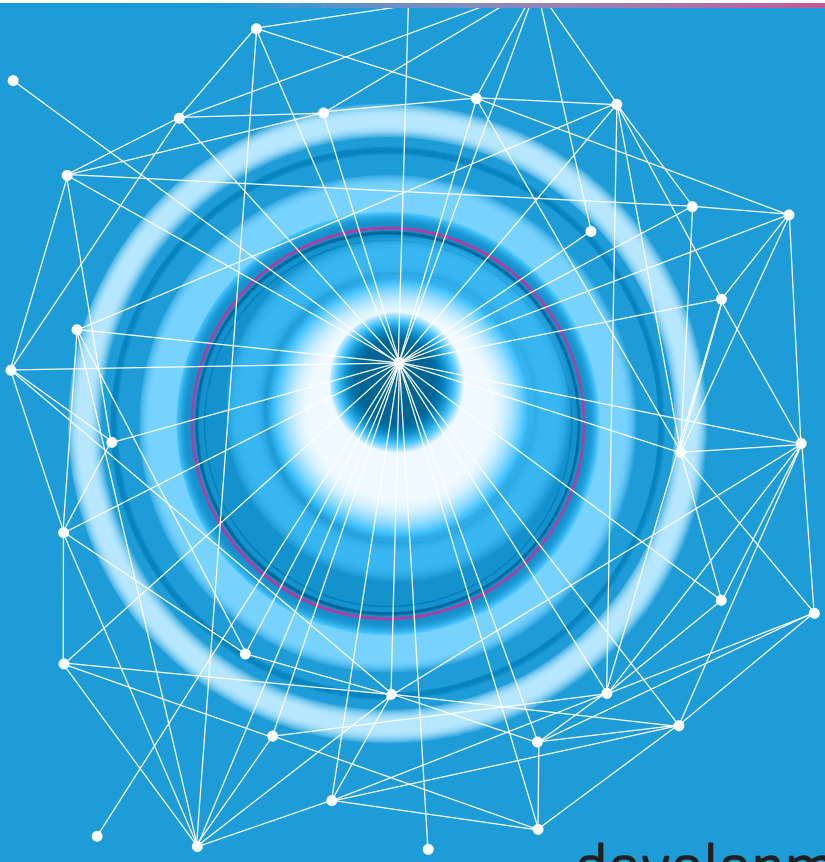
center for technology transfer and innovation
at the Jožef Stefan Institute

Jožef Stefan Institute, Ljubljana, Slovenia



development opportunities 4

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

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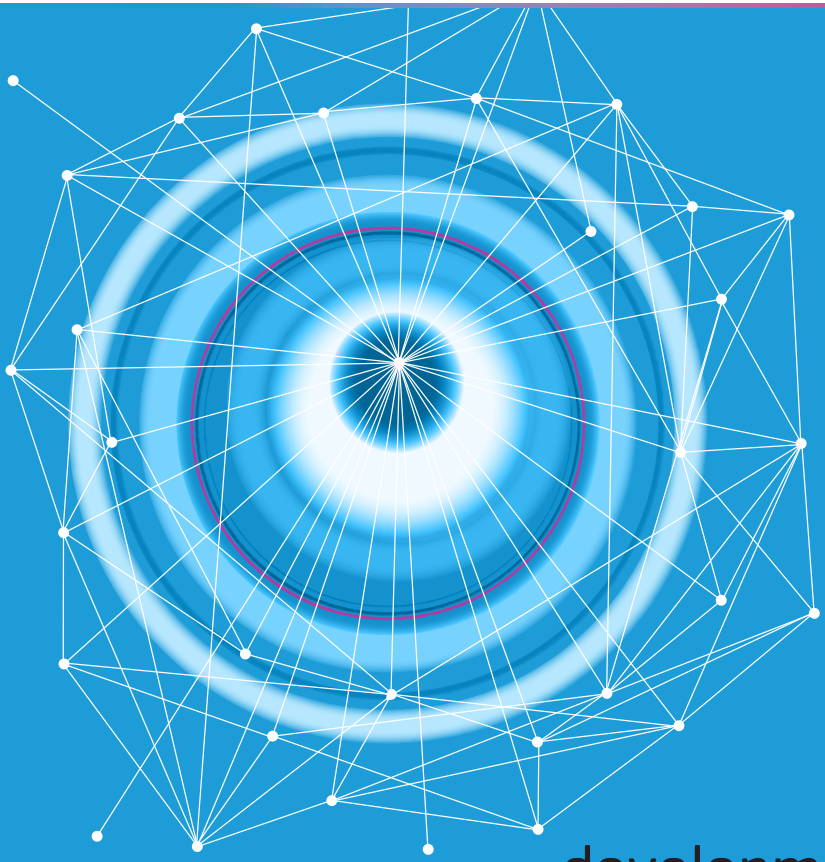

development opportunities 4

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

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INTRODUCTION

In front of you is a collection of the latest technologies developed at the Jožef Stefan Institute. Presented technologies solve various nanotechnology, ceramics, information technology, biotechnology, new energy sources, new materials, environmental technologies problems, etc.

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

In the second part of the booklet, you will find offers of technologies developed at the Jožef Stefan Institute and further developed and commercialised in spin-out companies.

To promote our technologies clearly and comprehensively, we have prepared a brief description of each technology. We included vital information on:

- The main field of application.
- The problem it solves.
- The main advantages of the technology.
- The status of its intellectual property protection.

We strongly believe that research and development opportunities can further support the cooperation between the research community and economy.

If you wish to collaborate with us by using the presented technologies in your entrepreneurial endeavors or work with us on further development, do not hesitate to contact us.

Center for Technology Transfer and Innovation
tehnologije@ijs.si

JOŽEF STEFAN INSTITUTE

Jožef Stefan Institute is the leading Slovenian scientific research institute covering a vast spectrum of basic and applied research. The founders established it in 1949 and named it 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 1000 specialises in natural sciences, life sciences and engineering.

Jožef Stefan Institute's mission is accumulation and dissemination of knowledge at the frontiers of natural science and technology to the benefit of society at large by pursuing 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 a part of Slovenia's image.

We finance our research work 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. In an essential part of the Institute's revenues, international contracts and industry support our explorations.

To increase the flow of knowledge and technology into the domestic and foreign economies and promote the Jožef Stefan Institute as a Centre of excellence for technological progress for all society segments, we established the Center for Technology Transfer and Innovation (CTT).

CENTER FOR TECHNOLOGY TRANSFER AND INNOVATION

The primary task of CTT is to enable and facilitate the transfer of new technologies and innovations, developed at the Institute and its Departments, to the industry. CTT has acted as a financially independent unit within the Institute since January 2011. The Center's success is currently based on thirteen experts, nine of which are educated in natural sciences and engineering (3 PhDs, 2 MSc), six in economics and one in law. At the same time, one of the experts is also qualified as a patent attorney, and two hold a Master of Business Administration degree (MBA) and one a Latin Legum Master (LLM). We are members of the ASTP (Association of Science and Technology Professionals), the LES (Licensing Executives Professionals) and three team members hold the U. S. "Certified Licensing Professional" certificate. We are coordinators of the Consortium for technology transfer from public research organisations into the industry (KTT). Members of the Consortium are eight major Slovenian public research organisations - Jožef Stefan Institute, National Institute of Chemistry, National Institute of Biology, University of Ljubljana, University of Maribor, the Agricultural Institute of Slovenia, Faculty of Information Studies Novo mesto and the University of Primorska. We are also coordinating the Enterprise Europe Network in Slovenia.

Our key activities encompass:
(1) technology testing facilities, reference experimentation facilities and technology consulting services;
(2) initiating new industrial cooperation: the search for industrial partners, including creating market analyses and support for contracting;
(3) establishing of new spin-off / spin-out companies, including the search for investors for licensing and the financing of spin-off / spin-out companies;
(4) marketing intellectual property, including support for negotiations and licensing contract relations establishment;
(5) supporting active integration of economy and science with internationalisation;
(6) supporting the protection of intellectual property including raising awareness about it;
(7) support and assistance in applying to national and EU tenders, including the provision of information on suitable Calls for application and full proposal revision, focused on the marketing, IPR, UVP and customer segment related issues;
(8) support and assistance to the competence centres (e.g. the competence centre in the domain of customised and low-energy computing);
(9) measures for the popularisation of science amongst the young population: organising visits to the Jožef Stefan Institute, mentoring students, and providing

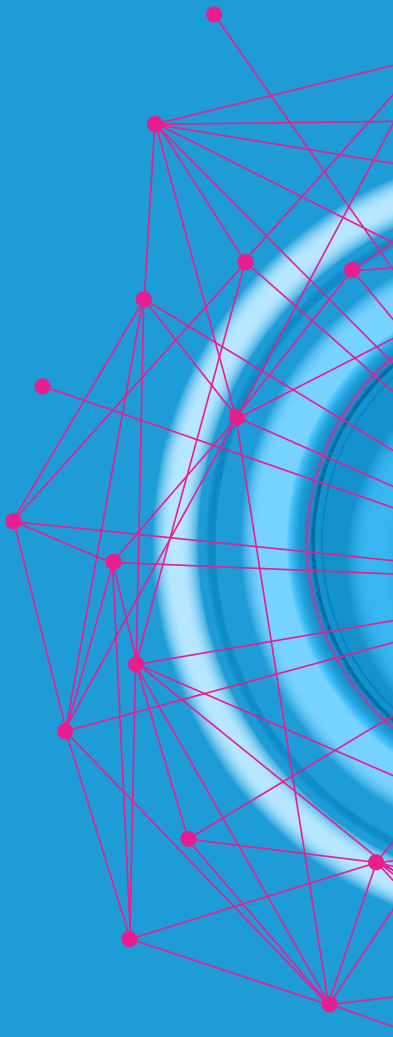
unique services for young researchers employed at the Institute.

Through our activities, we complement and enrich innovative research, innovation management and knowledge transfer, and organisation of focused meetings between researchers and industry representatives, thematic workshops, and training at the Institute. Our activities are driven by the desire to increase the Institute's visibility, raise companies' awareness of the Institute, and encourage their cooperation with us. At the same time, our activities are implemented to promote entrepreneurial mentality among researchers and sincere concern for the education and popularisation of science among young people.

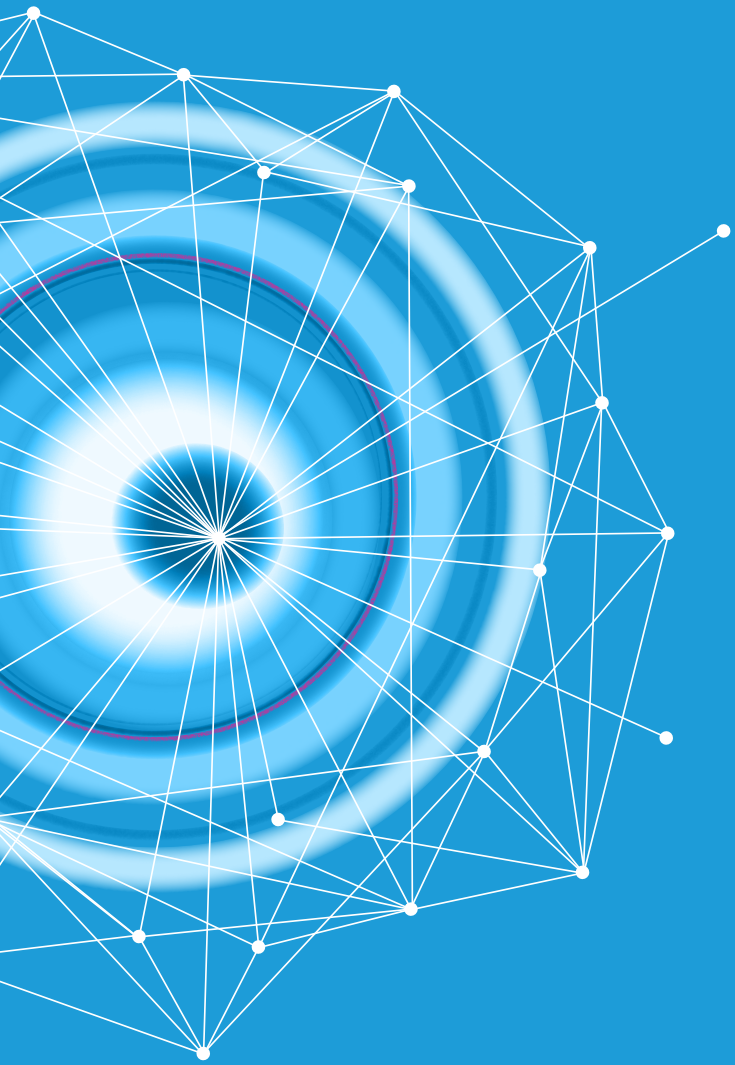
The Center for Technology Transfer and Innovation at the Jožef Stefan Institute's primary goal is to increase the flow of knowledge and technology into the domestic and foreign economy and promote the Jožef Stefan Institute as a Centre of excellence for technological progress for all segments of society.

TECHNOLOGIES

Technologies, described on the following pages, are divided into four categories:
Electronics, IT and Telecommunications;
Nanotechnology and New Materials;
Biological Sciences;
Physical Sciences.



Electronics, IT and Telecommunications



Innovative passive linear robot tracks without sensors and actuators available for license agreement

Summary
Slovenian researchers have developed an innovative passive linear robot tracks for use in industrial manufacturing processes. Solution enables the movement of the robot without the need of sensors and actuators. This primarily lowers the costs of assembling and manufacturing of the robot and later makes the robot purchase more accessible to companies to use it for the production of smaller series of (diversified) products. Researchers are looking for robot manufacturers for a license agreement.

Keywords
Automation, Robotics control systems, Machine tools

Applications
Process control equipment and systems, Robotics, Other industrial equipment and machinery

Department
E1 - Department of Automatics, Biocybernetics and Robotics

Stage of Development
Prototype available for demonstration

IPR
Secret Know-how

Description
Manufacturing and production processes in industry today utilize robots for completing tasks. Main features are production on a large scale and small diversity between the products. Robots enable continuous production for longer periods of time, can move and lift heavy objects or parts according to the programmed instructions. When the batch of products is changed or some modifications are necessary on the products, the robots in most cases need to be at least re-programmed and sometimes (mechanical) parts of a robot need to be replaced as well. This usually involves special expertise and services of professionals. The costs with these adjustments are relatively high, especially when changes need to be made relatively often. The degree of modifications that robots allow can vary and in some cases only minor or no alterations are possible.

Considering these facts, small and medium-sized companies can benefit with introduction of robots in the manufacturing processes, but the costs are high due to the production of small series and diversified products. Batches of products can be of only 10 or even less pieces. Therefore, solutions are being sought, that would enable implementation of robots in productions processes in small and medium sized companies, while also allowing the modification of instructions and corresponding tasks in a short time. Commonly used solutions are linear tracks, where the robot is placed on a moving platform that changes the position for every single step of production process. This expands the working space of the robot and whenever this is a requirement, linear tracks are appropriate solution.

Researchers from a Slovenian public research institute with more than two decades of experience on almost all fields of robotics and automation, have developed innovative solution, appropriate for all types of the companies, even small and medium-sized ones. The system is constructed in a way, where the robot (arm) is located on a platform with two tracks that enable movement, but only when it is necessary.

The main innovative approach is that the robot moves itself along the tracks without the actuators and sensors, that are commonly used for movement and determination of appropriate position of the robot (arm). Measuring and actuation system in the robot are responsible for movement. In this regard, the solution provides specific level of autonomy during the production process, where it is used. The next position of the robot can be calculated in advance based on the information about robot kinematics and angles in the robot's joints.

Stability and accuracy of the robot (arm) during each step of production procedure are ensured with pneumatic brakes. The pneumatic brakes prevent moving of the platform, but when they are released, the platform/robot can move into the (next) desired position along the tracks. As a consequence, the production of this solution results in lower costs and wider availability to companies, although the performance is on par with other solutions that are based on the use of actuators and sensors. Tests were performed on the practical industrial examples where the applicative value of the solution was determined. Additionally, the innovative solution can constitute part of large systems of robot manufacturing with implementation in them.

Advantages
With innovative approach the passive linear robot tracks were developed to allow movement of robot/platform without the need of sensors and actuators. This results in several advantages:

- Absence of sensors and actuators lowers the costs of manufacturing the robot systems for the industry and it makes it more accessible to small and medium-sized companies regarding the final price of the system.
- The movement is relatively autonomous and this lowers the need for human involvement.
- The use of linear robot tracks expands the working space and with that also increases the number of steps that can be performed on the same robot/location.
- The solution can be integrated in larger systems as supporting part.

Partner Sought

The researchers are looking for manufacturers of robots for production processes, where their solution could be implemented into their existing or new systems they produce. Cooperation will be based on a license agreement. Since the approach lowers the costs, this is an opportunity for manufacturers of robots to offer their solutions to even wider range of customers (small and medium-sized companies), also because it takes into the account the facts of small products batches and diversified products. Researchers will provide required information and specification for implementation of the solution in partner's manufacturing processes.

Contact

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A superconductor-based memory device using a switchable resistive element suitable for superconducting computing

Summary
Researchers and experts in the superconductor materials, have developed a memory device for superconducting computing that combines a switchable resistive element with a superconductor element to control the switching between the memory states. The device is highly scalable. Partners are sought for technical and/or research cooperation agreements.

Keywords
Superconducting computing

Applications
Memory device for superconducting computing

Department
F7 - Department of Complex Matter
The technology is co-owned by JSI.

Stage of Development
Concept stage

IPR
Patents applied for but not yet granted

Description
The memory device consists of a narrow channel made of a memristive non-volatile charge density wave (CDW) material. The memristive non-volatile CDW material may be referred to as a switchable resistive element. The normal state after cooling down to cryogenic temperature is a high resistance state. Above a certain current threshold, the resistive element is caused to undergo a transition to the low resistance state which constitutes the Write operation. The reverse transition from the low resistance state to the high resistance state of the memristive element (the Erase operation) is caused when the current exceeds a certain but different value of critical current, changing the shunt resistance to a high value. The superconducting memory device described may be in the form of a nanowire or a three-terminal device such as nano-cryotron (nTron) device. The suitable device operating temperature is 40 K or lower. The width of the device is few tens of nm enabling high scalability.

Advantages

A hybrid superconducting memory device proposed combines a superconductor element in parallel with a switchable resistive element. The proposed device is characterized by:

- ultrafast switching speed <40 ps,
- two- or three-terminal operation,
- scalability, ultralow switching energy (due to the ability to use low energy memristive elements) <0.25 pJ/bit,
- low-temperature operation,
- ease of integration, simple circuit design and compatibility with superconducting flux-quantum electronics.

Partner Sought

The institute is seeking an industrial partner for:

- Technical cooperation agreement - to provide technical cooperation for the development of the fully functioning memory chip
- Research cooperation agreements - to provide a technology for designing, testing and manufacturing of the superconductor-based integrated circuits.

Contact

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Data mining for customer relationship management in banks

Summary
Researchers from the Jožef Stefan Institute are developing data mining methods for customer relationship management (CRM) in banking. They are offering a customized solution to the banks based on their data about customers. The system enables extracting frequent questions, supporting business decisions related to customers and more. The researchers are looking for banks interested in the joint development of a customized CRM system under technical cooperation agreements.

Keywords
Artificial intelligence (AI), Computer software, Databases, Database management, Data mining, CRM - Customer Relationship Management, Business and office software, Other consumer related (not elsewhere classified), Conglomerates and holding companies, Other research and experimental development on natural sciences and engineering

Applications
The specific gains of such customized systems are an integration of learning algorithms with the information system of a bank; improvement of existing decision models in a bank; social networks analytics for scouting new customers. Additional customer profiling will take into account obtained data, such as the customer's revenues, fixed costs, cyclical trends within the year and over a longer period, periods of higher consumption and other specific customer data.

Department
E9 - Department of Intelligent Systems

Stage of Development
Concept Stage

IPR
Secret Know-how

Description
Today, many specialist organizations like banks and insurance agencies use customer relationship management (CRM) systems as an efficient tool to support sourcing of new clients, create better customer services and maximize the customer lifetime value. The main features of commercially available CRM

systems are customer segmentation, communication with customers and aligning products to customer needs.

The researchers of the Jožef Stefan Institute are developing data mining algorithms and tools that enable a human expert to actively participate in the knowledge extraction process and adapting existing algorithms for specific applications, such as banking CRM. The specific gains of such customized systems are an integration of learning algorithms with the information system of a bank; improvement of existing decision models in a bank; social networks analytics for scouting new customers. Additional customer profiling will take into account obtained data, such as the customer's revenues, fixed costs, cyclical trends within the year and over a longer period, periods of higher consumption and other specific customer data. The built models are also expected to be able to detect the increased consumption of certain customers in a particular industry, which will be a good indicator for the bank to establish partnerships with trading companies to be offered for instalment payment to their customers. The obtained data will be enriched by external financial and economic indicators as provided by regional or national statistical offices, Eurostat and OECD.

The researchers are experts in the computational theory of intelligence. They have developed several practical applications in the field of intelligent information systems, intelligent web retrieval, medicine, language technologies and others. The group has over 20 years of experience in R&D, natural language processing, and cognitive sciences

Advantages
The main advantages of the proposed solution, as opposed to currently available CRM systems on the market, are:

- Customized solution to specifics of the organization
- Analytics based on the keywords answering the questions like:
  – What are the main issues with the software?
  – Automatic feature requests extraction.
  – What are the main topics the customer support struggles with?
- More directed training.
- Specific training for individuals with problems.
- Faster learning for newly employed.

Partner Sought
The researchers are looking for companies in banking and insurance businesses which are interested in technical cooperation to jointly develop a CRM system for their needs by the employment of the innovative data mining algorithms based on the described concept. The system will be developed in the first phase

on a local level (limited customer segments and geographical area of one bank's branch) and in the second phase, the system will be implemented on a wider scale of other bank's branches.

Contact:
tehnologije@ijs.si

Detecting current state of the congestive heart failure from heart sounds

Summary
The Jožef Stefan Institute has developed a method for detecting the current state of the congestive heart failure (CHF) from heart sounds using a digital stethoscope. Patients have periods when feeling well and periods, where they notice weakness, heavy breathing, which often requires hospital treatment. The system provides early detection of CHF worsening. The industrial partners are sought for licensing, technical cooperation or academia for research cooperation agreements. Currently, no adequate, patient-friendly and non-invasive technology would allow monitoring of CHF patients. Looking for research cooperation for further research in this pioneering field of telemedicine.

Keywords
Computer software, Artificial intelligence (AI), Knowledge management, Process management, Applications for health, Artificial intelligence related software, Other therapeutic (including defibrillators), Other medical/health related (not elsewhere classified), Cognitive aid, Patient rehabilitation & training, Other research and experimental development on natural sciences and engineering, Health and beauty aids, Computer-aided diagnosis and therapy.

Applications
Early CHF worsening detection allows a physician to spare the patient from hospitalization. This is an entirely novel system, worldwide, to detect worsening of CHF. Although a trained physician can detect worsening using a stethoscope, the proposed method can be applied to a wearable device or a mobile phone. The computer algorithm developed allows the patient to monitor their health without (too) frequent visits at the doctor.

Department
E9 - Department of Intelligent Systems
The technology is co-owned by JSI.

Stage of Development
Field tested/evaluated

IPR
Secret Know-how

Description

The Jožef Stefan Institute developed a method for detecting the current state of the congestive heart failure (CHF) from phonocardiogram (PCG) using a digital stethoscope.

Congestive heart failure (CHF) is a chronic progressive condition where the heart is unable to pump enough blood to meet the body's needs. Typically, in the clinical progress there are periods of compensated phase (the patient feels well) and decompensated phase, where patients notice significant weakness, heavy breathing, and swelling in limbs and/or abdomen. Often, such deterioration requires hospital treatment with intravenous medications for successful recompensation. Early CHF worsening detection allows a physician to spare the patient from hospitalization

The method combines classic machine-learning (ML) and end-to-end deep-learning (DL). The classical ML learns from a large body of experts defined features and the DL learns both from the time-domain (i.e., the raw PCG signal) representation of the signal and the spectral representation of the signal. The method was evaluated on a dataset created at the local hospital and additionally on six publicly available PhysioNet datasets. There were 15 features identified that have different distributions depending on the CHF phase (compensated or decompensated). By using just two of these features, a simple and transparent decision tree classifier capable of distinguishing between the recompensated and the decompensated phases with an accuracy of 93.2%, calculated using a Leave-One-Subject-Out (LOSO) evaluation was built.

This is an entirely novel system, worldwide, to detect worsening of CHF. Although a trained physician can detect worsening using a stethoscope, the proposed method can be applied to a wearable device or a mobile phone. The computer algorithm developed allows the patient to monitor their health without (too) frequent visits at the doctor.

Additional originality comes from an innovative combination of knowledge from the fields of physics, medicine, electronics, and computer science.

The researchers are experts in the computational theory of intelligence. They have developed several practical applications in the field of intelligent information systems, intelligent web retrieval, medicine, language technologies and others. The group has over 20 years of experience in R&D, natural language processing, and cognitive sciences

Advantages

- The main advantages of the proposed solution:
- Improved CHF treatment;
- Fewer CHF episodes and therefore fewer hospitalizations;
- The approach can be applied using only a standard intelligent mobile phone.

Currently, no adequate, patient-friendly and non-invasive technology would allow monitoring of CHF patients.

Partner Sought

The partners are sought from among e-Health and electronic (mobile phones) industry as well as academia for licencing agreements to the secret know-how, technical cooperation agreements for joint development of the mobile phone or wearable application and research cooperation for further research in this field.

Contact:

tehnologije@ijs.si

Personal decision support system for heart failure management

Summary
The Jožef Stefan Institute has developed and clinically tested a personal health application that provides accurate personalized advice for patients with congestive heart failure. They are seeking industry and academic institutions to create new or enhance existing heart disease treatment solutions, leveraging their technology under technical cooperation and research cooperation agreements.

Keywords
Computer software, Artificial intelligence (AI), Knowledge management, Process management, Applications for health, Artificial intelligence related software, Other therapeutic (including defibrillators), Other medical/health related (not elsewhere classified), Cognitive aid, Patient rehabilitation & training, Other research and experimental development on natural sciences and engineering

Applications
Cognitive aid, Other leisure and recreational products and services, Health and beauty aids, Computer-aided diagnosis and therapy

The state-of-the-art personal health system helps patients manage CHF. Consists of a mobile application that coaches the patient; a wristband connected to the application that measures the heart rate, physical activity and respiration rate, as well as estimates the blood pressure; a backend that manages the patients' data and performs some of the reasoning about patient's condition, and a web application for medical professionals.

Department
E9 - Department of Intelligent Systems

Stage of Development
Field tested/evaluated

IPR
Copyright, Secret Know-how

Description
Congestive heart failure (CHF) is a serious disease in which the heart cannot pump enough blood to properly supply the body with oxygen and nutrients. The CHF is affecting 1-2% of people in western world and the percentage rises to

more than 10% among people older than 70 years. It cannot be cured and does get worse with time. The treatment is focused on mitigating the symptoms. In order to improve patients' quality of life it is crucial for patients to monitor their weight, take appropriate physical and mental exercises, watch what they eat and drink, and make other changes to their lifestyle. All this makes the disease management very difficult, and to make the issue even worse, each patient is different and may need to manage the disease differently.

Various solutions for personal activity monitoring, lifestyle and health management are available on the market. However, these solutions include only partly the required features to fully support the complexity of CHF treatment. For example, there is no existing solution which is taking into account the psychological state of the CHF patient and offering accurate advice on disease management adapted to each patient.

The application recognizes five important topics concerning self-management for these patients: physical activity, medication, nutrition, monitoring of symptoms and physiological parameters, and environment management. The application has access to patient's health records, it is connected to a monitoring wristband, and keeps a record of the user's past actions. Provided guidance is thus personalized and based on the patient's data. For example, the exercise program depends on the patient's physical capacity and current heart rate, while the nutrition education is adapted to the patient's comorbidities (diabetes etc.) and focuses on topics the patient has difficulties with. Healthcare professionals have a key role in the CHF. Therefore, the solution includes also a web portal designed specifically for professionals. The portal provides fast access to patient data from multiple sources, and simplifies the interpretation of patient information to improve disease management.

Advantages

Several mobile applications for congestive heart failure management have been developed in the last couple of years, but their main functionality is to track the information relevant for the patient's health, while their guidance is general and usually relatively simple. Most of them focus only on one or two problems (e.g. medication adherence, physical activity, etc.). The proposed system has numerous advantages and innovations as opposed to congestive heart failure systems which are available on the market:

- it provides comprehensive guidance to all relevant self-management topics identified through the literature review (physical activity, medication, nutrition, monitoring of symptoms and physiological parameters, and environment management);
- it offers a significant degree of personalisation;

- it raises the patient's awareness of their health through monitoring and providing advice;
- it has a high degree of adjustability for adding new functionalities or changing the (visual) design of the application;
- as a complete solution reduces mortality risks and hospital admission.

Partner Sought
The Jožef Stefan Institute is seeking academic institutions, hospitals and industry who would use the system to support the research (under a research cooperation agreement). The Jožef Stefan Institute is also keen to cooperate with an industrial partner for the commercialization of the technology (under a technical cooperation agreement).

Contact:
tehnologije@ijs.si

Smartwatch application for telecare and fall detection of the elderly

Summary
The Jožef Stefan Institute is offering a software for telecare and fall detection application for care of the elderly. The software is running on a smartwatch, which is adapted for the elderly who are still active but occasionally need some support from a caretaker. The Institute is looking for companies that develop and sell wellbeing devices with special focus on applications for the elderly and services in the telecare market, for license agreements.

Keywords
Computer software, Applications for health, ASP Application Service Providing, Socio-economic models, economic aspects, Infrastructures for social sciences and humanities, Message forwarding, queuing and answering systems, Artificial intelligence related software, Safety for the elderly, Sport facilities (gyms and clubs), Other services (not elsewhere classified), Other research and experimental development on natural sciences and engineering,

Applications
The main function of the application is automatic detection of falls and coma. If such a situation occurs, the smart watch informs relatives or caregivers by automatically calling them via established mobile phone connection or by sending them text messages with the event description and location of the person.

Department
E9 - Department of Intelligent Systems

Stage of Development
Field tested/evaluated. The application is ready for market. Based on field testing of over 200 users the application is being further developed with new features, e.g. battery power saving to enable the autonomy of the device up to 48 hours.

IPR
Copyright, Exclusive Rights, Secret Know-how

Description
The number of elderly living with cognitive impairment is growing rapidly due to increasing life expectancy. The percentage of those who live alone depends upon the condition, but the majority would like to live in their own home or with

a family, provided that it is safe, comfortable, and cost effective. Many commercial applications and research prototypes for automatic fall detection and telecare have been available on the elderly care market for the last couple of years. There is, however, a lack of a fully mobile application without the need of an external base station or other device to establish a communication with a caregiver. Mainly, the fall detection sensors (e.g. smart wristbands or necklaces) work within a limited range of a home base station or only in pair with an external communication device (e.g. smart-phone).

The proposed software application is helping the elderly to prolong and support their independent living. The product is a software application that is running on a smartwatch that works indoors and outdoors, is practical, intuitive and simple to use. The user interface and all functions of the application were developed for the elderly, however, they can be used by other groups of people (e.g. kids) as well. The main objective of the smart watch application is to give the elderly extra confidence and support with their everyday tasks indoors or outdoors. The main function of the application is automatic detection of falls and coma. If such a situation occurs, the smart watch informs relatives or caregivers by automatically calling them via established mobile phone connection or by sending them text messages with the event description and location of the person. The only limitation for communication of the smartwatch is the coverage of the mobile phone network. The use of mobile phone network and possibility of establishment of phone calls differentiates this solution from other systems on the market, which mainly work in the range of their in-house communication signal (e.g. Bluetooth or Wi-Fi). The system includes proprietary state-of-the-art technologies and award-winning algorithms for activity recognition. The system was thoroughly tested and evaluated by more than 200 individuals, over the period of at least 3 months each. The reviews and suggestions were then gathered and implemented into a final product (i.e. current version).

Authors of the algorithm are computer science experts employed at the Jožef Stefan Institute for research in sciences and technology. They are specialized in the development of proprietary methods and algorithms for analysing wearable sensor data used mainly in the health domain, but applicable to other domains. The team has been among finalists of the global competition for medical diagnostic devices. They have won the international competition for activity recognition (2013 and 2018). They are active in several projects for development of smartwatches and other wearable monitors for independent living of seniors with dementia; detection of falls and abnormal behaviours for the elderly; support older workers in reducing physical and mental stress using wristband and personalized advice and decision support to help patients with heart problems.

Advantages
The main conceptual advantage as opposed to many available solutions on the market is that the proposed solution runs on a commercially available and affordable wristwatch, which enables full mobility and communication, which is limited by the phone signal coverage of the mobile network operator.

Other advantages of the proposed solution are:

- Novel fall detection system, winning international competition for activity recognition;
- Coma detection;
- Modular and interoperable solution;
- Simple integration with carer support portal;
- Works indoors and outdoors;
- Practical, intuitive, simple to use;
- No internet or Bluetooth connection required;
- 3 different modes of operations increasing battery autonomy up to 3 days;
- Smart power saving algorithm is extending the autonomy of the device (battery save function).

Partner Sought
The research institute is looking for partners, which develop and produce wearable wireless wellbeing devices with special focus on elderly applications and companies which offer solutions and services for elderly care institutions, nursing homes, residential care institutions and adult day service centers.

The licence agreement is offered enabling partners to install the software in the smartwatches and offer the smartwatches and telecare services to the elderly and caregiving institutions.

Contact:
tehnologije@ijs.si

Stress-detection algorithm for wearable devices is offered for licensing

Summary
The Jožef Stefan Institute is offering a computer implemented algorithm for stress detection. The algorithm was evaluated in a real-life setting and is integrated in a prototype application for managing mental health and well-being. The researchers are looking for a company able to implement the algorithm in commercial wearable applications in the framework of a license agreement.

Keywords
Artificial Intelligence (AI), Computer Software, Applications for Health, Medical/health software, Cognitive aid, Other leisure and recreational products and services, Health and beauty aids, Other research and experimental development on natural sciences and engineering

Applications
The algorithm is integrated into a smartphone prototype application for managing mental health and well-being. The complete solution is available for demonstration.

Department
E9 - Department of Intelligent Systems

Stage of Development
Prototype available for demonstration. The algorithm was evaluated in a laboratory and in a real-life setting. The accuracy on 55 days of real-life data from 5 subjects, for distinguishing stress vs. no-stress events was 92%. These promising results are currently being re-evaluated on a larger group of participants (more than 50) from Slovenia and Belgium. The algorithm is integrated in a smartphone prototype application for managing mental health and well-being. Complete solution is available for demonstration. The algorithm is being constantly improved and tested. The authors of the algorithm have necessary knowledge to offer all the engineering expertise and support (research team of 30 people) to the potential licensee to implement the algorithm in a commercial product.

IPR
Secret Know-how, Exclusive Rights, Copyright

Description
Continuous exposure to stress is harmful for mental and physical health. Solutions for efficient, accurate and user-accepted automated stress detection are still missing on the market. Artificial intelligence researchers from the Jožef Stefan Institute have developed and tested an algorithm for continuous detection of stressful events. The algorithm is using data from a wrist device which is capable of measuring users' heart rate (HR), blood volume pulse (BVP), galvanic skin response (GSR), skin temperature (ST), time between heartbeats (IBI) and accelerometer data. The offered technology is a computer implemented algorithm, however the proposed algorithm in a combination with appropriate wrist device (which must be provided by the partner sought) can constitute a competitive product for the health and well-being market.

Authors of the algorithm are computer science experts specializing in development of proprietary methods and algorithms for analysing wearable sensor data used mainly in the health domain but applicable to other domains as well. The team has been among finalists of the global competition for medical diagnostic devices. They have won The International Competition for Activity Recognition. They are active in several projects for the development of smart watch monitors for independent living of seniors with dementia; detection of falls and abnormal behaviours for elderly; support older workers in reducing physical and mental stress using wristband and personalized devices and decision support to help patients with heart problems.

Advantages
Most of the related artificial intelligence algorithms for monitoring stress are tested in laboratory scenarios for which they are specialized. However, when tested in the real life scenarios their performance drops significantly. The offered algorithm in addition to the high performance in laboratory scenarios achieves high performance also in uncontrolled, real-life scenarios. This is thanks to the novel context-based machine-learning approach. The algorithm combines several machine-learning components to find out the context under which a certain event happens before it detects whether it is stressful or not. One of the components is a laboratory stress-detection classifier trained on laboratory data to distinguish between stress and no-stress physiological signals. Another component is a proprietary activity-recognition classifier which continuously recognizes user's activity and thus provides context information about real-life circumstances. The third machine-learning component is a classifier trained on real-life data which combines the outputs of the other two components (laboratory stress classifier and activity-recognition classifier) and provides the final decision whether a certain situation is stressful or not. The recognized user's activity and computation of features for stress detection from

the above mentioned physiological signals (Blood Volume Pulse, Heart rate, Skin temperature and Galvanic skin response) improves the ability to distinguish between genuine stress in real life and the many situations which induce a similar physiological arousal (e.g., exercise, eating, hot weather, etc.). This is the main advantage as opposed to other known approaches in the research community and on the market.

Partner Sought
The researchers are looking for companies who are interested in obtaining a licensing agreement for the stress-detection algorithm. Companies should be able to cover and organize all commercialization services (marketing and sales, distribution, after sales support). In particular, the following companies from wellness and health sectors are sought:

- companies which develop and produce wearable wireless wellbeing, sport and fitness devices;
- companies which offer solutions for remote patient monitoring, on-site professional healthcare monitoring and home/office/work environment monitoring.

The Slovenian institute researchers are also offering an option for partners to use the algorithm via SaaS service.

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Online workflows for distributed big data mining

Summary
The Jožef Stefan Institute has developed a cloud-based platform that supports the composition and execution of data and text processing workflows. It fulfils the needs of many companies facing the problem of collecting huge amounts of data but lacking intuitive user-friendly data mining tools. The platform is provided as a hosted service, with the ability for users to install it on a private cloud. Partners are sought for technical/research cooperation agreements.

Keywords
Artificial intelligence (AI), Databases, Database management, Data mining, Knowledge management, Process management, Cloud technologies, Data processing, analysis and input services, Big data management, Databases and on-line information services, Other computer services, Database and file management, Other research and experimental development on natural sciences and engineering, User Interfaces, Usability

Applications
The platform offers software components supporting data analytics and pattern discovery and workflow components allowing graphical user interaction during runtime and visualization of results by implementing views in any format and rendered in a web browser. Conceived as a suite of tools it is currently being used to design and execute scientific workflows.

Department
E8 - Department of Knowledge Technologies

Stage of Development
Field tested/evaluated, project already started

IPR
Copyright, Secret Know-how

Description
The Jožef Stefan Institute has developed a crowd-sourced workflows platform on the cloud. It is an open-source data processing workflow platform with a user-friendly graphical interface that can run in any browser and does not require installation on client computers. The platform offers software components supporting data analytics and pattern discovery and workflow components allowing graphical user interaction during runtime and visualization of results by implementing views in any format and rendered in a web browser.

Data processing in the platform is managed by connecting processing components into a workflow executable on the cloud, and the graphical user interface for constructing workflows follows a visual programming paradigm that simplifies the representation of complex procedures into spatial arrangements of building blocks.

Similar and related platforms exist, but no workflow construction tool would match the ease of use and workflow sharing abilities of the platform. Currently, probably the most advanced workflow management system (used primarily for bioinformatics research) is conceived as a suite of tools used to design and execute scientific workflows. A multilingual Internet service platform for supporting Intercultural collaboration is based on a service-oriented architecture and supports a web-oriented version of the pipeline architecture typically employed by natural language processing tools. Yet another platform, a more recent development, enables workflows to have interactive components, where the execution of the workflow pauses to receive input from the user.

The basic unit of the platform proposed is a processing component, which is graphically represented as a widget. Considering its inputs and parameters every such component performs a task and stores the results as outputs. Different processing components are linked via connections through which data is transferred from a widget's output to another's input. Alternative widget inputs are parameters, which the user enters into a widget's text fields.

The platform is easy-to-use, requires no expertise to construct new workflows while allowing complex data mining analyses to be performed on the input data set.

The technologies have been successfully applied to many practical problems, including earthquake prediction, selection of applicants for loans of the National Housing Fund, analysis of UK traffic accidents, medical diagnosis, analysis of the Slovenian public healthcare system, scientific digital editions of Slovene literature

Advantages
The graphical user interface (GUI) implements an easy-to-use formalism of arranging widgets on a canvas to form a graphical representation of complex procedures. Construction of new workflows requires no expertise apart from knowing (usually from widget documentation) the inputs and outputs of widgets to ensure their compatibility. Once constructed, the workflows can be shared (publicly or privately), reused, and extended.

Partner Sought

The partners are sought among data mining practitioners and developers for:

- Technical cooperation agreements in the implementation of existing workflows.
- Research cooperation: development of new workflows.

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Reliable, cost-effective condition monitoring, prognostics and health management of rotational machines and drives

Summary
The Jožef Stefan Institute has developed a platform built on a portfolio of hardware and software modules for diagnosis and prognosis of the remaining useful time of rotating machinery. The employed algorithms are completely new to the industry. The solution is capable of non-invasive monitoring on a wide range of classic industrial drive components. Partners are sought for licensing and technical cooperation agreements.

Keywords
Maintenance management system, Signal processing, Plant design and maintenance, Vibration and acoustic engineering, Sensor technology related to measurements, Specialised turnkey systems, Other measuring devices, Hydroelectric, Industrial measurement and sensing equipment, Other manufacturing, Other research and experimental development on natural sciences and engineering, Mathematical modelling statistical analysis, Machining (turning, drilling, moulding, milling, planning, cutting), Plant design and maintenance

Applications
Manufacturing/industrial

Department
E2 - Department of Systems and Control

Stage of Development:
Field tested/evaluated

IPR:
Secret Know-how, Design Rights, Exclusive Rights, Copyright

Description
The activities of the Jožef Stefan Institute's research group include analysis, control and optimization of various systems and processes, research and development of new methods and algorithms for automatic control, the design of computer-aided systems for control and supervision of devices, industrial and other processes.

On-line condition monitoring (CM), prognostics and health management (PHM)

are instruments that enable migration from resource-intensive to cost-effective proactive maintenance programs. Currently, the main cost drivers for CM and PHM systems are (i) costly design cycle, (ii) use of conventional CM methodology that cannot handle non-stationary operational conditions, (iii) limited prognostic abilities reduced to trending only, (iv) poor interoperability with existing production management computer systems.
Most of the answers to these issues are constituents of the PHM prototype platform proposed. It builds on a portfolio of hardware and software modules backed by unconventional award-winning algorithms for robust diagnosis and prognosis of the remaining useful time of the rotational industrial machinery. The system can be integrated into the new machinery or implemented to the existing machinery. The machines and drives targeted for PHM solutions fall in the middle power and cost range which represents the majority of the industrial machinery. Large machinery in the top price range - although not excluded - are probably already equipped with proprietary original manufacturer systems for this purpose.

The platform is a low-cost diagnostic and prognostic device and software capable of non-invasive automatic monitoring on a wide range of classic industrial drive components, embedded systems and high-speed electromechanical systems. Due to its relatively low-cost and the ability to not only monitor the condition of the machinery but also to predict the remaining useful life of a machine, the platform is offering a high return on investment to a broad spectrum of industrial end-users with ubiquitous and moderate price range asset portfolio, and not only to the owners of high-cost machinery.

The platform is developed to the level of prototype and is being functionally tested in an industrial environment. In the present form, it can already be used in many application areas like HVAC (Heating, ventilation, and air conditioning) systems, smart machines with self-diagnosability properties, etc. The results of field applications demonstrate all its powerful features: robustness to variable operating conditions, ability to perform prognostics of the remaining useful life, efficient and low-cost design cycle, and flexibility to specific demands of different applications. For example, implementation of the platform to a sending machine was able to assess the remaining useful time with 10-30% accuracy during the last half of the machine operation. There are other success stories, too.

Advantages
The platform has the following advantages over the conventional CM and PHM systems:

- High accuracy of predicting the remaining useful life of the machinery;
- Lower design-cycle cost;

- Capability to handle non-stationary operational conditions;
- Interoperability with existing enterprise resource planning (ERP) systems.

Partner Sought
The partners are sought among the manufacturers of the machinery and end-users in oil, petrochemical, gas, energy and process industry. The cooperation agreements can be in a form of:

- Platform and know-how licensing;
- Technical cooperation to integrate the platform into the rotational machines and drives.

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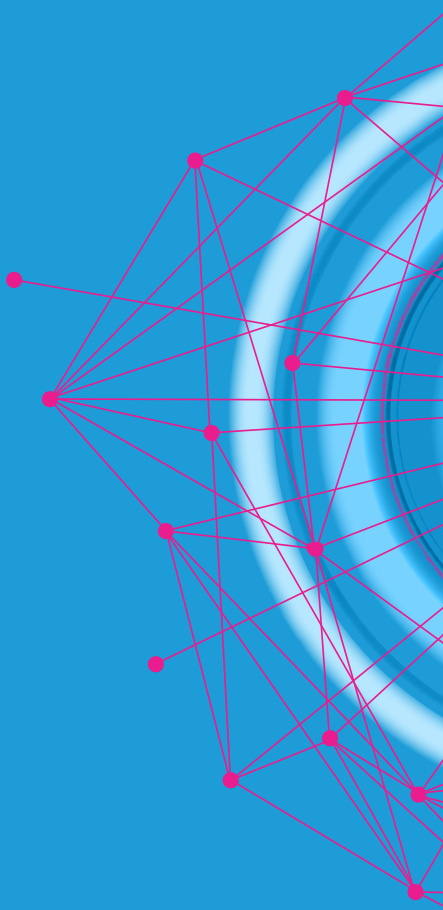
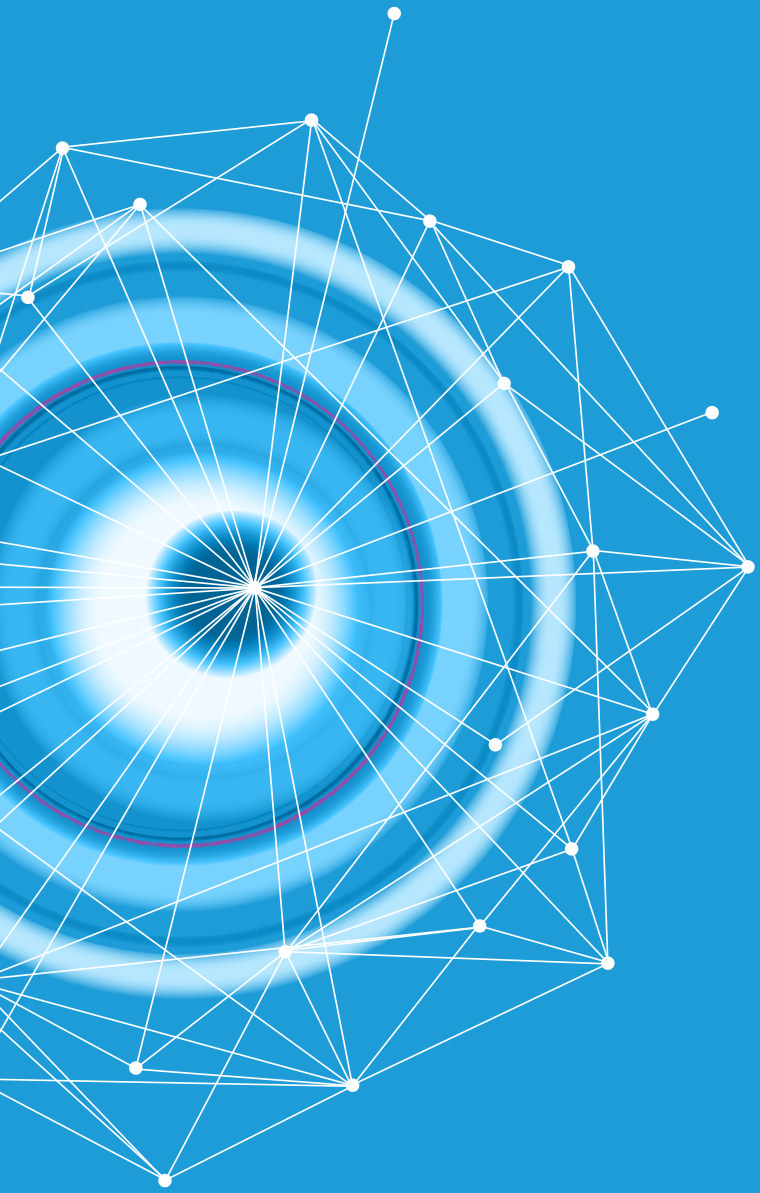


Nanotechnology and New Materials



Environmentally-friendly and energy-efficient method for recovery of rare-earth elements

Summary
A Slovenian research institute has developed an innovative method for the recovery of rare-earth elements from magnet scraps. The method is cost-effective, energy-efficient and environmentally friendly. Partners are sought amongst the companies that recycle magnets and producers of rare-earth oxides and alloys for technical cooperation agreements and license agreement to scale up and apply the technology in their production.

Keywords
Magnetic and superconductor materials/devices, Erosion, Removal (spark erosion, flame cutting, laser, ..), Metals and alloys, Non-ferrous metals, Special chemicals, intermediates, Speciality/performance materials: producers and fabricators, Speciality metals (including processes for working with metals), Other speciality materials, Chemical and solid material recycling

Applications
Magnets and magnet scraps recycling, production of rare-earth oxides and alloys

Department
K7 - Department for Nanostructured Materials

Stage of Development
Under development/lab tested

IPR
Patent(s) applied for but not yet granted

Description
Rare-earth elements (REEs) have excellent electronic, optic, catalytic, and magnetic properties, making them useful for a wide range of applications, such as catalysts, phosphors and pigments, batteries, permanent magnets, and ceramics. The global REE consumption was estimated at 119,650 metric tons in the form of rare-earth oxides (REOs) in 2016 with catalysts being the largest segment, followed by permanent magnets. Diverse methodologies for recycling Nd-Fe-B (neodymium, iron and boron) permanent magnets are currently under development which can be broadly classified into direct re-use, alloy reprocessing and raw material recovery. In conventional hydrometallurgical processes

large amounts of acid, alkali and other precipitation agents are used which cannot be recycled in the whole process and consequently a considerable amount of wastewater is produced.

A Slovenian research institute has developed a novel method for recovery of the REEs from Nd-Fe-B magnet scraps, which allows the selective leaching and recovery of the REEs with high efficiency and in a more environmentally friendly and cost-effective way. The method includes anodic oxidation of the magnet scraps and precipitation of rare-earth salts. Currently the research group can produce a few dozen grams of rare-earth salts using this procedure. In order to apply the procedure on an industrial level, the method needs to be scaled up. For the scale up, large baths for anodic oxidation and engineering knowledge are needed.

The research group has a lot of experience in magnetic materials and their development, access to research infrastructure, as well as several cooperation projects with industry.

Advantages
With the proposed method REEs can be selectively leached and recovered from Nd-Fe-B magnet scraps with a highly efficient REEs recovery rate of more than 90% and minimum production costs. The method does not require any roasting pre-treatment and can be performed at room temperature. The electrochemical scheme allows minimal input of chemicals and produces no output of chemical waste; in particular, it does not generate any wastewater. The method also allows the recovery of the pure metallic iron (Fe) deposited on the cathode.

Partner Sought
The research institute is looking for industrial partners for technical cooperation agreement and license agreement. Industrial partners should be companies that recycle magnets and magnet scraps and producers of rare-earth oxides and alloys. Expertise in electrochemistry is desired. Within the technical cooperation agreement, the partner sought shall jointly with Slovenian institute scale up the method and employ the method in their production process. If the partner successfully implements the method in his production process, he will be invited to sign a license agreement.

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Filament with oriented magnetic particles for 3D printing of anisotropic magnets

Summary
The Jožef Stefan Institute has developed an anisotropic polymer bonded magnetic filament. The filament comprises magnetically anisotropic particles aligned relative to each other. The filament makes possible the manufacturing of arbitrarily shaped permanent magnets using 3D printing technology. The researchers have decades of experience in magnetic, ceramic and other materials. Partners are sought amongst the magnet manufacturers for technical cooperation agreements to apply this technology to the 3D printing of permanent magnets.

Keywords
Magnetic and superconducting materials/devices, 3D printing, Extrusion, Composite, materials, Printed reel material, Speciality/performance materials: producers and fabricators, Other industrial products, Motor vehicles, transportation equipment and parts, Other manufacturing, Other research and experimental development on natural sciences and engineering

Applications
3D printing

Department
K7 - Department for Nanostructured Materials

Stage of Development
Under development/lab tested

IPR
Patent(s) applied for but not yet granted

Description
Additive manufacturing has proven applicable to the field of manufacturing permanent magnets. 3D printing as the additive manufacturing technology for production has the advantage of being waste-free while offering infinite possibilities for producing complex shapes that could not be manufactured by other techniques. A polymer-bonded magnetic material is best suitable for 3D printing of magnets. The polymer serves as a bonding material between magnetic particles and is essential in defining geometry, and for mechanical stability.

In 3D printing with present technology, the magnetic material in the filaments is magnetically isotropic. The novelty here is a filament with preferentially oriented anisotropic magnetic particles having superior magnetic properties.

Mixing of milled, magnetically anisotropic Nd-Fe-B particles, and a thermally softened polymer binder makes the filament. Extruding the filament, forming a wire, and exposing it to an external magnetic field aligns the magnetic particles in the preferred direction. The direction of alignment may be perpendicular, parallel or at a certain predefined angle relative to the long axis of the filament. The filament can also be segmented; the magnetisation axis can change along the length. This enables the fabrication of multicomponent magnets which can withstand higher demagnetization fields during operation. The anisotropic magnetic particles are aligned in the preferred direction before 3D printing, during the filament mass production in a factory. No further processing of the manufactured magnets requiring additional equipment at the customer site is needed.

The filament is typically provided in coils for storage. It is uncoiled and consumed during use. The handling is easy using the filament wire as a feedstock with a constant and regular input speed suitable for the 3D printing process. The filament is thermally labile such that it is softened for extrusion in a heated 3D printer head before solidifying shortly thereafter to retain its position at the printing coordinates.

One of the potential final applications is in the automotive sector. Permanent magnets are one of the key parts of electric cars and their components. Better efficiency in comparison with magnets produced by extrusion may be given by the production of specific and complex shapes magnets. 3D printing is one of the most appropriate solutions for the production of such kinds of polymer-bonded magnets, however, there is still no 3D print technology for producing efficient anisotropic magnets.

Advantages

3D printing as the additive manufacturing technology for production has the advantage of being waste-free while offering infinite possibilities for producing complex shapes that could not be manufactured by other techniques.
The filament can also be segmented; the magnetisation axis can change along the length. This enables the fabrication of multicomponent magnets which can withstand higher demagnetization fields during operation.

The filament for 3D printing proposed has the following advantages:

- 3D printing technology accommodates for arbitrarily shaped magnets;

- the anisotropy provides for the better magnetic properties of manufactured permanent magnets;
- other available filaments for 3D printing are isotropic;
- the filament is pre-processed and magnetized in the factory before 3D printing;
- the filament can be stored and used later in manufacturing.

Partner Sought
Partners are sought amongst the magnet manufacturing and 3D printing industry for technical cooperation agreements to test the filament for 3D printing an anisotropic polymer-bonded magnet.

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Cost-effective and environmentally friendly method for recycling magnets

Summary
The Jožef Stefan Institute has developed an innovative method for recovery of magnetic grains from bulk sintered magnets. The method is facile, cost-effective, energy efficient and environmentally friendly. Partners are sought amongst the magnet manufacturers and companies that recycle magnets for technical cooperation agreements and license agreements to scale up and apply the technology in their production.

Keywords
Electronic circuits, components and equipment, Magnetic and superconductor materials/devices, Industrial manufacturing, material and transport, Erosion, Removal (spark erosion, flame cutting, laser, ..), Materials technology, Metals and alloys, Non-ferrous metals, Protecting man and environment, Waste management, Recycling, Recovery, Other research and experimental development on natural sciences and engineering, Industrial products, Chemicals and materials, Speciality/performance materials: producers and fabricators, Speciality metals (including processes for working with metals), Other speciality materials, Pollution and recycling related, Chemical and solid material recycling

Applications
A novel method for recovery of Nd2Fe14B grains from bulk sintered Nd-Fe-B magnets and magnets scraps by electrochemical etching.

Department
K7 - Department for Nanostructured Materials

Stage of Development
Under development/lab tested

IPR
Patent(s) applied for but not yet granted. Patent application filed at the European Patent Office which issued a positive report about the patentability. Patent applications based on the same invention filed in the USA, China and Japan.

Description
Neodymium iron boron (Nd-Fe-B) magnets are widely used in many applications such as hard disk drives, wind turbines, industrial motors, acoustic transducers and electric vehicles due to their high energy density. They incorporate 20-30 wt%

of rare earth elements (REEs) so they represent an important secondary REEs resource. Since primary mining of REEs leads to a large environmental footprint associated with chemical usage and harmful emissions, the REEs are considered the most critical based on their economic importance and supply risk. Despite their criticality, currently, less than 1% of REEs are being recycled from end of life products. Up to 30% of the starting REE alloy can be lost during the magnet manufacturing process. Therefore, the recycling of the end-of-life Nd-Fe-B magnets or other magnet scraps has been considered as an important strategy to reduce the environmental risks related to rare earth mining and overcome the supply risk of REEs.

The Jožef Stefan Institute developed a novel method for recovery of Nd2Fe14B grains from bulk sintered Nd-Fe-B magnets and magnets scraps by electrochemical etching. Nd-Fe-B magnets or magnet scraps are anodically oxidized using a non-aqueous liquid electrolyte, the anodic oxidation releasing the Nd2Fe14B grains in Nd-Fe-B magnets or magnet scraps, wherein the released Nd2Fe14B grains are collected during or after the anodic oxidation. Currently the research group can produce a few dozens grams of Nd2Fe14B grains using this procedure. In order to apply the procedure on industrial level, the method needs to be scaled up. For the scale up, large baths for anodic oxidation and engineering knowledge are needed.

The research group has numerous experience in magnetic materials and their development, access to research infrastructure, as well as several cooperation projects with industry.

Advantages
Currently employed methods for recycling magnets require either high energy input or multiple process steps with consumption of large amounts of chemicals which generates large amounts of waste and effluents.
Our innovative method includes the recovery of Nd2Fe14B grains ready for new magnet making and recovery of rare earth elements ready for rare earth metal production by a facile, cost-effective, energy efficient and environmentally friendly route.

Partners Sought
We are looking for industrial partners for technical cooperation agreement and license agreement. Industrial partners should be manufacturers of magnets or companies that recycle magnets and magnet scraps. Expertise in electrochemistry is desired. Within the technical cooperation agreement, the partner sought shall jointly scale up the method and employ the method in their production. In case successful implementation of the method in production the license agreement shall be signed.

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Method for the synthesis of metal molybdates and tungstates from molybdenum and tungsten carbides and nitrides

Nanotechnology and New Materials

Summary
The subject of this technology is a method for synthesis of metal molybdates and metal tungstates from molybdenum and tungsten carbides and nitrides. The conversion is done in the presence of a water solution of metal-containing reactive compounds. The main advantage of this process is that the conversion takes place at low temperatures while currently, most syntheses of molybdates and tungstates require high temperatures and sharp reaction conditions, such as solid reactions.

Keywords
Chemicals and materials

Applications
Catalysis, moisture sensors, for scintillation detectors, optical fibres and solid state lasers, removal of lead from drinking water etc.

Department
F7 - Department of Complex Matter, K9 - Advanced Materials Department

Stage of Development
Under development/lab tested

IPR: Slovenian patent granted, European patent application filed

Description
To commercialize the technology further development is needed. The offered method is at the proof of concept level. Raw materials processing and final product need to be developed for the demonstration. The technology described is a replacement to the existing processes with a simpler and less expensive solution.

Advantages
The main advantage and innovation of this method is in that it allows the synthesis of large amounts of metal molybdates and tungstates:

- at low temperature, and
- using reactive compounds dissolved in water

Partner Sought

Industrial partners are sought in the field of inorganic chemistry and chemistry of transition metals. The partners are sought for:

- licencing agreements to the patented method to partners who would like to manufacture the offered technology.
- technical cooperation is offered for the development of the technology to a large-scale production level.

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Innovative antimicrobial and antioxidant food packaging films and foils

Summary
A Slovenian research institute and a university have developed an innovative antioxidant and antimicrobial flexible plastic material for making films and foils to be used in food industry and where food needs to be preserved for a longer period of time with help by temporary solutions. The Slovenian research institute and university are looking for manufacturers of foils and films for license agreements.

Keywords
Foil, film, chitosan, antimicrobial, antioxidant, nanoparticles, permeability, food packaging material

Applications
Food industry, preservation of food

Department
F4 - Department of Surface Engineering
The technology is co-owned by JSI.

Stage of Development
Available for demonstration

IPR
Patent(s) applied for but not yet granted

Description
Due to changes in increased public awareness about environment and health, strict packaging regulations and guidelines, a lot of effort has been put into development of innovative food packaging materials to achieve resistance against pathogens, to reduce unnecessary waste and spoilage, to reduce the use of chemical preservatives and to improve the nutritional and sensorial properties of food. Unfortunately, not many solutions proved to be adequate in terms of costs, environment and health.

Polypropylene and polyethylene commonly used for foils and films show permeability for gases like oxygen, little to no measurable antimicrobial activity and antioxidant activity at around 2 to 4 %. As a consequence, these materials are

treated with different solutions to enable desired characteristics like antioxidant and antimicrobial activity.

Researchers from a Slovenian institute and university with extensive experience in the field of food science and surface engineering have developed a method and initial design of corresponding apparatus for production of antioxidant and antimicrobial material.

The procedure starts with a substrate, usually made of polymeric materials like polyethylene (PE) or polypropylene (PP). PE or PP foil is treated to saturate the surface with polar functional groups, without changing its other properties. Wettability of the layer is improved at the same time, and that helps with the next step, where the chitosan layer is applied. The role of this layer is to provide a barrier for oxygen diffusion and antibacterial activity. Additionally, it helps the following layer, called active layer, to be adhered firmly and effectively on the previous one.

The third and final layer in general consists of antioxidant material (e.g. pomegranate extract) and chitosan nanoparticles that form a network. The chitosan in the active layer is intentionally used in form of nanoparticles due to particularly enhanced antibacterial properties when in this form. Along with the chitosan layers, the active layer also acts as additional oxygen permeation barrier.

Along with the method, adequate apparatus for producing packaging material was designed and it has several treatment units through which the material passes.

Advantages
The method for synthesis of films and foils has several advantages compared to untreated materials and other solutions:

- Increased antimicrobial activity (e.g. in tests the bacteria Staphylococcus aureus were reduced by more than 90%)
- Increased antioxidant activity by a factor of more than 10
- Reduced oxygen permeability by over 90%

As a result, the food packed in this material can last longer. Beneficial nutritional properties are also kept for a prolonged period of time, while detrimental effects are considerably slowed down.

Partner Sought
The research institute and university are looking for companies and other

industrial partners for a license agreement to use this technology. Partners should specialize in production of flexible plastic food packaging materials with emphasis on foils and films. The research institute and university will provide the necessary information and other specifications, required for efficient and proper implementation of the method and apparatus in a production process, while partner will be able to use this technology in their production processes.

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Methods for making vascular stents antithrombogenic

Summary
The Jožef Stefan Institute offers technologies for surface treatment of titanium, nitinol (nickel-titanium alloy) and stainless steel vascular stents. The developed methods reduce adhesion and activation of platelets on titanium and nitinol stents, thus preventing thrombosis as well as prevent release of toxic nickel. Producers of vascular stents and other medical devices are sought for technical cooperation and license agreement.

Keywords
Metals and alloys, Heart and blood circulation illnesses, Medical technology / Biomedical engineering, Medical devices, Micro- and nanotechnology related to biological sciences, Surgical implants, Cardiology, Surgery and anaesthesiology, Coatings and adhesives manufacturing, Other research and experimental development on natural sciences and engineering

Applications
The methods have been developed for titanium vascular stents, nitinol and stainless steel stents, heart valves and similar medical devices.

Department
F4 - Department of Surface Engineering

Stage of Development
Under development / lab tested

IPR
Patent(s) applied for but not yet granted

Description
The major cause of mortality in the modern world is coronary artery disease. Stents are commonly employed to enlarge the lumen wall and to restore the blood flow through the affected blood vessel. Bare metal stents (BMS) are made of hemocompatible and durable material, such as titanium, nitinol (nickel-titanium alloy), stainless steel and cobalt-chromium.

The problem:
Although stents are used to improve blood flow, blood platelets adhere to an

untreated vascular stent surface which leads to the formation of a thrombus. The thrombus obstructs the flow of blood through the circulatory system and increases the risk of heart attack. Nitinol stents contain nickel, a known allergenic carcinogen that exhibits one of the highest sensitivities in metallic allergen tests. Nickel is often detected on the surface of the nitinol stents, which represents a threat of nickel release in blood.

The solution:
The Jožef Stefan Institute developed several methods for improving biocompatibility of bare metal stents. The methods have been developed for titanium stents, nitinol and stainless steel stents.

Method for titanium stents involves nanostructuring of the surface of titanium by electrochemical anodization and subjecting the nanostructured surface to neutral oxygen atoms to eliminate surface induced thrombotic reactions. The method for nitinol stents includes treatment with hydrogen plasma and neutral oxygen atoms. Two further methods for nitinol and stainless steel stents have been developed.

All methods have been tested in the laboratory using blood samples, where platelet adhesion was studied on plain titanium/nitinol and on surfaces modified by the methods. According to microscopic analysis of the samples treated by the developed methods the platelet adhesion is prevented, as practically no platelets were observed on the surfaces of stents treated by the methods. Additionally, toxic nickel release is prevented after the treatment of nitinol stent.

The Jožef Stefan Institute is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research. The staff specializes in natural sciences, life sciences and engineering. The technology has been developed at the research department, which has numerous experience in plasma technologies for various applications.

Advantages

- The developed methods highly reduce adhesion and activation of platelets on the vascular stents, thus preventing formation of a thrombus, decreasing the risk of cardiovascular disease and heart attack;
- The surface of titanium stent is free of impurities after treatment;
- Nickel release from nitinol stent is prevented;
- No environmentally problematic chemicals are used during treatment of stents;
- The methods are applicable on bare metal stents (BMS) which are three to four times less expensive than drug-eluting stents (DES).

Partner Sought

We are looking for producers of vascular stents, heart valves and similar medical devices. Technical cooperation agreement with companies that wish to validate the technology on their vascular stents/similar medical devices is sought. At JSI we would test the methods on the stents/other medical devices, provided by the company. After the tests, commercialization of the technology is foreseen by concluding license agreement.

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Novel method for making Teflon® and other fluoropolymers hydrophilic

Summary
A Slovenian research institute has developed a novel method for surface treatment of polytetrafluoroethylene (PTFE, Teflon®) and other fluorinated polymers, which significantly improves wettability of the surface from highly hydrophobic to highly hydrophilic. The institute is looking for producers of PTFE products and other fluoropolymeric products for license agreement.

Keywords
Surface treatment (painting, galvano, polishing, CVD, ..), Microengineering and nanoengineering, Adhesives, Plastics, Polymers, Housewares, Commodity chemicals and polymers, Polymer (plastics) materials

Applications
The method is rapid and enables treatment of fluorine-containing polymers of almost any shape and size, including 'infinite' materials such as foils.

Department
F4 - Department of Surface Engineering

Stage of Development
Available for demonstration

IPR
Patent(s) applied for but not yet granted

Description
The wettability of polymer surfaces is an important consideration in some applications, for example where adhesion to the polymer surface is needed, such as when paint or functional coatings are applied to polymer substrates, or glue is used to stick a polymer substrate to something else. It may therefore be desirable to modify the polymer substrate surface.
Several methods for modification of polymer wettability have been reported. These include treatment with aggressive liquids, plasma and reactive gases. An already used method is treatment of polymer materials with gaseous plasma. A technological challenge, however, is formation of oxygen-rich functional groups on the surface of a fluorinated polymer. Currently used plasma treatment methods lead to etching rather than to functionalization of fluorine containing polymers with oxygen-rich functional groups.

A Slovenian research institute offers a novel method for modification of surface wettability of fluorine-containing polymers by a sequential two-step treatment.

The method is rapid and enables treatment of fluorine-containing polymers of almost any shape and size including 'infinite' materials such as foils. The wettability of objects made from, or containing, fluorine-containing polymers treated according to the methods of invention is close to the theoretical limit for smooth polymers - with this method a 20° water contact angle was achieved.

A surface finish with the novel method is stable and assures for long-lasting hydrophilicity of otherwise hydrophobic polymers. Unlike conventional treatment of fluorine-containing polymers with oxygen plasma, the novel method does not produce hazardous gases such as oxy- or peroxy-fluorinated carbon compounds.

The surface treatment method has been validated in the laboratory. Additionally, a device for surface treatment of fluorinated polymers in a batch or continuous mode has been developed.

The technology has been developed at the Slovenian research institute. The research group comprises experts in the field of surface treatment with emphasis on plasma technologies, thin films and vacuum science and have numerous experience in cooperation with industry.

Advantages

- The wettability of fluorinated polymers treated with novel method is close to the theoretical limit for smooth polymers (20° water angle contact)
- The method is fast and amenable to scale up, and enables continuous processing
- There is no measurable production of hazardous or harmful by-products
- The method is energetically efficient and can be fully automated.

Partner Sought

The institute is looking for producers of PTFE products (cookware, plain bearings, gears, slide plates, seals, gaskets, bushings, wiring in aerospace and computer applications, etc.) and other fluoropolymeric products. The industrial partners are expected to enter license agreements with aim of implementation of the developed method in their production line.

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Wetting-control polymeric surface-layer for printed electronics

Summary
The Jožef Stefan Institute developed a method of improving the wetting properties of surfaces by modifying the contact angle appropriately. In printed electronics applications the formation of nano-textured polymeric layers providing well-defined wetting conditions is required for high printing resolution and high stability upon drying. Partners are sought for licensing, technical and research cooperation agreements.

Keywords
Electronics, Printed electronics, Electronics printing, Nano, Nanotechnology, Polymeric, Polymeric surface, layer-on-layer printing

Applications
The substrates suitable for wetting-modification are not limited by size, composition, or geometry. The technology is suitable for wetting-modification of planar, non-planar and curved substrates, as the polymeric layer can be uniformly applied to these substrates. Suitable substrates include silicon wafers, glasses of various types, polished ceramic substrates, metal foils, polymers such as polyimide and other optical grade surfaces. Once an ink or other functional layer has been printed onto the polymeric layer, the polymeric layer can be removed by thermal decomposition. The process can be repeated, to print multiple patterns onto a substrate.

Department
F5 - Department of Condensed Matter Physics , K5 - Electronic Ceramics Department

Stage of Development
Available for demonstration

IPR
Patents applied for but not yet granted

Description
Problem: the regulation of wetting has an important technological role in many applications, including printing of functional inks on solid substrates, which is an essential part of printed electronics. In printed electronics, layer-on-layer printing is commonplace, such that each new pattern is printed on an

inhomogeneous surface i.e. a surface with the pre-deposited layer. This can result in complex and unpredictable wetting behaviour, characterized by differing contact angles on areas with pre-deposited structures and areas which are the bare surface of the substrate.

The wetting behaviour of the ink to the surface interface is crucially important for final print resolution. Currently, inkjet resolution in printed electronics is moderate, about 50µm. To achieve higher resolution in printing electronics separate surface treatment often involving UV/ozone, plasma/corona, hydrophilic–hydrophobic coating processes, is used. The need for fast, reliable and cost-effective techniques which can adjust the wetting of arbitrary solid optical grade substrates remain.

Solution: a polymeric layer proposed, was prepared by completely covering a glass substrate with the polymer solution and spin-coating. The polymeric layer on the substrate was dried on a hotplate, resulting in an 8 nm thick polymeric layer. The subsequent surface treatment with UV/ozone or oxygen plasma can be used to precisely control the wetting. Further post-treatment can increase the contact angle hysteresis of the surface. The coated surfaces can then be used for the printing of electronic components. The method provides a surface with a high contact angle hysteresis which has a favourable impact on the drying of printed structures.

Advantages
The polymeric surface layer formed by this method is a simple and inexpensive improvement to the existing technology. It has the following advantages compared to existing/known polymeric layers:

- Increases the pinning energy of the wetting liquid, and its contact angle hysteresis.
- The larger contact angle hysteresis provides higher printing resolution, a better quality of pattern definition, and better morphology of dried deposits.
- The wetting of the polymeric layer may be regulated by exposure to reactive polar species (for example, oxygen or nitrogen).
- The polymeric layer can be used for wetting adjustments of many inks (commercial silver inks, inks containing 40 vol% or more of ethylene glycol, ethanolamine, 1,3-propanediol, diethylene glycol or any other solvent with similar surface tension).
- The polymeric layer readily decomposes at temperatures higher than 350 °C.

Partner Sought
Partners sought are industrial partners in the printed electronics sector.

Partners role would be to conduct testing, provide feedback, scale-up and manufacture the polymer solution and apply the method in their manufacturing process. The development can be done by the partner alone based on a licencing agreement or in cooperation based on a respective technical cooperation agreement.

Research cooperation agreements are sought to develop new wetting control layers-materials for other specific combinations of inks and substrates.

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A novel approach for reaching highly effective antibacterial action using activated gold

Summary
A Slovenian research institute has developed a novel approach for reaching highly effective antibacterial action in a human- and environmentally- friendly way using active gold. The technology can be used for the formation of implants in orthopaedics, dentistry, plastic surgery, for antibacterial protection in first-aid material, in cosmetics for hygiene etc. The institute is looking for partners interested in a licensing agreement or research cooperation agreement.

Keywords
Ceramic materials and powders, Metals and alloys, Nanomaterials, Virus, Virology/antibiotics/bacteriology, Medical biomaterials, Microbiology, Surgical implants, Surgical instrumentation and equipment, Pharmaceuticals/fine chemicals, Food and feed ingredients, Other research and experimental development on natural sciences and engineering

Applications
Products with antibacterial properties (e. g. implants in orthopaedics, dentistry, plastic surgery, first-aid material, paints, cosmetics for hygiene like tooth pastes, mouthwash liquid, soaps and shower gels), filters and food industry

Department
K9 - Advanced Materials Department

Stage of Development
Available for demonstration

IPR
Patents granted

Description
A novel approach in which activated gold particles are used has been invented for formation of material with reduced toxicity and increased antibacterial activity. Gold nanoparticles, which are naturally inert for living organisms and ineffective against bacteria, are combined with ceramics and carefully selected organic biomolecules into composites with very high antibacterial activity. This material has been activated for antibacterial activity in such a manner that it is twice as efficient as compared to silver. At the same time, it possesses very high in vitro biocompatibility which is a significant improvement in comparison

with previously used materials. This invention is concerned with:

1. Material:

The functionalized ceramic/metallic (apatite structured material/gold) composite is formed of apatite plate-like, micrometer-sized particles as a carrier of spherical gold nanoparticles attached to their surface. Such gold nanoparticles are functionalized by natural-sourced amino acids essential for the human organism (glycine, histidine or arginine). The material is active against bacteria and entirely nontoxic to humans.

2. Synthesis procedure:

A sonochemical method has been developed for the synthesis of a functionalized ceramic/metallic composite. The procedure includes the use of ultrasonically dispersed apatite within an aqueous solution of gold-precursor. The reduction of the gold is initiated by amino acids and supported by the radicals formed after the sonication of a low concentration of isopropanol. The developed method is easy, fast, and does not use any toxic substances. Method also shows good possibilities for scale-up.

Advantages
Silver is a metal with natural antibacterial action. It belongs to the group of the most effective antibacterial agents today. This metal has strong action not only against various types of bacteria it is also active against many other pathogens including viruses and fungi. Moreover, because of its non-selective action against pathogens this metal is able to overcome resistivity issue regard all commercially available antibiotics today. Because of the listed properties, majority of the commercially available products with an antibacterial component contain silver for this function. However, the safety of already widely used silver nanoparticles has been questioned by European Union.

The functionalized ceramic/metallic composite based on gold is a novel material, able to overcome the toxicity limitations of the silver. It is also at least twice as effective against bacteria compared to the same composites with a silver component. The listed characteristics make the presented material a very good candidate for the replacement of silver in all products on the market, especially those used for health care and cosmetics.

Partner Sought
The Slovenian research institute is looking for industrial partners - manufacturers of products that need to have antibacterial properties such as implants in

orthopaedics, dentistry, plastic surgery, first-aid material, cosmetics for hygiene (tooth pastes, mouthwash liquid, soaps, shower gels, etc.), paints etc. Important market application of antibacterial products are filters (component of face-masks, respirators or antibacterial layer inside air-conditioners for elimination of bacteria from air in hospitals, laboratories and enclosed public and domestic places, antibacterial filters inside refrigerators, washing machines, vacuum cleaners, etc.). Food industry is also significant area for implementation of green and healthy materials that are able to prevent development of bacteria. These components are applicable for coating of the packaging as well as for chewing gums with antibacterial activity for prevention of caries and other dental and oral infections and as dietary supplement.

The industrial partners are expected to enter licensing agreements with the aim of implementing the antibacterial material into the existing or emerging products. If the industrial partner finds that complementarity between their products and the offered material needs to be improved, the Slovenian research institute is willing to enter into research cooperation agreement as well.

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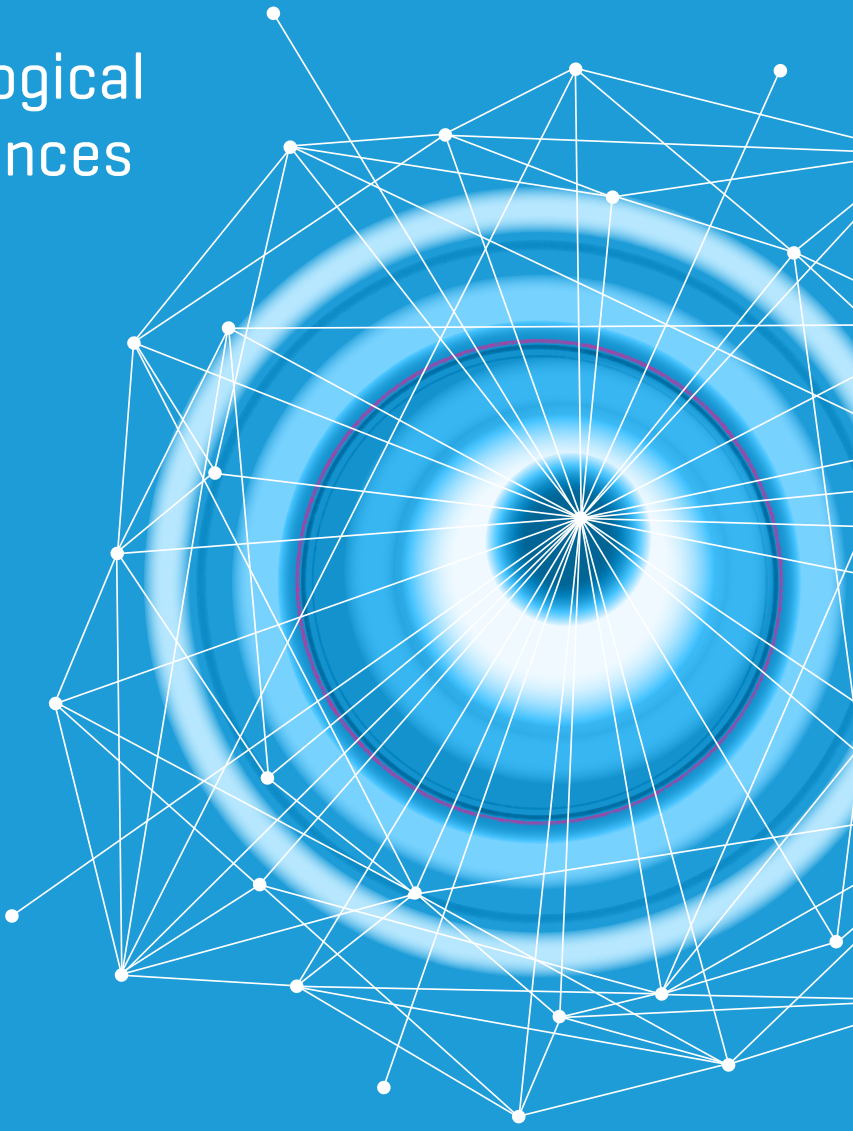
Biological Sciences



Assessing the degree of authenticity of natural flavourings

Summary
A new system for authenticity assessment of natural flavourings. This system is based on the analysis of specific compounds and their stable carbon isotope composition. The measurement data are analysed by machine-learning algorithms to characterise the authenticity of natural vs. artificial flavourings. Partners are sought among the food and aroma industry for technical and research cooperation agreements.

Keywords
Food and feed ingredients, General food products, Data processing, analysis and input services, Artificial intelligence (AI), Information technology/informatics, Knowledge management, Process management

Applications
Food forensics
Production authentication method of marketed products
Prevention of economically motivated adulteration of food products
Detection of counterfeit food

Department
02 - Department of Environmental Sciences

Stage of Development: Available for demonstration

IPR: Secret Know-how

Description
The expanding industrialization of food and aroma products have generated the need to authenticate the production method of marketed products. With increasing pressure to satisfy consumer needs and the high price of natural flavourings compared to synthetic ones, makes naturally flavoured products especially vulnerable to economically motivated adulteration. The relatively new science of food forensics is employing a range of developing isotopic techniques that have allowed detecting adulterated and counterfeit food. The research group has developed a new system for authenticity assessment of natural flavourings. Typically, the artificial aroma is produced by mixing several different compounds originating mostly from oil. In essence, they are chemically

very similar to natural compounds and usually being added to natural products makes them even more difficult to identify. The complexity of the problem has led to the development of a system based on machine-learning. The basis of the system is a database describing different aromas, both authentic and artificial. The data are based on chemical analysis of compounds in a sample obtained by several methods: gas chromatography/mass selective detector (GC-MSD), gas chromatography–combustion–isotope ratio spectrometry (GC-C-IRMS) or elemental analyser/isotope ratio mass spectrometry (EA/IRMS). The data obtained along with the expert knowledge are collected in a database and analysed. The analysis is based on the degree of confidence in the partial characterisation of the authenticity for any given flavour. It is a multi-step procedure, where each next step is driven by the previously obtained estimates.

The multidisciplinary research involves a combination of physical, chemical and biology processes influencing the environment. On the other hand, there is a group of computer and artificial intelligence specialists who contributed to the flavours-characterization system based on data-mining approaches.

Advantages
Aroma classifications are performed by machine learning rather than manually by an expert.

Partner Sought
Seeking for partners in the food and aroma industry for technical cooperation agreement for sample testing and verification and specialized laboratories for testing the food products for research cooperation agreements for expanding the database and expert knowledge in classifying aroma compounds.

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Controlled aggregation of microbial cells

Summary
A method for controlled aggregation of microbial cells. The method is useful in different biotechnology fields such as plant and food biotechnology, fermentation, remediation, biofouling etc. Partners, who use microbial co-cultures in their biotechnological applications, are sought for technical cooperation agreements to validate the technology in an industrial environment.

Keywords
Biological sciences, Microbial cells, Medical/health related, Biological sciences

Applications

1. The novel method enables layering of microbial cells of the same or different type in a way that controls the size, structure and number of aggregates as well as the potential spatial distribution of the different species of cells within the aggregates.
2. Preparation of smart carriers composed of particular cells placed in particular spaces
3. Exchange of growth substrates, secondary metabolites as well as quorum sensing molecules,
4. Increased local scavenging of oxygen, enabling the formation of anaerobic niches within the aggregates.
5. Determination of temporal and spatial activities of multicellular aggregated formations.

Department
02 - Department of Environmental Sciences
The technology is co-owned by JSI.

Stage of Development
Under development / lab tested

IPR
Patent(s) applied for but not yet granted

Description
Use of microbial co-cultures is getting more and more important in many biotechnological processes, such as food biotechnology, plant biotechnology, production of fuels, fermentation, remediation, biofouling etc. It can improve the process or the final biotechnological product.

The problem: The systems of co-culture are hard to optimise due to different growth dynamics of different strains and increased distances between cells when complex substrates are broken down to the level that is acceptable for use by microbes that produce desired substances. For example, scavenging oxygen is currently difficult to monitor within the whole microbial culture. Also, the co-culture process is often separated into two steps, aerobic and anaerobic, and managing the process with currently available techniques is limited in efficiency due to the large distances between the cells.

The solution: we developed a method for controlled aggregation of microbial cells, which enables close contact between cells and more intensive interactions. Moreover, the precise placement of different bacterial cells using a top-down approach enables preparation of smart carriers composed of particular cells placed in particular spaces. The interactions facilitate (i) exchange of growth substrates, secondary metabolites as well as quorum sensing molecules, (ii) increased local scavenging of oxygen, enabling the formation of anaerobic niches within the aggregates, and (iii) determination of temporal and spatial activities of multicellular aggregated formations.

The novel method enables layering of microbial cells of the same or different type in a way that controls the size, structure and number of aggregates as well as the potential spatial distribution of the different species of cells within the aggregates. Microbial cells are coated with charged polyelectrolytes as well as magnetic nanoparticles or any other types of organic or inorganic colloids, which enables building layers of microbial cells in either two- or three-dimensional structures. Laboratory experiments have been successfully conducted on *Escherichia coli, Pseudomonas putida,* and *Pseudomonas stutzeri* as well as on *Lactococcus lactis* and different *Staphylococcus* spp. and *Bacillus* spp. strains, and the cells were separated from the solution.

Advantages

The cellular aggregates formed by this method have the following advantages compared to existing/known co-culture technology:

- microbes can transfer metabolites more efficiently, produce biofilms and develop particular niches based on local physicochemical properties;
- cell aggregation process can be controlled to achieve the desired size and distribution of cells;
- controlled aggregation can improve properties of final product (plant biomass; taste and structure of different food...) and biotechnological process (i.e. remediation)

Partner Sought
The Jožef Stefan Institute would like to validate this technology in a relevant industrial environment and is looking for partners for a technical cooperation agreement. The technology has many applications in different biotechnology fields such as plant and food biotechnology, remediation, biofouling as well as in medical setups including preparation of vaccines and bacteriotherapy in anticancer treatments etc. The role of partner(s) would be to test the developed method on their applications (usage of microbial co-cultures for different bio-technological processes) in technical cooperation agreement.

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An environmentally friendly method for inactivation of viruses in water

Summary
A consortium of Slovenian public research organizations has developed a new method and device for disinfection of water without chemicals. The method has been validated by a laboratory prototype. The researchers are looking for hydroponic plant production farms for technical cooperation and joint venture to further develop commercial water cleaning devices for hydroponic systems.

Keywords
Plasma physics, Mechanical engineering, Virus, Virology/antibiotics/bacteriology, Biocontrol, Food processing, Industrial water treatment, Food and feed ingredients, Water treatment equipment and waste disposal systems, Agriculture, Forestry, Fishing, Animal husbandry & related products

Applications
Hydroponic and aquaponic crops growing, Water disinfection/sterilization

Department
F4 - Department of Surface Engineering
The technology is co-owned by JSI.

Stage of Development: Field tested/evaluated

IPR: Exclusive Rights, Patent applied for but not yet granted, Secret Know-how

Description
A multidisciplinary team of researchers of two Slovenian public research institutes and Slovenian university have invented a method and constructed a device for efficient deactivation of viruses (and other microorganisms) in water. The proposed innovative technology is completely chemical-free and eco-friendly.

The solution combines two environmentally friendly methods, cold gaseous plasma and hydrodynamic cavitation, which efficiently inactivates waterborne viruses. For example, many important human pathogenic viruses can be transmitted by water and cause mild to severe gastrointestinal problems, more serious health complications and even death. On the other hand, plant viruses can destroy entire crops and results in high economic losses for the plant owner.

After intensive market and technology research, the team aims to develop the device for water disinfection in irrigation systems for hydroponic farming. This is an initial application area. However, the technology has a wider potential in other applications such as wastewater treatment and processing of drinking water or disinfecting heavily polluted hospital wastewater.

The team has all the necessary knowledge, infrastructure and resources to build and modify the prototypes, perform laboratory testing and microbial analysis, and monitor the efficiency of the sterilization process. Members of the team have been involved in industrial research and development for over 10 years. The team members developed an industrially implemented technology for plasma treatment of surfaces, obtained the EU patent, constructed the production line, and optimized the production at the large industrial company which has over 50% of the global market share in the segment of composite commutators for car pumps.

The team is willing to establish a spin-out company to develop and commercialize the devices which are able to lower the virus concentration 4-5 log for smaller volumes, i.e., 60 L/h, with a possibility to scale up more devices for bigger volumes in applications for closed irrigation systems and highly-contaminated discharge water from hospitals. Currently, the team does not need any help with development of the device for installing it in a pilot system. Still, the team would require a partner to provide the space and hydroponic facility for installing a pilot system and further extensive testing and development of the water disinfection device under technical cooperation agreement.

The researchers do not have financing resources to finance the partner under technical cooperation agreement. The partner should be able to invest and allocate their resources in the project. Slovenian researchers' consortia will also seek public funds (preferably EU structural and/or regional funds). In case of interest of the partner sought, they are willing to apply with the partner for a project worth 2-3 M€. In addition to the partner with ability to provide the hydroponic facility, the project partners would be academic institutions (experts in plasma science, hydrodynamic cavitation, virology), equipment producers (treatment chambers, pumps, powerful plasma sources, installation devices), and companies specialized in automation, software, remote control, etc.

- Additionally, after installation and testing of a pilot system, a partner's contribution in the detailed assessment of potential markets and applications will be highly appreciated. The partner's ability to actively participate in the final development of variations of commercial product for different applications, and with possibility to invest in the product manufacturing,

measurements and calibration, certification, counselling, product support, customer acquisition and marketing, under the joint venture agreement would be a surplus.

Stage of Development: The researchers have developed and successfully tested a prototype of the device in a laboratory environment. The optimized version of the laboratory prototype enables smooth operation and highly repeatable results. Long-lasting experiments have not been performed yet. The researchers have tested the device on a model virus and have accomplished total virus inactivation. They have used 10- to 1000-times higher virus concentrations that can be found in nature (treatment time varies, of course). As a next step, the team plans to build a pilot system in a partner's hydroponic farm.

Advantages

In recent years, novel waterborne viral inactivation technologies, such as autoclaving, membrane filtration, toxic chemicals, reverse osmosis, ultraviolet light and ozone treatments, gamma rays, and hydrodynamic cavitation, have been developed, each of which has its advantages and limitations. For chlorination, or similar chemical methods, which are used for wide-scale water disinfection, represent a potential environmental hazard. Chlorinated water released to the environment can cause adverse changes to many useful, but chlorine susceptible microbes.

Typical disadvantages of commercially available technologies are cost inefficiency, scalability problems, unsustainable power usage, production of waste and toxic intermediates, and insufficient virus inactivation. For example, chlorine production is a dirty, environmentally harmful process.

The inventive combination of hydrodynamic cavitation and plasma technology enables no production of waste or toxic by-products at minimal running costs. The system comprises only a water pump, a specifically designed

Water sterilization prototype

cavitation chamber where a large cavitation bubble is generated, and a low-power plasma device.

To summarize, the main advantages of the proposed method are:

- no use of chemicals and zero waste production in the process;
- lower energy consumption as opposed to heat-related solutions;
- lower maintenance costs as opposed to solutions with chemicals, filtration, and ozone;
- higher virus inactivation efficiency.

Partner Sought
Hydroponic crop production farms are sought for cooperation under the following agreements.

Technical cooperation agreement:
To cooperate in building a pilot water disinfection system for hydroponic irrigation under test. The partner should be able to provide space, hydroponic facility and a batch of crops to be extensively tested with specific plant viruses. After successful technical cooperation, a partner might get the ownership of the pilot/operating system.

Joint venture agreement:
To commercialize the solution. A specific partner's contribution would be in the detailed market assessments, final development of variations of commercial product. The possibility to invest in manufacturing, measurements and calibration, certification, counselling, product support, customer acquisition and marketing, would be a surplus.

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Single plasmid systems for balanced inducible protein production and gene regulation in lactic acid bacterium *Lactococcus lactis*

Summary
The Jožef Stefan Institute has developed a new series of plasmids for advanced genetic modification of lactic acid bacterium *Lactococcus lactis*. The method is useful in the dairy industry as a cell factory and as a host for recombinant protein expression. Partners are sought in industry and academia in biotechnology for technical and research cooperation agreements.

Keywords
Cellular and molecular biology, Enzyme technology, Synthetic biology, Microbiology, Bioprocesses, Industrial genetic engineering applications, Medical genetic engineering applications, Cellular and molecular biology, Enzymology/protein engineering/fermentation, Drug delivery and other equipment, Research and experimental development on biotechnology, Other research and experimental development on natural sciences and engineering, Tertiary education, Other human health activities

Applications
Simultaneous expression of two or more proteins is beneficial for various applications, including the expression of multi-subunit proteins, the use of *L. lactis* as a mucosal delivery vehicle or as a multistep biocatalyst.

Duplication of the nisin promoter enabled the balanced, inducible expression of two model proteins in *L. lactis*, thus constituting a new tool for recombinant protein expression in this organism. A similar strategy resulted in a single plasmid CRISPR-Cas9 system that can be used, among other possible applications, for plasmid curing or CRISPRi-mediated gene regulation in *L. lactis*. Plasmids will be applied in the future research in *L. lactis* for concomitant expression of therapeutic and reporter proteins, as well as for plasmid curing and gene silencing.

Department
B3 - Department of Biotechnology
The technology is co-owned by JSI.

Stage of Development
Available for demonstration

IPR
Know-how

Description
A Slovenian research organization has developed a new tool for recombinant protein expression and gene regulation in *Lactococcus lactis* - a food-grade lactic acid bacterium that is used in the dairy industry and as a cell factory and as a host for recombinant protein expression. The nisin-controlled inducible expression (NICE) system is frequently applied in *L. lactis*. Its advantages are generally recognized as safe (GRAS) status and absence of endotoxins. *L. lactis* was recently recognized as a probiotic and has been genetically engineered as a vector for the delivery of antigens and therapeutic proteins to the mucosal surfaces.

Tools for recombinant protein expression have been relatively well developed. *L. lactis* is therefore comparable to other well established bacterial expression systems, such as Escherichia coli and Bacillus subtilis.

Advanced techniques for genetic engineering are required to develop *L. lactis* further as a microbial cell factory. Simultaneous expression of two or more proteins is beneficial for various applications, including the expression of multi-subunit proteins, the use of *L. lactis* as a mucosal delivery vehicle or as a multistep biocatalyst.

Here, plasmids for co-expression of two recombinant proteins in *L. lactis* have been developed and their effectiveness assessed by the expression of model proteins. Plasmids were further upgraded and a single plasmid CRISPR-Cas9 system has been developed. Duplication of the nisin promoter enabled the balanced, inducible expression of two model proteins in *L. lactis*, thus constituting a new tool for recombinant protein expression in this organism. A similar strategy resulted in a single plasmid CRISPR-Cas9 system that can be used, among other possible applications, for plasmid curing or CRISPRi-mediated gene regulation in *L. lactis*.

Plasmids will be applied in the future research in *L. lactis* for concomitant expression of therapeutic and reporter proteins, as well as for plasmid curing and gene silencing.

Our research groups expertise is related to probiotic and other lactic acid bacteria and best described by the following three focal points and references:

1. Genetically engineered lactic acid bacteria as vehicles for the delivery of therapeutic molecules to different mucosal surfaces - treatment of inflammatory bowel disease, binding the Shiga toxin, targeting cancer cells and delivering viral antigen for vaccination;
2. Methods that facilitate the study of lactic acid bacteria - assessment of novel anchors for nonGMO surface display, in vivo imaging of lactic acid bacteria in mice, and first CRISPR-based tools for genomic engineering of *Lactococcus lactis*;
3. Advanced delivery systems for probiotics - lactobacilli incorporated in viable nanofibers enabling the formation of dosage form for probiotics.

Advantages
This is a new tool for recombinant protein expression in *L. lactis*. Duplication of the nisin promoter enabled the balanced, inducible expression of two model proteins in *L. lactis*.

Partner Sought
The Jožef Stefan Institute is seeking collaboration with companies and academia related to its expertise in producing proteins for development and research. This represents a broad range of R&D topics. The JSI research team is seeking both technical as well as research cooperations and is also interested to participate in consortia created in the framework of forthcoming FP8 calls.

Partners sought are companies and academia related to the field of biotechnology, more specifically molecular biology, protein production, enzymology and medical imaging.

Partners are sought for:
- Technical cooperation: due to the broad range of the application field of this kind of plasmid systems, partners interested in genome editing, gene regulation, production of next-generation antimicrobials, DNA imaging and other applications are invited for cooperation.
- Research cooperation: future research in *L. lactis* for concomitant expression of therapeutic and reporter proteins, as well as for plasmid curing and gene silencing.

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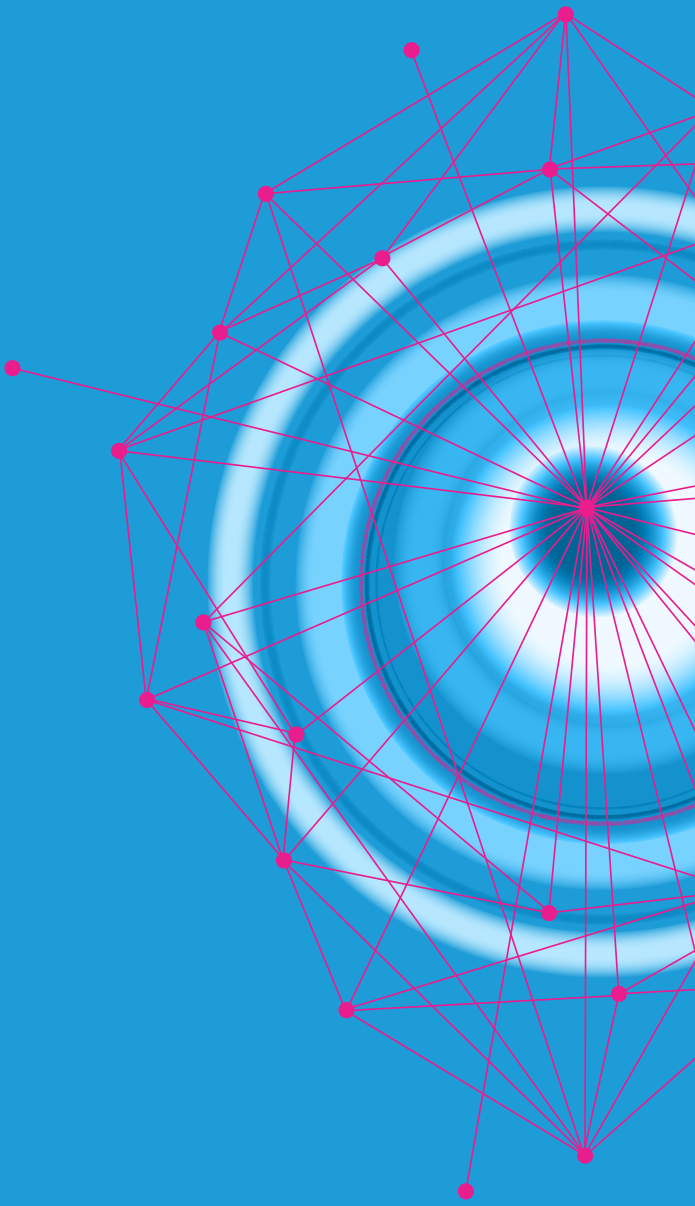
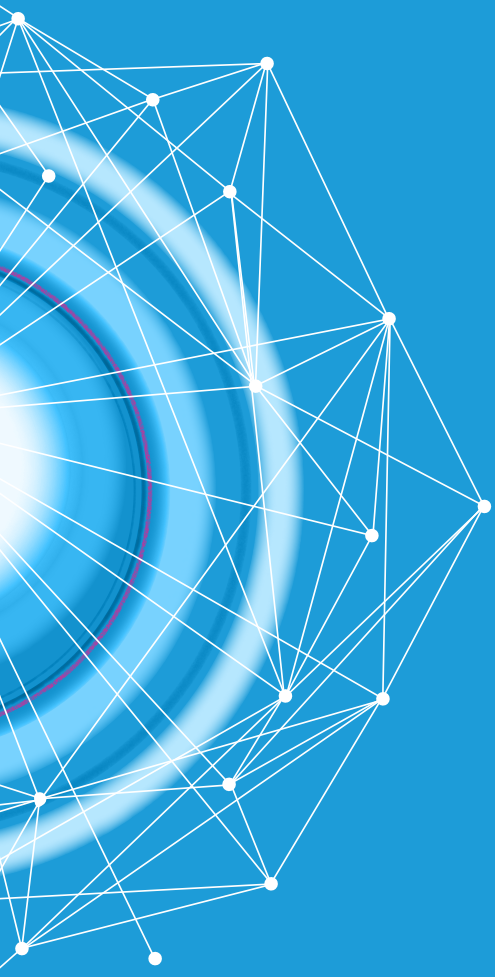


Physical Sciences



System for assessing the state of the spent-fuel facility in a nuclear installation

Summary
The Jožef Stefan Institute has developed a method for assessing the state of spent-fuel facilities at nuclear power plants. The method provides superior accuracy over the state-of-the art techniques that rely on measuring water-level elevation. Critical water levels and the need for evacuation can be more reliably estimated increasing the security of the site and the personnel during an extreme event. Partners are sought for licensing rights to the patent amongst nuclear power plant operators and equipment manufacturers. A partner's role would be to implement the method and algorithms based on technical cooperation agreements for implementation of the method at the partner's site.

Keywords
Nuclear, Nuclear fission, Nuclear power plant, Nuclear power plant systems, Radiation, Spent-fuel facility, Energy

Applications
Assessing the state of spent-fuel facilities

Department
R4 - Department of Reactor Engineering

Stage of Development
Stage of Development: Concept stage

IPR
Patent granted

Description
In the course of the Fukushima accident, there were concerns raised about the safety of the spent fuel. This concern was further justified by the very short grace period available in high-density fuel pools if the active cooling gets interrupted or the integrity of the shell is compromised.

An interruption of the cooling in the course of an extreme event such as an earthquake could lead to unacceptably high and possibly fatal radiation levels in the vicinity of the spent-fuel facility. An identified damage of the spent-fuel facility would require an immediate response from the operating staff, possibly working short of reliable data required to establish an optimal intervention strategy.

Currently, the methods that allow to characterize the rupture and to forecast the development of coolant level elevation in the spent-fuel pool are based on measuring the change of the coolant level. While current approaches allow predicting the cause and development of the extreme event, the prediction techniques achieve only relatively poor accuracy. Other techniques that calculate the time for water to reach its boiling point and evaporation or leak due to a rupture in the spent-fuel pool presuppose a rupture with a known location and size. In an extreme event locating and measuring the size of a rupture or crack may be impossible or at least impractical.

The offered method of assessing the state of the spent fuel facility comprises measuring leakage of coolant and forecasting the development of coolant level elevation. Based on water-level monitoring during a given nuclear event, the rupture is characterized in terms of the mean cross-section and the elevation of the crack, while the water-level elevation is predicted for the period after the initiating events.

Spent-fuel facilities are usually equipped with a collecting dyke located underneath and such collecting dykes already have means to measure the amount of leakage and could readily be equipped with flow meters. Hence, the method can be implemented in conventional facilities without requiring major modifications to the site.

Also, measuring a radiation level alongside the leakage of coolant allows to significantly enhance the reliability of the forecast.

Temperature and the expected or estimated evaporation rate is also considered.

An important advantage of this method is related to the instant calculation of the crack characteristics. In the eventual case of compromised integrity of the shell, cracks are very difficult if not impossible to examine in a due time unless they are obtained indirectly.

The authors have years of experience in operating nuclear reactors. They implemented the method in the form of a computer program and commercially available sensors connected via data links.

Advantages

The method has the following advantages:

- Higher accuracy of the forecasting of future developments of the state of the spent-fuel facility in the case of an extreme event.
- Instant indication of location and size of the rupture or crack in the shell.

Characterization of the event such as coolant spilling over the edge, debris intake in the pool, leakage, water evaporation, are performed automatically.

Partner Sought
The partners are sought among nuclear plants operators to integrate the software and any required measuring devices into their facilities based on:

- Technical cooperation agreements for implementation of the method at the partner's site.
- Licensing agreements: licensing rights to the patent.

Contact:
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Method for determination of radiation hardness of electronics/materials against neutron and gamma irradiation

Summary
The Jožef Stefan Institute has developed a method for determination of radiation hardness of electronics/materials against neutron and gamma irradiation. All electronics are affected by the radiation including housing, screws, gaskets, etc. The method provides qualitative and quantitative assessment of the radiation hardness and the lifetime of the equipment exposed to radiation. Partners from the nuclear and medical sectors are sought for commercial agreements with technical assistance.

Keywords
Radiation, Irradiation, Neutron irradiation, Gamma irradiation, Nuclear power plant, Equipment, Medical equipment, Industrial equipment, Medical/health related, Other industrial technologies, Energy, Physical and exact sciences, Other electronics related

Applications
Measuring X-radiation, gamma radiation, corpuscular radiation, cosmic radiation, neutron radiation

Department
F8 - Reactor Physics Department, RIC - Reactor Infrastructure Centre

Stage of Development
Operational use

IPR
Know-how

Description
The developed technology provides a method to estimate the radiation hardness of the components, maximum allowed irradiation dose, estimating the lifetime of the devices and components and testing of specific materials for protection against irradiation. The method is useful for:

- estimation of the lifetime for devices and components in the harsh operating environment;
- research and testing of the irradiation protection methods;
- radiation hardness testing of the protective components while exposed

against maximal radiation dosage

The researchers have years of experience in operating nuclear reactors. They have the technology and knowledge to perform the testing under harsh environmental conditions inside the working nuclear reactor.

Advantages
The technology can be used before the live operation, during research, development or production of the equipment. Life expectancy can be estimated in advance before installation into a harsh environment.

Partner Sought
Nuclear plant operators and manufacturers of the equipment in nuclear and medical applications, exposed to gamma or neutron radiation for testing their equipment are sought. The foreseen cooperation would be in a form of commercial agreements with technical assistance.

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Rapid fluorescence lifetime measurement system

Summary
The Jožef Stefan Institute has developed a novel method for measuring the fluorescence lifetime instead of or in addition to its intensity. The method enables the fluorescence lifetime of a sample to be determined without lengthy data acquisition and photobleaching of the sample. Partners are sought among optical instrumentation manufacturers for licensing and technical cooperation agreements.

Keywords
Electrical technology related to measurements, Optical technology related to measurements, Sensor technology related to measurements, Laser related chromatographs and related laboratory equipment, Other analytical and scientific instrumentation, Industrial measurement and sensing equipment, Other research and experimental development on natural sciences and engineering

Applications
Measurements of the properties of fluorescent light emitted by various samples are used in a very wide range of applications. Just some examples are imaging of cell structures, tracking of antibodies and DNA sequencing in biology, detection of cancer cells in medicine and quality control in pharmaceutical production.

Department
F9 - Experimental Particle Physics Department, F7 - Department of Complex Matter, F8 - Reactor Physics Department
The technology is co-owned by JSI.

Stage of Development
Available for demonstration

IPR
Patent(s) applied for but not yet granted - The patent application has been filed in Great Britain. Further applications are planned.

Description
Fluorescence is the emission of light by certain substances, for example, fluorophores, such as dyes, or biomolecules, after they have been illuminated with light of specific excitation wavelengths. Measurements of the properties of fluorescent light emitted by various samples are used in a very wide range of applications. Just some examples are imaging of cell structures, tracking of antibodies and DNA sequencing in biology, detection of cancer cells in medicine and quality control in pharmaceutical production.

The fluorescence lifetime is most commonly determined with a time-correlated single-photon counting (TCSPC), a method, where the time between the excitation pulse and the detection of individual fluorescence photons is measured. Intrinsic slowness of the TCSPC method and the induced photobleaching limit the applicability of measuring fluorescence lifetime in many potential fields, like in pharmacy, where high throughput of tested samples is required. Also, the TCSPC method requires complex and expensive instrumental setup.

A silicon photomultiplier, on the other hand, is a very fast photodetector, whose response to a single photon is faster than the fluorescence lifetime. Therefore, the shape of the electronic signal, i.e., the waveform, output by the silicon photomultiplier will follow the exponential decay of the fluorescence light resulting from a single pulse of excitation. If the resulting waveform is sampled with sufficient accuracy, the need for long accumulation of single-photon arrival times and also large excitation light intensities can thus be avoided. Excitation light with low intensities reduces the risk of photobleaching. Silicon photomultiplier photodetectors and waveform sampling chips developed for the needs of high energy physics experiments have become low-cost, off-the-shelf components. Thus, the method allows a cost-effective way to measure the fluorescence lifetime and, at the same time, avoids lengthy data acquisition and photobleaching of the sample.

Our research involves experimental particle physics on large particle accelerators and development of complex detectors.

Advantages
The main advantages of the proposed method over TCSPC:

- Cost-effective compared to common TCSPC technology;
- Long accumulation of single-photon arrival times and also large excitation light intensities of TCSPC are improved
- Excitation light with low intensities reduces the risk of photobleaching.

Partner Sought
The partners are sought among optical instrumentation manufacturers. The Jožef Stefan Institute's researchers are available for:

- Licensing agreement where potential partners will be offered a license to the pending patent application;
- Technical cooperation for the development of a complete instrumentation device for measuring the fluorescence lifetime by this method.

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Physical vapour deposition hard coatings for protection of tools

Summary
The Jožef Stefan Institute has developed several types of hard protective coatings to increase the lifetime of tools in machining. The benefit of deposited coatings is in their improved mechanical properties such as hardness, chemical inertness and adhesion. Partners that wish to prolong the lifetime of cutting and forming tolls are sought for commercial agreements with technical assistance.

Keywords
Industrial manufacture, Materials technology, Energy topics, Physical and exact sciences, Medicine and health, Life sciences, Chemistry & chemical engineering, Renewable energy, Industrial manufacturing, material and transport, Machine tools, Surface treatment (painting, galvano, polishing, CVD, ...), Other research and experimental development on natural sciences and engineering, Industrial equipment and machinery, Machine tools, other metalworking equipment (excl. numeric control)

Applications
The hard protective coating is distinctively application-oriented, as the main goal is to increase the lifetime of tools in cutting (drilling, milling, reaming), processing of plastics, sheet metal forming, etc.

Department
F3 - Department of Thin Films and Surfaces

Stage of Development
Already on the market

IPR
Secret know-how, granted patent or patent application essential - Slovenian patent granted.

Description
The Jožef Stefan Institute has a 30-year tradition in hard coatings for tools and has developed several different coatings to protect cutting and forming tools against wear. The most important materials for hard coatings are transition metal nitrides, but other materials such as diamond-like coatings are also used. The emphasis of coating characterization is in mechanical properties, such as micro- and nanohardness, adhesion and tribological properties. Some of the techniques can also be applied for surfaces of bulk materials.

Using different coating machines, they offer the deposition of various physical vapour deposition (PVD) coatings based on: titanium nitride TiN, chromium nitride CrN, titanium aluminium nitride (TiAlN, AlTiN and TiAlSiN), and amorphous carbon (aCN), as well as others upon request. Maximum tool size is limited to 400 mm x 400 mm.

Optimal combination of properties required for hard coatings can only be achieved by understanding the process of coating growth, analysis of the influence of deposition parameters on coating properties, and analysis of coating wear processes. The coated tools and parts have improved properties regarding surface hardness, thermal stability, friction, etc., extending the lifetime several times.

In addition to deposition of coatings, we also offer advanced analytics of samples related to surfaces and thin films. This may also include failure analysis or consulting for choosing a proper surface engineering treatment.

Deposition of coatings is offered to companies under commercial agreements with technical assistance - the company sends / delivers the tools that need to be coated and the researchers apply the coating. Often the characterisation of the base material is done before the most suitable deposition coating is selected.

Advantages
The main advantages of coated surfaces are:

- High hardness
- Thermal stability
- Chemically inert surface
- Self-lubricating, low friction coating

Partner Sought
Partners are sought for commercial agreements with technical assistance. Companies that use or manufacture machining cutting tools (drills, mills, reamers), and forming tools (stamps, punches, inserts), are sought to prolong the lifetime of such tools. The company sends the tools, researchers, if needed make the analysis of the material and suggest the most suitable coating. After the approval of the company the researchers deposit the coating.

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Technologies of the Jožef Stefan Institute Spin-out companies

Electronics, IT and Telecommunications

Passive Hexapod positioner with innovative preloaded joints for accurate reconfigurable positioning of fixtures or jigs

Summary
A spin-out company of Slovenian research institute is offering a patented technology as a reconfigurable alternative to dedicated jigs and fixtures in automated production lines. The company is looking for automation integrators for technical cooperation under commercial agreement with technical assistance and an investment partner for collaboration under an investment agreement.

Keywords
Automation, Robotics control systems, Reconfigurable tooling

Applications
Process control equipment and flexible systems
Robotics and reconfigurable tooling
Other industrial equipment and machinery

Company
FlexHex, Denmark
The technology is co-owned by JSI.

Stage of Development
Already on the market

IPR
Exclusive Rights, Patent granted

Description
A spin-out company of a Slovenian research institute in the area of robotics and industrial automation is offering an innovative 6-axis hexapod positioner technology as a reconfigurable alternative to dedicated jigs and fixtures in production. The technology has been developed in in collaboration with the leading Slovenian public research technological institute which is further providing its support to the company with its automation and robotics research and development competences and infrastructure. For the commercialization purposes the spin-out company was founded in Denmark.
A 6-axis motion hexapod platform is a well-known Stewart hexapod concept for use in various industrial applications. For example, where motion in 6 degrees of freedom is needed for a freely-suspended body to move, e.g. in robotic assembly,

welding and manufacturing. Such competitive hexapod platforms lack of sufficient accuracy and rigidity of the flexible joints which enable the platform to move in 6 degrees of freedom and to accurately position the robotic arm to the desired position in the automated production process.
The proposed hexapod technology of the spin-out company comprises an innovative solution of flexible joints which enable very accurate positioning by an external positioning device (e.g. robot) of the tool in the fixture or jig in the production process and fewer changes to dedicated fixtures e.g. in the precision welding, automated assembly and other manufacturing application. This is especially important in automation applications such as automotive white body assembly, automotive light assembly, personalised assembly of mechanical elements, etc, which have to be done automatically, fast, accurate and in an affordable way.
The spin-out company is seeking manufacturing systems developers and automation integrators who seek to offer clients an innovative method of improving the flexibility of their production lines.
The partner sought develops and sells automation production lines for manufacturing industries which have ambition to reduce the costs of frequent reconfiguration of their production lines and would like to enable the use of the proposed hexapod technology in their commercial offer of the automated production lines for their customers. The preferential industries are automotive and aerospace industry, and also other industries where assembly processes need personalised features and are a big part of production, like semiconductor, plastic, rubber, metal and railways industries.
The spin-out company is offering the cooperation under commercial agreement with technical assistance. Services included in the offered cooperation are:

- assistance with the transfer of all technical know-how needed for integration of the technology in the specific application of the partner sought;
- assistance with the customization of the hexapods for specific applications - (e.g. different payloads of the platform) can be developed and produced;
- supply of the hexapods;
- the spin-out company will provide the support in the definition of the value of the proposed solution (Return of investment, yearly savings and reduce of work) for the end customers.
- the spin-out company will support the partner in the integration and maintenance activities.

Additionally, the spin-out company would like to establish a relationship with an investment partner. The investor should have an experience with projects in the area of industrial automation.

Advantages

Autonomous hydromechanical system: the hexapod system requires no motors, no cables and no wires. A pressure intensifier, controlled by a single external pneumatic valve effectively releases and activates the hydraulic clamping system around the segment securing an accurate position.

Fixture configuration: several hexapods can be aligned - the number will depend on the fixture configuration. Beside automatic (robotic) reconfiguration, it can also be reconfigured manually.

Easy reconfigurability: the hexapod system ensures flexible transition between batch productions, especially in production lines like automotive industry, while also assuring the ability to keep clamping position in case of power failure or disconnecting the fixture from external power when moving on the production line. The reconfiguration takes between 5-30 seconds, depending on degree of difficulty of the reconfiguration.

Short return on investment (ROI): because the hexapods are passive and use an already-present robot to reconfigure itself, it is significantly more cost-effective then existing solutions, including motorized hexapods available on the market today, motorized fixtures or regular dedicated fixtures / jigs. Replacing even a small number of dedicated fixtures will thus provide a short return on investment for the user.

As opposed to the well-known concepts of the 6-axis motion hexapod platforms, the proposed technology comprises a patented solution of preloaded cardan joints at the crossing over to six mounting points on a bottom plate and on a top plate of hexapod platform. The innovative joints enable very high and adjustable stiffness and thus accurate positioning by an external positioning device (e.g. robot) of the tool in the fixture of jig in the precision welding, automated assembly and other manufacturing application.

The Hexapod positioner

Partner Sought

Type of partner sought:
The company is seeking automation integrator to adopt the technology via commercial agreement with technical

assistance. Additionally, the company would like to find a possible investment partner for a collaboration in the form of a partial transfer of its shares.
Activity of Partner:
The partner sought develops and sells automation production lines for manufacturing industries. In case of establishment an investment agreement the investment partner should have the production capacities, experience and established relationships in the market of industrial automation.

Specific role of partner sought:
Implement the innovative technology with the support of the company to enable flexible automation system with better reconfigurability and more accurate positioning of the jigs and fictures in the reconfigurable robotic cells.

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Scientific instrument for studying transient currents in semiconductors

Summary
A spin-out company of a leading Slovenian scientific research institute has developed a highly specialized instrument for applying transient current technique in research of semiconductors. The company is looking for companies specialized in development and marketing of scientific instruments to jointly develop a new version of mass produced instrument for educational purposes. The company seeks technical agreements, and distributors for cooperation agreements with technical assistance.

Keywords
Semiconductors, Apparatus engineering, Micro- and nanotechnology, Analyses/test facilities and methods, Other analytical and scientific instrumentation

Applications
Studies of fundamental semiconductor material properties, characterization of a wide range of particle detectors, material research and electronics industry.

Company
Particulars Ltd., advanced measuring systems, Slovenia
The technology is owned by JSI.

Stage of Development
The Scanning-TCT measurement system is already in production and is being confirmed as a highly valuable instrument in international scientific community. The compact version of the instrument for mass production for educational purposes and material research studies is in the development stage and is ready for demonstration.

IPR
Copyright, Exclusive Rights, Secret Know-how

Description
One of the major challenges in the field of semiconductor detectors is the adjustment of semiconductor detectors to operate in high radiation fields (particle physics, nuclear, beam therapies) and medical applications. Transient current technique is one of the most versatile techniques allowing the studies of fundamental semiconductor material properties on one side and complex device performance on the other. It is used in characterization of a wide range of

particle detectors, material research and electronics industry.
The technique exploits generation of non-equilibrium carriers in semiconductor by short pulses of laser light (or particle) and follows the response of the device as the carriers drift/diffuse/recombine.

A spin-out team at the Slovenian research institute has developed two different systems, a Compact/Educational Transient Current Technique (TCT) System and a more elaborate and larger system, called Scanning-TCT.

The compact Compact/Educational TCT System is a portable/table system intended for use at educational institutions (basics of semiconductors) and at research institutions for state-of-the-art studies of semiconductor material properties. It is used in elementary particle physics and all other applications where semiconductor changes after exposure to different types of radiation are explored, such as dosimetry, photovoltaic, nuclear medicine and radiology.

On the other hand, the more elaborate and larger system, called Scanning-TCT, uses focusing optics (beam spot of few microns) and a full 3D translation stages to move the laser beam with sub-micron precision across the device for studies of position resolved response.

Both systems encompass fast pulsed laser (full width at half maximum, FWHM ~350ps) of different wavelengths, full readout electronics chain (HV filters, Bias-T, wideband amplifiers), temperature controlled mounting plane (Peltier element), data acquisition and control software and a software package for signal analysis. The Scanning-TCT includes in addition the computer controlled stages and complex focusing optics. There are several add-ons to the system such as multi-electrode readout, beam monitors, beam locators etc. Due to the good results obtained with this system, ease of use and because of the long experience and reputation of the research group in this area, many research institutions have already acquired TCT instruments from the Slovenian company.

In collaboration with leading scientific institutions the company team has detected a market niche of available scientific instruments applying TCT technique in educational purposes. Though the team has developed the prototype of Compact/Educational TCT System, in the next stage they would like to find a partner for joint development of a commercial TCT instrument for educational purposes which could be mass produced and sold internationally.

Advantages
Different innovative measurement procedures are supported in the analysis package of the instrument: such as Edge-TCT (Transient Current Technique

device edge illumination), Top-TCT or Single Event Upsets configuration. The main advantages over custom made systems are: ease of use, standardized mounts, user support; high quality results of the TCT measurements; cost effective and cheaper than currently available solutions. The system contains the following innovative solutions for basic requirements for good TCT measurements:

- fast laser pulses (FWHM~350 ps)
- high bandwidth amplifiers (>3 GHz)
- Bias-T enabling high voltage (2 kV) connection to Device Under Test (DUT)
- focused laser beam and precise positioning of DUT allowing studies of response of the device depending on the place of laser light impact. DUT is mounted on a <1 μm resolution x-y-z moving stages with range of 10 cm.
- Temperature control of DUT is provided by liquid cooled Peltier element.

Partner Sought

The Slovenian company is looking for partners specialized in scientific instrument development with established access to market to jointly develop a new version of commercially available instrument for educational purposes. Also, distributors with access to market of educational instruments with extensive experience about demands in science and engineering education community are sought. The company is offering cooperation under technical agreement and commercial agreements with technical assistance.

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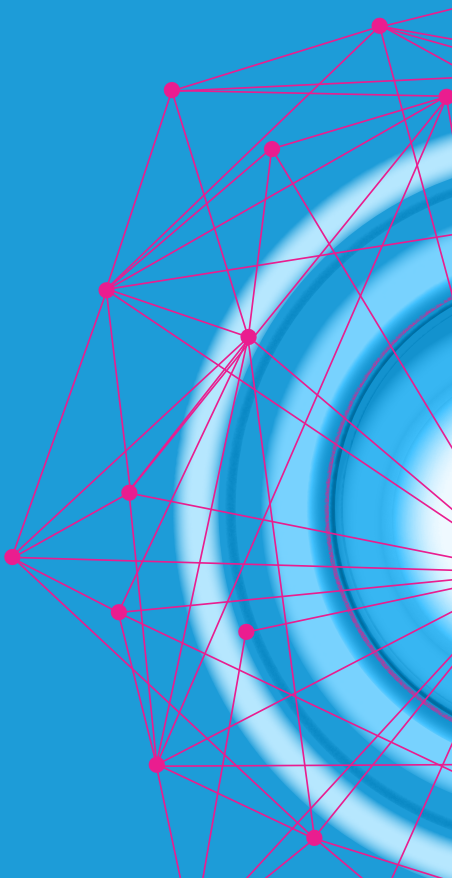
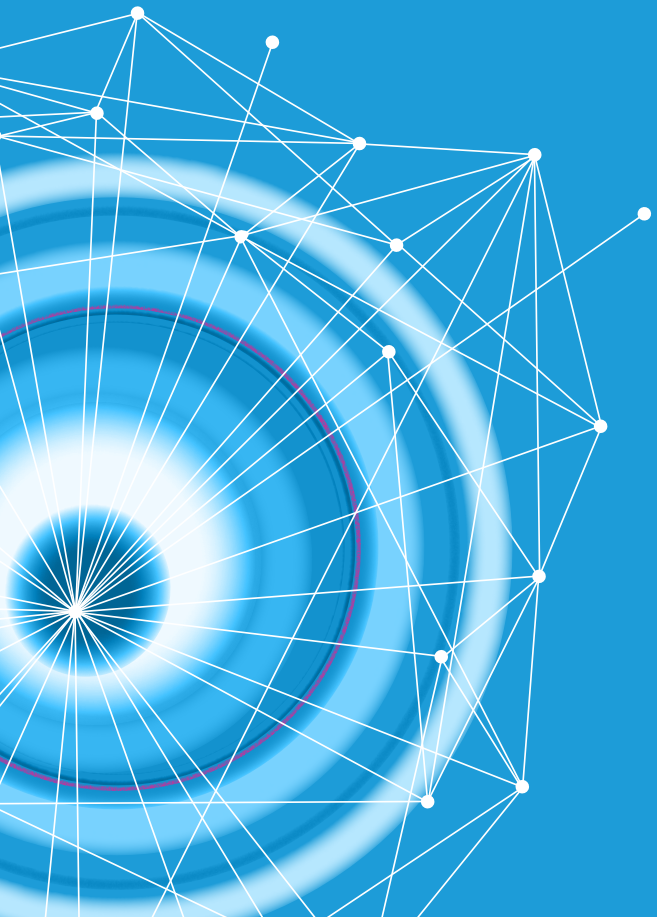


Nanotechnology and New Materials



A Slovenian company is offering calcium silicate-based cement powder-like dental root sealer product under a distribution agreement

Summary
The Slovenian spin-out company is offering a synthetic, bioactive calcium silicate-based cement of high purity, a powder-like dental root sealer used in dentistry for endodontic treatment for a clinically effective dental root canal filling. The company is looking for distributors under a distribution services agreement.

Keywords
Dentistry/odontology, Stomatology, Micro- and nanotechnology related to biological sciences

Applications
Dentistry, endodontic treatment

Company
Genuine Technologies Ltd., razvoj in proizvodnja, Slovenia
The technology is co-owned by JSI.

Stage of Development
Already on the market

IPR
Exclusive Rights

Description
The Slovenian spin-out company is offering a calcium silicate-based cement (CSC), a powder-like dental root sealer used in dentistry for endodontic treatment to permanently fill the root canal system. The root sealer is intended to permanently fill the root canal system in endodontic therapy. It is intended for classical and the most widely spread cold lateral condensation-obturation technique, as an apical plug before the root canal filling with warm gutta-percha in case of the wide apex of non-vital teeth, for the repair of root perforations during root canal therapy or as a consequence of internal resorption, as a pulp capping material.

Endodontic treatment consists of several procedures, starting with making adequate access preparation to reach the pulp chamber and to locate the root

canal orifices, which is followed by chemo-mechanical debridement of root canals. The final step of endodontic treatment is three-dimensional obturation of root canals where the use of offered silicate-based cement as biocompatible root sealer is indicated.

The cement powder consists of fine hydrophilic particles that set in the presence of moisture. Hydration of powder creates a colloidal gel, a paste-like slurry that solidifies and form a strong impermeable seal.

The cement powder, registered as medical device, when in operation, doesn't require any additional accessories since it operates as a standalone product, sealing the apical opening and root end of avital teeth, i.e., serving as obturation agent of the endodontically treated teeth.

The spin-out company brings together scientists of leading Slovenian scientific research institute, experts and young researchers from various complementary fields of science: chemistry, technology, physics, materials science and mineralogy. Their basic and applied research includes ceramic materials, intermetallic alloys and minerals. To answer the drawbacks of existing solutions on the market such as poor handling properties and long setting time, the scientists have developed a non-toxic, biologically-active, and cheaper endodontic repair cement with improved handling properties, shorter setting time, and minimal post-treatment complications such as discolouration.

The CE certificate for medical devices (Class IIa medical device) and the ISO 13485 standard, which defines the quality management system for medical device manufacturing, have been acquired. The company manufactures the material in small scale for customers in Slovenia. First distribution partners are already cooperating with the company and the product is available to Slovenian dental clinics. Company wants to go international.

Advantages
Features:

- Biocompatible permanent calcium silicate-based cement (CSC)
- Increased pH values (antibacterial response)
- Fast setting time
- Bioactive
- Excellent handling due to high flowability
- Excellent radioopacity based on biocompatible radioopacifier

Partner Sought
Partners are sought for distribution of the brand-named product

internationally, to dental professionals/doctors, under a distribution services agreement. Potential partners should already have experiences in the distribution of dental products.

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Real time control of low-pressure plasma processing parameters

Summary
A spin-out company of Slovenian research institute has developed a device for real time control of stability and uniformity of treatment parameters in industrial plasma reactors suitable for surface functionalization, etching and sterilization of different materials. The company is looking for industrial users and manufacturers of plasma reactors for implementation and technical cooperation under licence or technical agreement.

Keywords
Semiconductors, Cleaning (sandblasting, brushing), Surface treatment (painting, galvano, polishing, CVD, ...), Plastics, Polymers, Cleaning technology

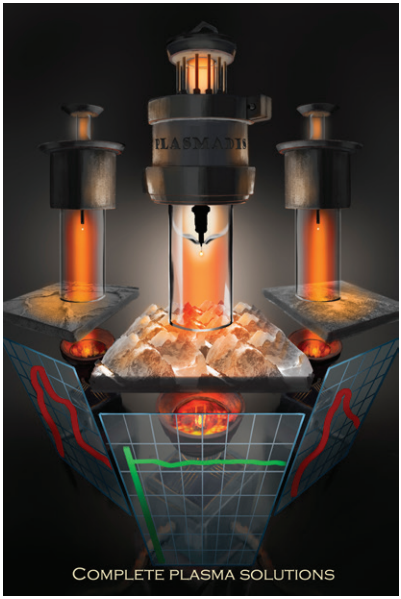
Applications
Surface functionalization, etching and sterilization of different materials

Company
Plasmadis Ltd., Plasma Systems and Diagnostics, Slovenia
The technology is owned by JSI.

Stage of Development
Available for demonstration

IPR
Patent granted

Description
Nowadays numerous industries (electronic, textile, also medicine) use low pressure plasma technologies to achieve desired material modification. Examples include surface finish of polymer and composite components in order to obtain desired surface free energy, nano-structured surface and appropriate surface composition. The key parameter controlling the quality of said surfaces and materials is the density of



radicals, in particularly neutral atoms. The ability for real time measuring of this parameter during the processing enables process optimization which in turn leads to better quality of products. Although widely used in industry, plasma technologies are capricious due to the fact that the plasma parameters often drift without touching the reactor. The drift represents a nightmare in electro and chemical industries where polymer or composite components are treated by plasma in order to obtain the desired surface finish. The drift is a natural consequence of the fact that the surface properties of treated materials as well as plasma-facing surfaces change upon treatment. The changed surface functionalities, the modified surface roughness, the deposits formed on surfaces and the thermal effects all cause the drift in the density of radicals and its non-uniformity in the processing chamber. Such a drift makes the processing unpredictable, so many users over treat the components to be on the safe side. The overtreatment, however, often leads not only to the waste of time but also to the loss of optimal surface finish due to thermal instability of surface functionalities and loss of nanostructured surface on the expense of micro-roughness. A good example is surface functionalization of polymers which is theoretically accomplished in few seconds of plasma treatment but producers prefer minutes of treatment just because of the radical gradients inside the processing chamber. The only technique for compensation of the drift is based on optical absorption spectroscopy but this technique is not suitable for measuring gradients of atoms during the treatment so it has not been introduced to a massive production yet. The Slovenian spin-out company has solved the problem by adjustment of the key plasma parameter (radical density) simultaneously. The plasma reactor is equipped with a probe capable of real time measuring of atom density. Recently such a sensor - Laser Optic Catalytic Sensor (LOCS) - has been developed. Its operation has been demonstrated in a laboratory plasma reactor. The LOCS is capable of detecting even minor changes of the radical density, both time and space resolved. The detection limit of few percent of drifts of atom density during etching of organic materials is achieved and the response time of the LOCS is below a second what makes the innovative sensor applicable for example in microelectronics (for measuring atom density during etching of photoresist what typically lasts few minutes) and in etching of composite commutators (the treatment also lasts few minutes in batch process). The stakeholders of the Slovenian spin-out company are researchers that have many academic experience and references. In the last 10 years, they have submitted approximately 20 patent applications, of which most of them were granted (7 of them were granted through the EU or US patent office).

Advantages

The main advantages of LOCS over other neutral atom measuring techniques (primarily Two-Photon Absorption, Laser-Induced Fluorescence - TALIF) are:

- lower complexity of the device and ease of handling ("plug and measure"); - smaller size (approximately the size of a large handbag); - doesn't require any calibration and works in different plasma reactors with a wide range of plasma parameters; - simple integration of the sensor on the existing plasma reactor - no expert knowledge is required; - lower cost: an estimated market price for LOCS is third of TALIF's price. In the case of functionalization and etching of products made from polymers or polymer composites the reactors are large enough that gradients of radical density are unavoidable. A typical reactor allows a treatment of about 1000 components in a batch so it is advisable to use two or three sensors - one in the centre of the reactor and another close to the walls to monitor the radical's gradients that occur naturally. The benefit of the company using the sensor arises from reduced treatment time which is adjusted automatically according to the loss of radicals upon processing of materials and components with different surface properties. The benefit will be at least € 10 per batch. Current reactors allow for about 30 batches per day, so the benefit is € 300 per day or about € 100.000 per year. The integration is straight forward so this cost is minimal. The investment is thus returned in less than one year.

Partner Sought
Possible partnerships:

1. Manufacturers of plasma reactors for cooperation under licence agreement are sought.
2. Industrial users for implementation and technical cooperation under technical agreement are sought.

Possible applications are in all industrial sectors where plasma reactors are used in production. Partners with a goal to improve the efficiency of their existing plasma reactors are sought.

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Magnetic precipitation of yeast biomass from sparkling wine

Summary
A spin out company from Slovenian research institute has developed MagYeast - a process and a device for a rapid magnetic removal of yeast biomass from sparkling wine. By using magnetic particles that are absorbed by the yeast, the response of biomass to a magnetic field is achieved, and can thus be magnetically separated. The new technology marks a turning point in the production of sparkling wines as it eliminates existing up to several weeks long, rigid and costly yeast removal process. Partners active in the industry of sparkling wine production and wine processing equipment are sought for technical and further R&D cooperation.

Keywords
Mixing (powder, etc.), Separation (sorting, filtering), Biobased materials, Nanomaterials, Micro- and nanotechnology related to energy, Biobased high-performance materials, Drink technology, Food processing, Food technology, Detection and analysis methods, Food microbiology/toxicology/quality control, Micro- and nanotechnology related to agrofood

Applications
Removal of yeast biomass from sparkling wine, Wine and liquors, Speciality/performance chemicals, Electronic chemicals, Other speciality chemicals

Company
InoVine Ltd., Slovenia
The technology is owned by JSI.

Stage of Development
Prototype available for demonstration

IPR
Secret Know-how

Description
High quality sparkling wine is usually produced by a method of secondary fermentation in the bottle. As opposed to other production methods (such as large tank fermentation), this results in the most profound contact of yeast with the wine, which provides aromas of superior quality. Bottle fermentation is followed by a complex process of removing the yeast sediment from the

bottle (the so-called riddling process), which presents the key limiting factor for a more cost efficient and flexible production.

The subject of invention is a process of magnetic separation of yeast biomass from sparkling wine using magnetic particles, which replaces this time consuming and expensive process. The existing process is based on either manual or mechanized riddling of the bottles (the process of rotating and inclining the bottle gradually until all the yeast cells settle into the neck of the bottle), which is demanding and takes up to several weeks to complete. It requires precisely planned processing through the year, high storage capacities and high personnel and energy costs. It also requires the additional step of freezing the settled yeast in the neck to remove the sediment.

MagYeast is a disruptive innovation that enables the removal of yeast from the sparkling wine bottle to be accomplished in a matter of minutes, which is incomparably more efficient and more than 1000 times faster than any of the existing yeast removal methods. The innovation is based on the fact that yeast cells bear negative surface charge and therefore the positively charged magnetic particles are strongly attracted toward them. When they meet, a relatively strong, electrostatic bond between them forms. The yeast cells become magnetically responsive and can be manipulated by external magnetic field and thus magnetically separated from the sparkling wine.

By doing so, MagYeast provides sparkling wine producers with a game-changing solution, that enables a highly flexible and lean production, capable of processing and shipping sparkling wine to the market in the same day.

Advantages

MagYeast is an excellent demonstration of efficient utilisation of magnetic separation methods in bioprocessing applications, which show a great potential to overcome the limitations of the existing industrial processing methods, particularly in food and beverage industries. Although high efforts have been invested in research and development of novel solutions, the knowledge on validation of these approaches on a commercial level is still very limited. As such, MagYeast sets an important scientific and technological milestone, as it enables the first successful utilisation of magnetic separation method in F&B industry at a commercial scale.

MagYeast represents a green technology that uses minimal energy sources for its operation. Compared to existing solutions, it enables processing of the same number of sparkling wine bottles up to 1000-times faster, thereby directly increasing the efficiency of the process both in terms of energy and

space consumption as well as overall environmental footprint. Processing of 200.000 sparkling wine bottles with MagYeast uses only 3,4 MWh compared to 12-14 MWh with current technology, which equals a 4-fold reduction of energy use.

With that said, MagYeast enables the producers to significantly improve their sparkling wine production processes in terms of cutting costs and time of processing as well as providing flexibility and scalability. Considering the continuous growth of global demand for sparkling wine, MagYeast enables the producers to capitalize these emerging market opportunities and improve their overall competitiveness on the global wine market.

MagYeast is also environmentally friendly technology in terms of utilisation of magnetic materials that are completely degradable and do not pose any risks to the environment. It also leads to radical minimisation of current vast use of mechanization equipment in sparkling wine production process, which reduces its environmental footprint over its entire lifetime and beyond.

As about 80% of global sparkling wine production is based in Europe, MagYeast first and foremost strengthens the growth and competitiveness of European wine producers. The European wine sector plays a vital role in the economic, social and environmental sustainability of European rural regions and provides employment to millions. Global competitiveness of European still wine production has been steadily declining over the past 20 years and is about to face serious challenges in terms of employment sustainability in the future. In fact, sparkling wine presents the key strategic market segment for Europe to secure a long-term sustainability of wine sector.

Partner Sought
The company is looking for industrial partners from sparkling wine industry. The specific partners sought are:

- producers of sparkling wines
- manufacturers of processing equipment for sparkling wine production and quality control
- providers of turn-key solutions for wine and beverage processing
- wine technology institutes and research centres

Producers of sparkling wines are sought for setting up a pilot production line with the proposed solution under technical cooperation agreement.

Manufacturers of equipment for sparkling wine production and quality control providers of turn-key solutions for wine and beverage processing are sought to

integrate the solution in the new sparkling wine production facilities.

The exact role of the partners to be discussed after introductory acquaintance.

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Magnetically guidable nanobeads and nanochains for biomedical applications

Summary
A spin out company from Slovenian research institute has developed an innovative technology - superparamagnetic nanoparticle clusters composed of a number of individual maghemite magnetic nanoparticles. Compared to individual superparamagnetic nanoparticle - SPION, the nanoparticle clusters (size 70-150 nm) display much larger magnetic moments needed in applications involving manipulation with magnetic field. The technology can be used for various applications including nanophotonics, nanoelectromechanical systems (NEMS), biosensors and biomedicine. The industrial or academic partners are sought for technical cooperation and for research cooperation agreements.

Keywords
Nanomaterials, Pharmaceutics, Micro- and nanotechnology related to energy, Medical biomaterials, Micro- and nanotechnology related to biological sciences, Drug delivery and other equipment (including kidney dialysis machines), Pharmaceuticals/fine chemicals

Applications
Nanophotonics, nanoelectromechanical systems, biosensors and biomedicine

Company
Nanos Scientificae Ltd., Slovenia
The technology is owned by JSI.

Stage of Development
Already on the market

IPR
Secret Know-how

Description
Each nanocluster is composed of many single 10-nm maghemite (gamma-Fe2O3) magnetic nanoparticles, thus retaining the superparamagnetic behaviour at room temperature. The appropriate surface modifications of formed nanoparticle clusters enable homogeneous dispersion of nanoparticle clusters in aqueous suspensions. The nanoparticle clusters have high saturation magnetization up to 55 emu/g, depending on the silica-shell thickness or the amount of other surface non-magnetic material. On demand modified nanoparticle

clusters can accelerate your research in various important biomedical applications such as delivery systems, bioseparations etc.

Nanochains are anisotropic 1D nanostructures composed of silica nanoparticle clusters. The structure is achieved by magnetic assembly of nanoparticle clusters in a magnetic field followed by fixation of the structure with an additional layer of silica. Nanochains with defined spacing between adjacent clusters can be synthesized using nanoparticle clusters with different silica shell thickness. The nanochains exhibit superparamagnetic properties i.e. magnetic responsiveness, a uniform size, and good colloidal stability. These properties make nanochains suitable for various biomedical applications and magneto-rheology.

The nanoparticle clusters have desirable properties to be used in nanophotonics as building blocks for magnetic tunable colloidal photonic crystals. The nanoparticle clusters form ordered structures along the direction of the external magnetic field with a regular interparticle spacing on the order of hundreds of nanometers resulting in strong diffraction of visible light in suspension. There are many applications such as telecommunications, lasers, sensors, optical switches, color displays etc., where manipulation of photons is required in their photonic components. Very important feature nanoparticle clusters offer is a tunable bandgap which can be controlled by conventional external magnetic field over the broad diffraction range. However, when the nanoparticles are very small, that is below approximately 15 nm for magnetic iron oxide, their magnetic moments spontaneously relax; the nanoparticles become superparamagnetic. The superparamagnetic nanoparticles or nanoparticle clusters show no magnetic remanence. They are therefore non-magnetic when outside an external magnetic field. That is crucial in preparation of the stable suspensions because the superparamagnetic nanoparticles do not magnetically agglomerate. When placed into the magnetic field they behave similarly to ordinary magnetic materials.

The company is looking for industrial partners from different industries (nanophotonics, nanoelectromechanical systems (NEMS), biosensors and biomedicine - magnetic drug delivery systems) for technical cooperation agreement or partners from academia for research cooperation agreements.

Advantages
Compared to individual superparamagnetic nanoparticle - SPION, the nanoparticle clusters (size 70-150 nm) display much larger magnetic moments needed in applications involving manipulation with magnetic field.

The most useful advantage of superparamagnetic nanoparticle clusters over

single superparamagnetic iron oxide nanoparticles (SPIONs) is the strength of magnetic force acting on the nanoparticle clusters in the gradient of the magnetic field, which is crucial for their remote manipulation. The nanoparticle clusters can be collected from the stable suspension using a standard permanent external magnet easily while the single superparamagnetic nanoparticles are difficult to effectively separate from stable suspension or control their movement in blood using moderate magnetic fields.

Partner Sought
The company is looking for industrial partners from different industries (nanophotonics, nanoelectromechanical systems (NEMS), biosensors and biomedicine) for technical cooperation agreement or partners from academia for research cooperation agreements.

Role of partner sought:
1. Industrial partners from different industries (nanophotonics, nanoelectromechanical systems (NEMS), biosensors and biomedicine - magnetic drug delivery systems) are invited to any of above-defined collaboration options.
2. Academic organizations are sought for further technology application development.

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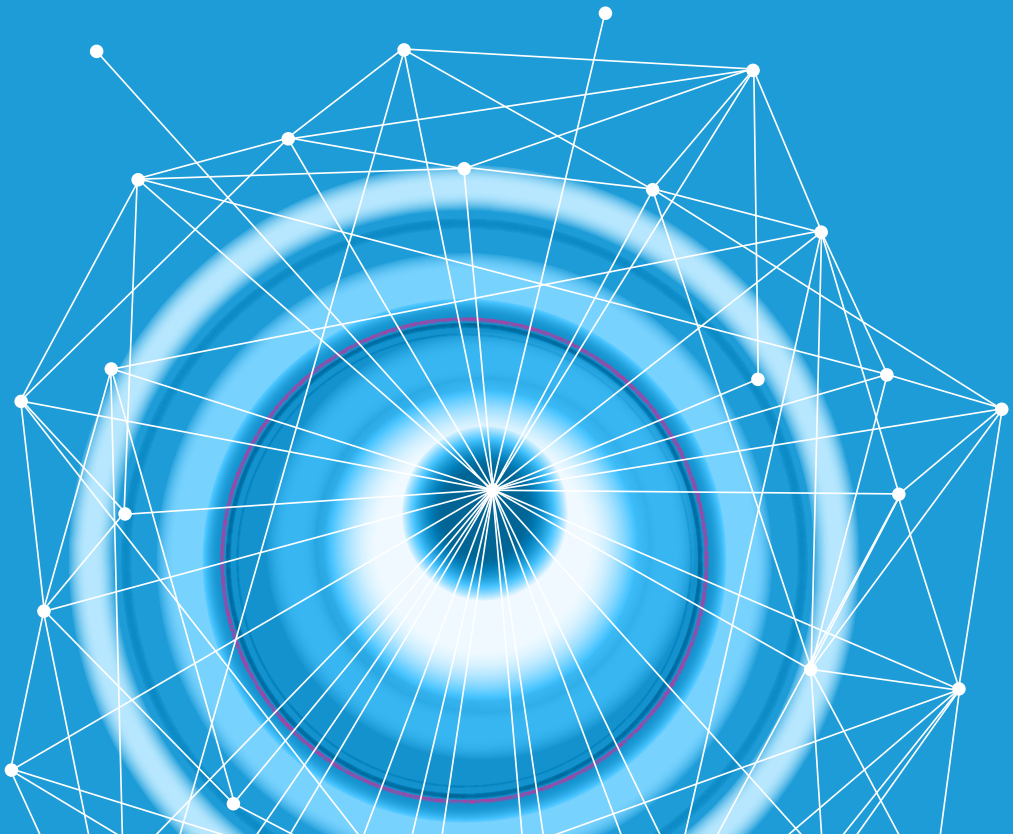
Biological Sciences



Development of superior varieties of wheat

Summary
A spin-out company of a Slovenian research institute is developing conventional and alternative methods for exploiting the genetic potential of heterosis (higher fitness of progeny over the parents) in grasses, particularly common wheat, for the purpose of improved breeding of wheat. Financial partners and/or industrial partners for technical cooperation / joint development or a joint venture, are sought.

Keywords
Agro chemicals, Organic chemistry, Genetic engineering, Crop production, Seed coating

Applications
Modern wheat germplasm formation, development of commercial varieties of wheat

Company
RGA Ltd., Slovenia
The technology is owned by JSI.

Stage of Development
Field tested/evaluated

IPR
Exclusive rights, Secret know how

Description
Regional and global seed markets are saturated by different varieties of wheat whose genetic potential is on the level of the year 2000 or even further back. Global consumption of wheat is increasing, and agricultural areas are shrinking, pushing breeders to improve the yield potential of new wheat varieties. Extant native lines of wheat have weak genetic potential, making it difficult to foresee further improvement. Investigation of hexaploid wheat pre-ancestors for exploitation of heterosis (higher fitness of progeny over the parents) is at an early development stage; nevertheless, it already shows added value in modern wheat breeding. The invention represents an innovative way of modern wheat germplasm formation and exploitation through development of commercial varieties.

The described approach to wheat breeding may be applied to other economically important plants as well.

The founders of the spin-out company are also researchers at the leading Slovenian public research institute and are among the leading scientists in their respective departments with strong international publication records. They are experts in organic chemistry, applied pharmacology, plant genetics, and biotechnology, with the focus on development of environmentally friendly organic synthesis and genetics. Their collaboration with the pharmaceutical industry have resulted in a patent and are already implemented in the production. The spin-off company focuses on research and development activities in genetics, biotechnology and agro chemistry, and is active in the field of commercial breeding of field crops.

Advantages
The approach does not include, produce, or apply genetically modified organisms produced by (expensive) genetic engineering, nor does it apply environmentally harmful agro-chemicals. The technology uses targeted evolution by breeding of ancestors of native hexaploid wheat in order to develop highly productive genetics. Thus obtained wheat varieties offer superiority with high productivity and good adaptability to changing environmental conditions. The cost of described technology is similar to classical breeding procedures and is therefore acceptable for further commercial exploitation.

The described technology represents a method for exploitation of heterosis in the first filial generation, and generations which follow the first filial generation. Heterosis is thus preserved as a uniform genotype.

Partner Sought
The company seeks industrial agricultural biotechnology companies with experience in plant breeding, seed production and / or agricultural chemicals production, for joint development of the technology, such as adaptation to other economically important plants, field testing, and seed production. The company will benefit from partners with capacities of expanding their present activities. Partners for entering joint ventures, and/or financial partners, are likewise sought for the financial support of the company's activities.

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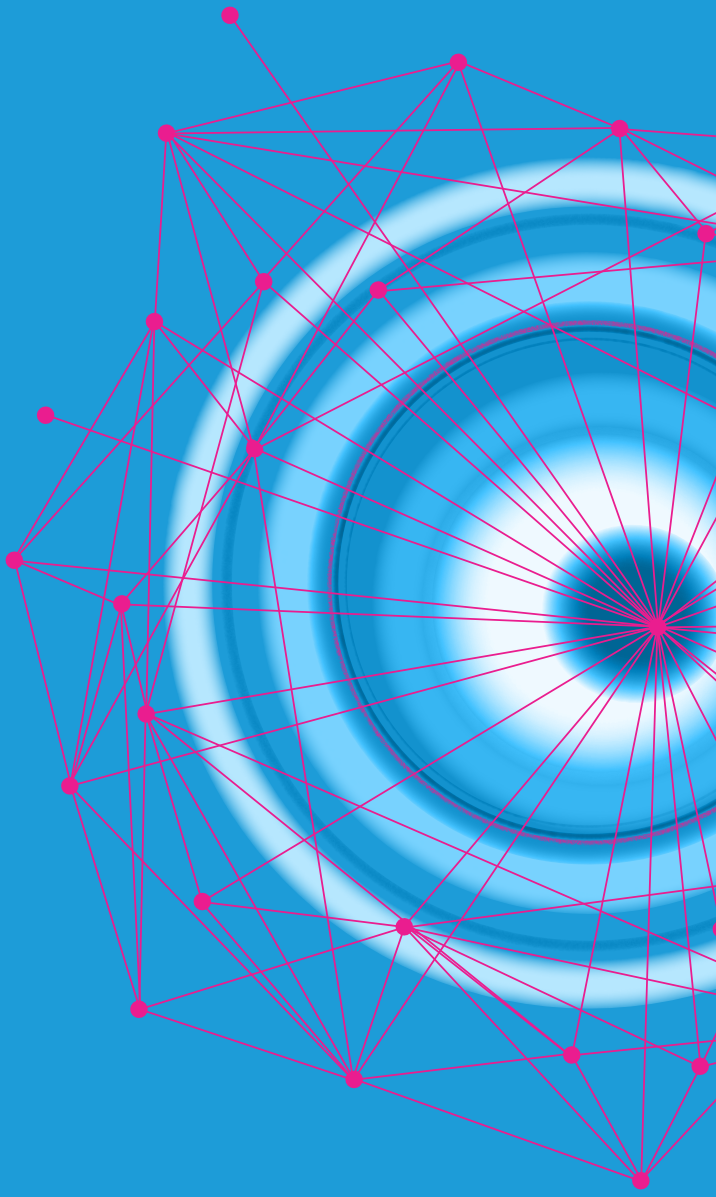

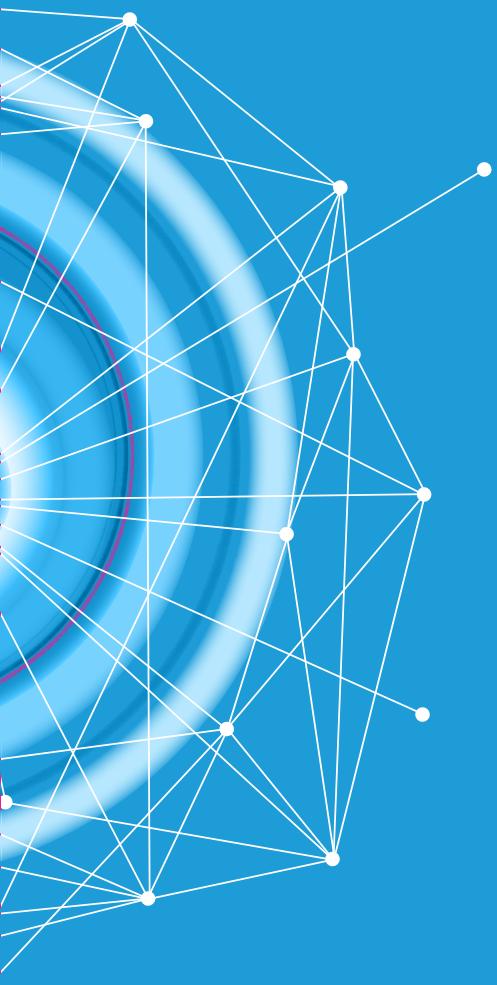

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