industry;
- Manufacturing of rooftops, walls, facades and similar products;
- Photovoltaics and electronics.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Under development/lab tested

IPR Status

Patent applied for but not yet granted



Description

Materials that are currently used as photocatalysts are mainly based on titanium dioxide. The problem with these materials is in, although high, but still limited photocatalytic activity. Therefore, new materials with even higher photocatalytic activity and new methods of their manufacturing are needed.

Several studies performed by different research groups concluded that zirconia shows a high photocatalytic affinity for degradation of hazardous hydrocarbons, chlorides and nitrides, such as methane, ethane, formic acid, methanol, formaldehyde, tetrachloromethane and nitrogen oxides. The thin zirconia layers are previously known from the state of the art, but are all very expensive and complicated to manufacture, which makes them practically non-applicable at the industrial level. Known procedures of synthesis encompass sol-gel processes, pyrolysis and calcination of zirconia as well as spin-coating processes. One of the main problems for practical application of zirconia thin layers is their stabilization. Stability is necessary for application of zirconia on surfaces of different products and components, for example industrial pipelines, parts of vehicles, rooftops and windows. Such applications facilitate a degradation of hazardous molecules present in atmosphere or produced as waste product during industrial processes.

We have developed a two-phase process for industrial formation of thin zirconium dioxide (zirconia) layers. In the first phase, the chemical vapour deposition is used to form a thin layer of glassy alloy containing a large amount of zirconium, usually over 5 volumetric percent. For better stability and increased photocatalytic activity some copper, titanium and/or niobium ions are added. In the second phase, oxidation of thin layer in the presence of oxygen, elevated temperature and strong oscillating magnetic field is carried out. The oxidation is mediated by oxygen or any other oxygen containing gas. The second phase is very short, usually taking around half a minute. Following the described procedure a thin layer of tetragonal zirconia is produced. The procedure, e.g. both phases, can be carried out in a single chamber. Alternatively a high vacuum chamber can be used for deposition of a thin layer, while other steps are carried out in a separate chamber. The resulting thin layers of zirconia are 10 to 100 micrometers thick.

The advantage of described method is in its industrial applicability, a demand that has not been met so far. The method of synthesis is simple, fast and cost efficient. Prepared materials display improved catalytic activity when compared to common titania photocatalysts. The characteristics of thin layers of zirconia are independent of the crystallinity of the support material. The material can be applied in different pipelines, especially for chemical industry, industrial filters, for parts and/or catalysts in automotive industry, rooftops, walls, facades and similar. Thin layers of zirconia are also applicable in photovoltaics and electronics. The surface of such layers can be easily cleaned after the contamination, with no detectable loss of photocatalytic activity. Such losses are otherwise common for the powder type zirconia.

For the characterization of photocatalytic activity a model organic pollutant compounds, such as benzoic acid and di-tert butyl catechol (DTBC) have been used. The comparison showed up to four-time increase in photocatalytic degradation of model pollutants when compared to commonly used titania photocatalyst under the same operating conditions.

Advantages

- Industrial applicability;
- Superior photocatalytic properties;
- Easy to clean surface;
- Simple, fast and cost efficient preparation;
- Prolonged photoactivity;
- Characteristics are independent of the crystallinity of the support material.

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// Cardiovascular Implants with Improved Antithrombogenic Properties

Summary

A process of specially optimized plasma treatment of synthetic vessel implants that enable reduction of the concentration of the bound thrombocytes on the surface of cardiovascular implants by 10 times or more in comparison with non-treated cardiovascular implants.

Keywords

Nanomaterials, Heart and Blood Circulation Illnesses

Applications

- Synthetic blood vessel implants.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Under development/lab tested

IPR Status

Patents granted



Description

The material used for synthetic vessel implants must meet the requirements for biocompatibility/haemocompatibility and must, also have adequate mechanical properties, especially flexibility and simplicity of surgical fitting. The polymers polyethylene terephthalate or Dacron, and polytetrafluorethylene, used for this purpose, have adequate mechanical properties and have been used for years for synthetic blood vessel implants. The drawback is that they do not provide sufficient surfaces haemocompatibility. This however is critical since properties of the materials that come in contact with blood need to have antithrombogenic properties, which prevents the occurrence of thrombosis. The problem is solved by plasma treatment of cardiovascular implants surface by an adequate combination of a dose of neutral oxygen atoms and positively charged oxygen ions.

The method of the invention comprises exposure of an implant to a mixture of neutral oxygen atoms and positively charged molecular and atomic oxygen ions.

By the exposure of the implant the new functional groups are formed on the surface such as C-O, C=O, C-O-O, O=C-O, and the same time the topographical properties of the surface get changed as well, which increase the roughness. Optimised conditions of this type of treatment allow the surface to have an adequate number of new functional groups and adequate topography. A result of the treatment is also the surface becoming more hydrophilic, which promotes expansion of endothelial cells. Moreover, a treatment of this type also provides antithrombogenic properties on the surface and therefore a reduced binding of thrombocytes by 10 times or even more.

In comparison to known solutions this technique allows a quick and efficient modification of surface, which leads to antithrombogenic properties of surface. A modification of surfaces of biomedical polymers can be carried out in a period shorter than one minute based on the needed dose of atoms and ions. This is a great advantage over the currently used technique, because the methods for application of various antithrombogenic coatings are extremely time-consuming and may take several hours or even days. Moreover, the surface treated by the method of the present invention do not require any further treatment with cells, like for instance application of endothelial cells, which needs to be applied onto the surface of a biomedical material prior to implantation.

Advantages

- The concentration of thrombocytes on the surface is reduced for more than 10 times;
- Decreased the appearance of the thrombosis;
- Low manufacturing costs. (The procedure takes less than one minute).

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// Significantly Improved Quality of Dental Prosthetic Products

Summary

A process for applying an adhesion coating to fixed partial dental material. The coating provides aesthetic appearance and significantly improves the adhesion of dental cements to dental material. The coating is formed during submersion of dental material into the aluminum nitride suspension.

Keywords

Ceramic Materials, Dentistry / Odontology, Stomatology, Surgery

Applications

- Dental material;
- Dental device industry;
- Dental and prosthetics laboratories.

Department

K7 - Department for Nanostructured Materials

Stage of Development

Prototype available for demonstration



IPR Status

Patents granted

Description

Sintered oxide ceramics, particularly tetragonal zirconium oxide ceramics are extensively employed for fixed partial dental materials, such as inlays, crowns and bridges. One of the disadvantages of sintered ceramics is poor adherence to the dental cements. The invention solves this problem by applying thin adhesion coating to dental material. The coating is formed by submersion of dental material into the solution of aluminum nitride followed by thermal treatment at elevated temperatures. The dental cements are better adhered to the dental materials with such adhesion coatings. Consequently, the sealing of dental prosthetic to the hard dental tissues is stronger and better quality of dental prosthetics is achieved. Thus, the thin porous adhesion coating is a longterm and clinically effective improvement in the adhesion of dental cements to the substrates. The invention is applicable for dental prosthetics and esthetic surgery and is especially interesting for dental device industry, dental laboratories and prosthetics laboratories.

Advantages

- Higher price of existing dental material by minimum increase in production costs;
- Highly improved mechanical adhesion of dental material;
- Highly improved adhesion of the dental material to natural hard tissues;
- Resistance to cracking caused by subsequent thermal processes.

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// Multifunctional Bioactive Coating Material for Bone Implants

Summary

A process for production of bioactive and protective coating on implants having porous surface layer. The new process minimises the problems and deficiencies of implants that are currently in use. The coating is completely resorbable within 10 weeks (confirmed in-vivo) and was confirmed to enhance osseointegration in comparison with non-coated implants.

Keywords

Human Health, Dentistry / Odontology, Stomatology, Orthopaedic Technology

Applications

- Orthopaedic and coating industry;
- Ti or Ti alloys bone implants, to improve implants' longer-term behaviour.

Department

K7 - Department for Nanostructured Materials

Stage of Development

Available for demonstration



IPR Status

Patent applied for but not yet granted

Description

A new bioactive multifunctional coating material for bone implants and the process of preparing such coating material for bone implants. The bioactive coating on implants having a porous or otherwise roughened surface layer is coated with a thin firmly bonded coating by means of immersion of the implant into submicron powder suspension and thermal treatment at moderate temperature. The coating is completely resorbable within 10 weeks after implantation (confirmed in-vivo).

Bone implants with their multifunctional coating are not only biocompatible but also bioactive. They promote attachment of the needed protein from the extracellular fluid and enhance bone cells to easily cling to the implant. This accelerates and facilitates osseointegration. The role of the multilayered coating is also to hinder the release of metal ions from the implant and so to minimise osteolysis.

Advantages

- Enhanced adhesion of proteins
- Improved osseointegration
- Longer life cycle
- Reduced allergic responses and inflammation

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// Improved Biocompatibility of Artificial Vascular Grafts

Summary

A specially optimized treatment of artificial vascular grafts, based on combination of plasma and solution chemistry. This reduces the concentration of the bound thrombocytes on the surface of vascular grafts in comparison with non-treated vascular grafts.

Keywords

Micro- and Nanotechnology, Pacemakers and Artificial Organs

Applications

- Synthetic vascular grafts.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Available for demonstration



IPR Status

Patent applied for but not yet granted

Description

Artificial vascular grafts are widely used for the treatment of obstructive atherosclerotic disease, which is a major cause of mortality in the western world, especially in cases where replacement with an autologous vascular graft is not an option. Vascular grafts have been used successfully to replace large-diameter blood vessels, however on the other hand the long term use of small-diameter vascular grafts is still unacceptable, primarily due to stenosis and thrombus formation. To overcome this problem special surface modification of vascular grafts is needed. Recent discoveries showed that utilizing the surface modification by gaseous plasma improves biocompatibility of the prosthetic vascular grafts. However, a rather large problem is the ageing of the surface. After the surface modification, the generated functional groups start to react with the surrounding atmosphere and/or start to diffuse into the treated sample, which increases thrombus formation.

The problem can be solved by immobilizing the anticoagulant agents, such as heparin, on the surface, which improves the haemocompatibility of the artificial surface by binding to anti-thrombin III. The method for immobilization of heparin on polymeric material is achieved by interaction of polymeric material with NH₂ radicals under low pressure conditions and subsequently dipped into a water solution of activated heparin. The effectiveness of heparin immobilization is best determined from adsorption and activation of blood platelets on the surface of a polymeric material. Results of the experiment revealed that blood platelets adsorb in large concentrations on the untreated surface of a polymeric material which exhibits high thrombogenicity. In contrary, material treated according to the offered method demonstrates a small number of spread platelets, which indicates on improved properties, low thrombus formation, of vascular grafts.

Advantages

- Improved biocompatibility of artificial vascular grafts;
- Decreased appearance of thrombosis.

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// Transition Metals (Molybdenum) Nanowires Applicable in Transparent Electrodes and for Lithium Ion Batteries

Summary

A method for synthesis of quasi one-dimensional nanowires and nanotubes of transition metals. The synthesis is achieved by conversion of quasi one-dimensional compounds with a submicron cross-section in the presence of hydrogen. The resulting conducting molybdenum networks are suitable for production of transparent electrodes and lithium ion batteries.

Keywords

Nanotechnologies related to electronics and microelectronics

Applications

- Vacuum industry;
- Nanoelectronics;
- Battery production industry.

Department

K1 - Department of Inorganic Chemistry and Technology

Stage of Development

Available for demonstration



IPR Status

Patent applied for but not yet granted

Description

Transition metals are highly useful materials in the high-technology industry. Due to their high ratio between surface and volume, quasi one-dimensional structures of transition metals have very unique features promising for the broad usage in nanoelectronics and conductive composites. Molybdenum, which is very resistant to high temperatures and only insignificantly softens and expands when heated, is used in applications accompanied by intense heating, such as in aircraft industry, electric contacts, industrial engines. It is widely used in steel alloys to improve corrosion resistance and weldability. So far the limitation of broader usage of nanowires of transition metals was large scale synthesis of nanowires.

The invention solves the problem of large scale synthesis of transition metals (molybdenum) nanowires. The synthesis occurs by the chemical transformation of quasi one-dimensional compounds with a sub-micron diameter, during the heating in the presence of hydrogen.

An efficient, low-cost and scalable method has been developed to fabricate pure molybdenum nanowires. The overall morphology of the synthesized Mo nanowires shows a one-to-one correspondence with the initial parent materials. This allows synthesis of a variety of Mo nanowires of relatively uniform diameters and lengths, including ones with aligned nanowires on free-standing foils. Large diameter Mo nanowires (>20 nm) are highly porous and can be selectively produced by controlling

the growth parameters and the stoichiometry of the starting material. Such nanostructures have a very large surface area and can be advantageous for use as a host material for Li ion batteries or as fillers in composites. Oriented Mo nanowires of various sizes have also been grown directly on substrates and can be integrated into different device architectures such as field-emission devices and other nanoelectronic applications. Interestingly, narrow-diameter Mo nanowires are flexible, highly conductive, and carry relatively large current without suffering structural degradations. The formation of a conductive network can be achieved due to coalescence of the nanowire bundles templates during transformation.

Advantages

- efficient, low-cost and scalable method for the synthesis of nanowires;
- narrow-diameter Mo nanowires are flexible, highly conductive, and carry relatively large current without suffering structural degradations.

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// Modification of Tools for Early Cancer Diagnostic

Summary

A method for surface treatment of polymeric tools that enable higher isolation yields of microvesicles. Such surface modification enables higher yields and lower fragmentation of microvesicles by preventing their adsorption on the surface of different tools used for collecting, sampling, storage, transport and isolation of microvesicles.

Keywords

Biobased Materials, Nanomaterials, Micro- and Nanotechnology, Diagnostics

Applications

- Medical equipment dealing with microvesicles;
- Optimization of isolation of other similar biological substances.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Available for demonstration



IPR Status

Patent applied for but not yet granted

Description

Recently it has been confirmed that fingerprint of initial cancer stages is found in blood as well as in cerebrospinal fluids in the form of small subcellular structure called microvesicles or nanovesicles. The microvesicles carry information on the existence of cancer cells well before they are developed into tumours. In addition, the technology is especially beneficial in the cases where direct cellular biopsy may be difficult or otherwise unattainable. The vesicles, however, are not abundant in human and should be therefore isolated carefully to gain satisfactory concentration for diagnostics or therapeutic purposes. Isolation of microvesicles currently represents a major drawback due to a simple fact that they are likely to interact with surfaces of medical tools, especially surfaces of Eppendorf tubes where blood or cerebrospinal fluid is stored. The interaction leads to depletion of the microvesicles in liquid so their concentration usually falls below the detection limit. The problem can be solved by plasma treatment of inner surface of isolation and detection tools (Eppendorf tubes, pipettes, etc) by which adsorption of microvesicles on the surface is highly reduced.

The method of the invention comprises exposure of the tools to short pulses of highly ionized gas. The inner surface of tools after the treatment with this method is altered so that it becomes enriched with oxygen functional groups, has higher wettability and special nanotopography. These surface properties strongly influence the adhesion and fragmentation of microvesicles.

Surface of polymeric tools with changed surface properties will therefore not

Surface of polymeric tools with changed surface properties will therefore not interact with body liquids, such as human blood, in the same manner as untreated materials. Unmodified, flat surface represents infinite site for various blood particles especially microvesicles. Therefore, microvesicles adhere well onto the surface of untreated materials causing depletion of blood. On the contrary, the surface of materials treated according to the invention exhibits lower adhesion of microvesicles compared to untreated materials. According to the results the concentration of microvesicles isolated by prior treatment of isolation tools according to our invention will increase microvesicle yields by at least two times.

This invention prevents excessive adsorption of microvesicles as well as other similar biological substances on the surface of tools used for collecting, sampling, storage, transport and isolation.

Advantages

- Provide real-time access of molecular genetic information of cells in the body, without the need to have direct access to the actual cells;
- Useful tool for cancer diagnostic;
- Can be used also as molecularly-targeted therapy, which is gaining its importance in cancer therapy.

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// Targeted Anti-Cancer Drug Delivery System

Summary

A molecular system for delivery of anti-cancer drugs specifically to target sites, by using cathepsin inhibitors as guides towards cathepsins released by tumor cells. The system prevents toxic side effects, reduces the dosage, and treatment costs.

Keywords

Cancerology, Oncology, Diagnostics

Applications

- Targeted delivery of both anti-tumor and anti-inflammatory drugs;
- Detection purposes (e. g. by specific delivery of a fluorescent marker to a tumor site).

Department

B1 - Department of Biochemistry and Molecular Biology

Stage of Development

Under development/lab tested



IPR Status

Patents granted

Description

One of the characteristics of tumor cells is their secretion of the enzymes cathepsins, which actively promote tumor growth and are therefore amenable as targets for targeted delivery of anti-cancer drugs. In the invention, a specific cathepsin inhibitor is linked to a liposome via a lipid tail. The system is then used for specifically targeting cathepsins in the tumor microenvironment, and therefore bringing the liposome containing the drug (eg. doxorubicin), to the target site. Successful functioning of the system has been demonstrated both in cell cultures and in vivo (on mouse tumor models).

Advantages

A number of drugs exhibit major harmful side effects or are inefficient because of low bioavailability. The invention solves this problem by safely and accurately delivering the drug to its target. Drug toxicity is reduced using a liposome-based delivery system. The drug is guided directly to the tumor tissue using liposomes with bound inhibitors of cathepsins, which are characteristically secreted by tumor cells. The use of liposomes as drug delivery systems is safe as liposomes are biologically inert, natural occurring particles in the human body; use of liposomes as drug carriers is common, and approved by the U. S. Food and Drug Administration. Using targeted delivery, therapy is made more efficient, thereby reducing the required dosage. This, in turn, leads to reduced treatment costs. Compared to passive drug delivery, the system has a 20-fold higher tumor cell killing capacity. Since liposomes are inert, side effects are minimized and the drug is delivered exclusively to tumor cells, increasing drug efficiency and patients' survival.

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// Engineered Lactic Acid Bacteria Capable of Binding TNF-a for the Treatment of Inflammatory Bowel Disease

Summary

Recombinant lactic acid bacteria that express TNF-a-binding peptides on their surface. Since TNF-a (Tumor Necrosis Factor Alpha) is a cytokine with an important role in inflammation, such micro-organisms can be used for treatment of inflammatory bowel diseases including Chron's disease and ulcerative colitis.

Keywords

Pharmaceutical Products, Enzyme Technology, Protein Engineering

Applications

- Pharmacy,

Department

B3 - Department of Biotechnology

Stage of Development

Available for demonstration



IPR Status

Patent applied for but not yet granted

Description

The team of researchers have combined anti-TNFa therapy with oral application and local immunosuppressant effect. TNFa-binding peptides have been expressed on the surface of the probiotic lactic acid bacterium *Lactococcus lactis*. *L. lactis* is able to survive passage through the gastro-intestinal tract and serves as a delivery system for TNFa-binding peptides located on its surface. Peptides that are expressed on the surface of the bacteria are highly resistant to chemical and enzymatic degradation in the gastro-intestinal tract. Microorganisms expressing these peptides are therefore capable of binding TNFa, reducing its amount and consequently reducing the level of inflammation in the gastro-intestinal tract. Recombinant bacteria bind and eliminate redundant cytokine from the gut (but do not influence other organs and have no systemic side effects). It has previously been shown that diminishing of TNFa concentration in the gut alone can significantly improve the clinical picture in experimental animals. Bacteria carrying TNF-a-binding peptides can be used for treatment of inflammatory bowel diseases including Chron's disease and ulcerative colitis.

Advantages

- Expected to significantly lower production costs (i.e. lower purification costs due to oral application, rapid introduction into production line - with established fermentation equipment) compared to monoclonal antibodies;
- Possible different types of application: OTC drug or possible GMO-free approach.

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// Design of New Generation Strains of Industrial Yeast

Summary

A new method for designing improved industrial yeast strains which contain genetic elements responsible for specific desired traits, and at the same time are not limited by the presence of inhibitory genetic elements.

Keywords

Genetic Engineering, Microbiology, Enzymology / Protein Engineering / Fermentation

Applications

- Industrial yeast strains.

Department

B2 - Department of Molecular and Biomedical Sciences

Stage of Development

Available for demonstration



IPR Status

Secret Know-how

Description

The technology addresses a growing demand for development of new and more efficient industrial yeast strains, and the new generation strains generated by the developed technology can provide improvements in terms of decreasing the costs and increasing the efficiency of yeast-based biotechnology processes, including biofuel production, beer, wine and bread making, specialty chemicals production and yeast cell factory applications. The offered technology consists of genetic analysis for accurate identification of specific genetic elements with positive and negative impact on the desired characteristic, and of a method for transferring the combined genetic elements into thus generated novel yeast strains (considered non-GMO in most countries outside EU).

Advantages

The developed technology enables design of improved industrial yeast strains with the correct combination of genetic elements for desired characteristics and which, unlike strains designed by traditional methods, are not limited by inhibitory genetic elements hindering the productivity or robustness of the industrial yeast strain. For the first time, the respective genetic elements can be characterized down to gene and often even single nucleotide variation level, enabling very precisely designed genetic engineering of novel strains.

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// A Simple Method for Preparation of Liquid Crystal Polymers (Elastomers) for Use in Small Electronic Devices

Summary

A simple and reliable method for preparation of thermoresponsive polymer composite materials (polymer dispersed liquid crystal elastomers). Mixing of thermoactive elastomers into polymers allows for controlled and reversible reshaping of the material by changing its temperature. It can be used for components in macro- and micromechanical devices.

Keywords

Micro and Nanotechnology related to Electronics and Microelectronics, Composite materials, Plastics, Polymers

Applications

- Small electronic devices.

Department

F5 - Department of Condensed Matter Physics

Stage of Development

Under development/lab tested



IPR Status

Patent applied for but not yet granted

Description

Liquid crystal elastomers (LCEs) are smart polymer materials that combine the ordering of mesomorphic molecules (liquid crystals) with the elastic properties of polymer networks. The invention basically involves (i) creating microscopic LCE particles, (ii) dispersing and orienting the particles in a liquid elastomer matrix, and (iii) polymerizing the matrix. The resulting polymer dispersed LCEs (PDLCEs) are binary soft-soft composites and exhibit elastic behavior intermediate between the rubber elasticity of the matrix and soft/semi-soft elasticity of the LCE particles.

PDLCEs can replace conventional LCE material in LCE-based actuator devices; these materials could be used in manufacturing components of electronic devices, including macro-, micro-, and nanoscopic devices (switches, valves, 3D printers, microfluidic systems, micro-pumps imitating peristaltic motion, artificial muscles in robotics, etc.).

Advantages

The invention involves a reliable method for manufacturing LCE composites with customtailored properties. The composites can be shaped into arbitrary forms and functionalized by using a pre-functionalized matrix, e.g. a matrix containing micro- or nano-sized fillers. LCE particles are mixed in a manner that allows for thermomechanical responsiveness of the composite, which is a novel property among such materials. The resulting thermo-mechanical behavior of the composites allows for a more versatile response as compared to the standard one.

The advantages are as follows:

- Efficient customization of the thermo-mechanical response is achieved using a simple manufacturing approach, mixing either preexisting or synthesized LCE particles with polymer/elastomer resin;
- Use of different fillers allows for preparation of materials for different applications; multiple LCE materials of different properties may be included in the composite in different ratios, and may be locally ordered as desired; in addition, the composite may also be prepared sequentially in layers and thereby made to respond differently at different points;
- Polymerization inhibition issues, known from standard LCE functionalization procedures, are avoided by the thermo-mechanical responsiveness of the LCE particles;
- Particles can be produced by milling the poly-domain LCE material, avoiding the tedious twostep crosslinking approach for production of mono-domain LCEs;
- Since the volume of LCE particles is much smaller than the volume of the surrounding matrix, the final properties of the composite are defined as superposition of individual properties of included particles.

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// Device for Remote Source Tracking During Brachytherapy Treatment

Summary

A unique device for simple and cost effective tracking of Ir192 source location during brachytherapy treatment. The main advantage is compactness, simple operation and cost effectiveness, achieved by the use of detectors, readout electronics, data acquisition and data analysis methods from the field of particle physics.

Keywords

Medicine, Human Health, Diagnostic

Applications

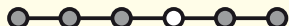
- Medical equipment;
- Brachytherapy devices.

Department

F9 - Experimental Particle Physics Department

Stage of Development

Available for demonstration



IPR Status

Secret Know-how

Description

Remote measurement of radioactive source (Ir192) location during brachytherapy treatment by means of source self imaging through a pinhole and detection of photons with position sensitive silicon detectors with precision of about 1 mm on a sub-second time scale with aim to detect large discrepancies between planned and actual progress of treatment caused by various errors and to provide independent record for post treatment analysis. Such a device does not exist on the market and would improve the quality of brachytherapy treatment. Two prototypes with different types of photon detectors were successfully tested with clinical brachytherapy source.

Advantages

A similar device does not exist yet. The main advantage of possible commercial product is compactness, simple operation and cost effectiveness, achieved by the use of detectors, readout electronics, data acquisition and data analysis methods from the field of particle physics. The low cost prototype is already finished.

The basic idea of source self imaging through pinhole is not new and was published several times before. Results of measurements with clinical source were also presented at conferences and published as a scientific paper, however the technical detail and experience gained during work on the project are the major advantage.

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// Camera for Gamma Radiation Detection

Summary

An angle-sensitive camera for detecting the direction of incident gamma radiation. The camera senses, in real time, the position of the radiation source, which simplifies procedures in cancer radiation therapy and in other radiation-related industries.

Keywords

Radiation Protection, Medical Technology, Cytology, Cancerology, Oncology

Applications

- Medical radiotherapy, specifically in high dose rate brachytherapy in clinical oncology;
- Detection and localization of radioactive contaminations in nuclear medicine environments and in nuclear power installations;
- Real-time control of inventory and transportation of special nuclear material.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Available for demonstration

IPR Status

Patent applied for but not yet granted



Description

In the current medical practice in radiation procedures in clinical oncology (high dose rate brachytherapy), catheters are surgically positioned through a malignant lesion of the patient. This is followed by the temporary insertion of a gamma-radioactive source into the catheters in order to locally deposit a therapeutic radiation dose over a volume of the lesion. These practices suffer from an absence of real-time feedback on the actual deposited radiation dose. The invention, a camera, sensitive to the incoming direction of gamma radiation, or other penetrating radiation, is capable of sensing, in real time, the position of the radiation source inside the treated patient and thus introduces a quality-control component to the described radiotherapy procedures. The camera includes a processor which receives intensity data from a sensor, and determines the incident direction of the radiation from that data. The camera is connected to a computer and operated and controlled via computer software. A prototype has been developed and is ready for demonstration.

Advantages

Current practices suffer from an absence of real-time feedback on the accuracy of targeting and the actual deposited radiation dose. A camera, sensitive to the incoming direction of gamma radiation, senses, in real time, the position of the radiation source inside the treated patient. Some of the existing solutions use considerably more complicated technical solutions, including complex detectors, readout, and interpretation of data, which adds complexity and cost to the design. Some, in addition, severely lack the detection efficiency. The invention involves a

simple gamma ray detector and a corresponding readout system, making its use more economical as well as more accurate. The technology is conceptually simple and may be set up as a stationary device (for therapeutic applications), or installed on a remote-controlled element for increased safety (for applications requiring detection of radiation in potentially hazardous material, such as radioactive waste).

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// Method and Capacitive Sensor for Counting Aerosol Nanoparticles

Summary

A novel method and capacitive sensor for counting aerosol nanoparticles in an electric way. Detectors for nanoparticles in the air can be used for monitoring aerosols in environment and in buildings. The method is demonstrated experimentally and verified by numerical simulations. The counter construction is simple, portable and cheap.

Keywords

Nanotechnologies related to electronics and microelectronics, Environmental and Biometrics Sensors, Sensory/Multisensory Technology, Measurement Tools

Applications

- Environmental sensing and monitoring.

Department

F5 - Department of Condensed Matter Physics

Stage of Development

Available for demonstration



IPR Status

Patents granted

Description

A novel method for counting nanoparticles in the air, based on measuring capacitance of a condenser with one electrode perforated in a way that nanoparticles can enter the dielectric field and under the impact perturb liquid dielectric and cause electric signal. Detectors for nanoparticles in the air can be used for monitoring aerosols in environment, in production plants, near roads and in special buildings, where the quality of air is important, like hospitals for pulmonary diseases, schools or infection clinics. Such a counter can replace counters based on laser scattering in commercial detectors of nanoparticles and enable production of cheap and portable device. Aerosol particles, onto which a fluid was applied in an earlier process by known methods, change the capacitance of the dielectric of the capacitor when entering its field, which causes an electric signal. The method provides for detection of aerosol particles in a wide scope of their presence in the air and is not specific for any shape or chemical composition of nanoparticles.

Advantages

- The method is suitable for detection of aerosols in wide concentration range in the air;
- The method is not specific for a shape or chemical composition of nanoparticles;
- The counter allows a construction of a simple and portable nanoparticle detector;
- Price of a single sensor would be low, low operating and maintenance costs;
- Mass production would be possible.

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// Neutron Radiography for Nondestructive Imaging of Light Chemical Elements over Heavy Chemical Elements

Summary

A non-destructive imaging method - neutron radiography- based on the transmission of neutrons through matter and detection thereof. The method is sensitive to light chemical elements and strong neutron absorbers, e.g. cadmium, gadolinium and boron. The method is applicable in diverse fields, e.g. archaeology, biology, nuclear and material sciences, industrial applications.

Keywords

Optics

Applications

- Production industry requiring the detection of water or organic compounds (oil, glue, etc.) inside metal / ceramic structures;
- Detection of mold fragment inclusions in the casting of metal objects;
- Investigation of archaeological finds, water ingress into materials, lubrication or adhesion issues.

Department

F8 - Reactor Physics Department

Stage of Development

Already on the market



IPR Status

Exclusive rights

Description

Neutrons interact with matter mainly through the processes of scattering and absorption. Being electrically neutral, they are in general able to penetrate through non-absorbing matter to a greater extent than X-rays. Neutrons are affected by light chemical elements through scattering (particularly by hydrogen) and by elements which are strong neutron absorbers (e.g. cadmium, gadolinium, boron, etc.).

A neutron radiography system requires a neutron source (typically a nuclear reactor or an accelerator based spallation source), a neutron collimator and an image acquisition system, which can be based on photographic film, neutron-sensitive imaging plates or charge-coupled device (CCD) cameras in conjunction with neutron to light converters, e.g. lithium glass. At the TRIGA reactor neutron radiography is performed using neutron-sensitive imaging plates. Neutron radiography is a non-destructive method, which means that the physical properties of the object being investigated are preserved. A possible issue is the production of an inventory of radionuclides within the object through neutron activation. The induced activities during typical imaging sessions are however not significant, due to the small neutron flux to which the investigated objects are exposed.

Due to its inherent sensitivity to light chemical elements and particular neutron absorbing materials neutron radiography is suitable for a variety of applications. In combination with X-ray radiography a more detailed picture of the composition of investigated objects can be obtained. This is particularly useful in the investigation of archaeological finds, water ingress into materials, lubrication or adhesion issues, etc. The use of contrast materials (neutron absorbers), where possible, increases the applicability of neutron radiography to different fields. In the sand casting process, for example, if a neutron absorber is added to the mold material, residual mold fragments in the cast object can be identified.

Advantages

Neutron radiography is a complementary imaging method to X-ray radiography, in that it enables the detection of light chemical elements over heavy, high Z chemical elements, e.g. iron and lead. It is particularly useful in applications requiring the detection of water or organic compounds (oil, glue, etc.) inside metal / ceramic structures or products. Through the use of neutron absorbing contrast material it is possible to further diversify the applicability of neutron radiography, e.g. in the detection of mold fragment inclusions in the casting of metal objects.

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// Pressure Measurements in Evacuated Sealed Devices as a Lifetime Assessment Tool

Summary

Expertise and related know-how in low-pressure and outgassing related measurement systems. These skills and knowledge are absolutely necessary during the R&D phase and quality control of any evacuated sealed device with a long life-time such as vacuum insulation panels, cathode ray tubes etc. in order to obtain fast feedback on the pressure evolution.

Keywords

Vacuum / High Vacuum Technology, Construction Technology, Joining

Applications

- Vacuum insulation panels;
- Vacuum glazing;
- Other vacuum-related activities.

Department

F4 - Department of Surface Engineering and Optoelectronics

Stage of Development

Already on the market



IPR Status

Secret Know-how

Description

The researchers provide the expertise in the measurement of low-pressure (from ultra high vacuum up to atmospheric pressure), particularly when monitoring small and slow pressure changes in evacuated sealed devices such as vacuum insulation panels, cathode ray tubes, vacuum glazing, dewars and similar. Other services that are provided:

- determination of the pressure rise (outgassing rate) of a material after certain (thermal) treatment, this may also include the determination of the gasses being evolved (using quadrupole mass spectrometer);
- permeation measurements for various (even highly impermeable) materials;
- vacuum processing;
- identification of leaks;
- determination of pressure and gas composition accumulated inside small sealed devices;
- measurement of thermal conductivity vs. internal pressure for planar vacuum insulation panels (VIP).

These measurements and know-how are crucial in the R&D phase and/or later quality control of small evacuated sealed devices whose functionality inherently relies on the low level of pressure inside them. The techniques and skills are particularly suitable for developers and producers of vacuum insulation panels. In the vacuum insulation

panels, the long-term pressure rise can be predicted and lambda vs. internal pressure relation can be measured. With these measurements the lifetime of the vacuum insulation panels can be rapidly estimated.

Advantages

The main advantage of this method is an innovative type of envelope – one made of stainless steel (SS) foil that is used for evaluation of the outgassing rate of various core materials for vacuum insulation panels. Such testing envelope is impermeable for water and does not degrade with time at any reasonable temperature when compared to conventional Al laminated polymeric envelopes. Furthermore, the native pressure rise in an empty SS envelope can be made extremely low and it can be quantified. For determination of pressure rise only inert gauges are being used: spinning rotor gauge, capacitance manometers.

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Publisher	Center for Technology Transfer and Innovation at the Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia
Original Source	Patents, Scientific Papers, Personal Correspondence with Researchers
Source	Technology Offers: mag. R. Blatnik, A. Draganovič, L. Gruden, Dr. D. Odič, Dr. L. Pal, F. Podobnik, Dr. Š. Stres, LL.M., U. Šegedin, mag. M. Trobec, Dr. A. Veber
Introduction	L. Kane, Dr. Š. Stres, LL.M., L. Virag
Edited by	Dr. Š. Stres, LL.M., L. Virag
Design	L. Virag
Print	Spletna tiskarna (F DVOR d.o.o.).
Reprint	200 copies

Ljubljana, August 2018

Co-financing of the Brochure:



The investment is co-financed by the Republic of Slovenia and the European Union under the European Regional Development Fund.

CIP - Katalogni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

061:001.891.5(497.4)Ljubljana)

INSTITUT Jožef Stefan (Ljubljana)

Development opportunities 3 : an overview of the latest technologies developed at the Jožef Stefan Institute / [introduction L. Kane, Š. Stres, L. Virag ; edited by Š. Stres, L. Virag]. - Ljubljana : Center for Technology Transfer and Innovation at the Jožef Stefan Institute, 2015

ISBN 978-961-264-059-0
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