

Medical Technologies

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Design Of Alcohol Dehydrogenase 2 (ADH2) Promoter Variants By Promoter Engineering

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Ethanol-Induced Hybrid-Architecture ADH2 Promotor Variants

Engineered ADH2 promoter variants for use in P. pastoris cell-factory design

Advantages

High performance protein production platform: Engineered ADH2 promoter variants relative to the naturally occurring strong ADH2 promoter enable enhanced gene expression and therefore increased production;

Fermentation with ethanol: Engineered ADH2 promoter variants are controlled by non-toxic ethanol instead of toxic methanol in P. pastoris cells;

Modular: Engineered ADH2 promoter variants can be used in the production of therapeutic proteins, profitactic proteins, enzymes, peptides and vaccines;

Providing well-designed bioreactor system control: Engineered ADH2 promoter variants are regulatable (inducible) promoters and provide efficiently controlled fermentation processes through control of bioreactor operating conditions;

Low-cost production: The use of ethanol, an inexpensive and non-toxic carbon source, simplifies the production process and subsequent sanitization, thereby reducing plant set-up and operational costs, as well as increasing production and productivity.

Enhanced recombinant protein production

The most commonly used promoter for recombinant protein production with P. pastoris is the PAOX1 promoter, which is strong and tightly regulated. However, toxic methanol poses risks in the production environment and requires more intensive post-production sanitization and more difficult risk assessment and regulatory documentation steps before the protein can be used in the pharmaceutical and food industries. P. pastoris PADH2 is regulated by the non-toxic carbon source ethanol and has the same productivity as PAOX1. P. pastoris is a popular host for industrial recombinant protein production and this invention provides engineered ADH2 promoter variants that are more potent than the native PADH2 and PAOX1 promoters and can be used in the design of ethanol-regulated enhanced recombinant protein production platforms. The engineered ADH2 promoter variants can be used for the production of industrially important therapeutic proteins, prophylactic proteins, enzymes, peptides and vaccines.

Reinforced AOX1 Promotor Variants for Production with or without Methanol

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Modified AOX1 Promotor Variants

The invention relates to the design of enhanced AOX1 promoter variants that can produce higher yields than bioprocessing systems developed with the natural AOX1 promoter for P. pastoris yeast, which is becoming more and more widely used in industry, and can be controlled with a safe carbon source that has been used for centuries.

Advantages

Higher quantities can be produced from the natural and already powerful AOX1 promoter.

Controllable with safer carbon source instead of toxic methanol.

Can be used for the production of therapeutic and prophylactic proteins and all other proteins of industrial importance The amount and duration of R-protein production can be controlled by determining the induction conditions.

By using a cheap and safe carbon source, high amounts of product can be produced in a short time.

Production of r-protein in high quantity and yield

Promoter genes are one of the most important tools of recombinant protein (r-protein) production processes. With this invention, promoter variants of the most widely used AOX1 promoter of Pichia pastoris yeast in industrial biotechnology applications have been developed that are more potent and can be controlled by methanol-free fermentation media. The enhanced AOX1 promoter variants allow higher yields of r-protein production than the native promoter in methanol or non-methanol (with a safer carbon source) media.

The developed technology enables the production of the desired therapeutic protein or industrial enzyme in a shorter time, in higher quantities and using a carbon source that is safer for human health.
The inventive amplified AOX1 promoter variants can be used in bioprocess development studies for the production of all therapeutic and prophylactic proteins and enzymes of industrial importance.

A System to Obtain Higher Quality and Resolution Images from 2-Dimensional Ultrasound Images

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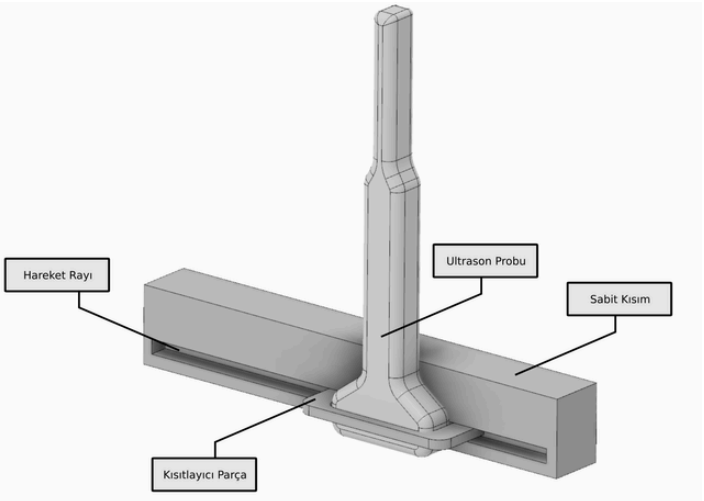
A System to Get High Quality and Resolution Images from 2D Ultrasound

Advantages

Easily Adaptable: It can be adapted to common 2D ultrasound devices used in clinics with the help of a video card or any protocol that supports video.

Fast Application: Application can be extremely accelerated with the use of GPU

Increase in Detail: Good results are obtained according to objective image quality evaluation methods. As the edge sharpness is improved, the speckle pattern is reduced.



Increasing the image quality of 2D Ultrasound, which is one of the most important devices for diagnosis in many fields such as radiology, obstetrics and cardiology

A system that uses Bayesian, multi-image, super-resolution, correlated Gaussian model to produce higher resolution images, reducing the negative effects of speckle pattern in ultrasound images, is presented.

Statistical and model-based image processing methods, which are prominent in the literature, are brought together for medical ultrasonography to increase image quality. The correlated Gaussian speckle pattern model was studied specifically for ultrasound and combined with multiple super-resolution restoration. Optionally, the probe movement can be made more controlled with the help of an apparatus.

MEMS Airborne Ultrasonic Transducer System for Detecting Brain Haemorrhage

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Brain Haemorrhage Detector

This invention focuses on the fast and affordable detection of brain haemorrhage. This detection uses ultrasensitive impeditive ultrasonic detector, which via frequency sweeping collects thermoacoustic generation of ultrasound wave caused by the RF-induced volumetric expansion of blood in the brain.

Advantages

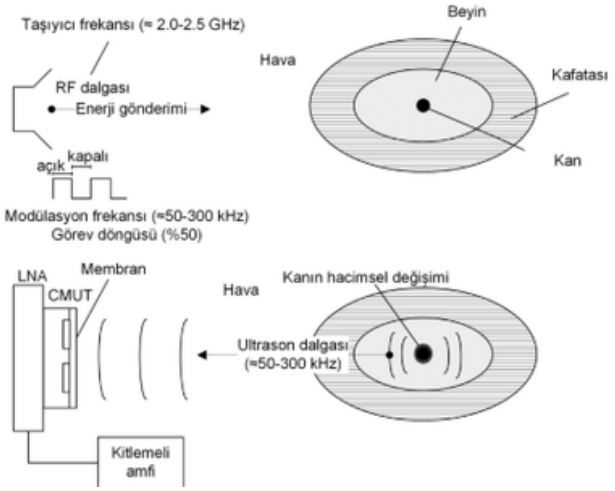
Unique approach: Spectral scanning and collection of signals with ultimate signal-to-noise ratio (SNR)

Sensitive: unique ultrasensitive ultrasound transducer

Fast: whole brain data collection at once enabling detection in minutes

Affordable: basic system having RF-transmitter and ultrasound-receiver based system reducing cost compared to expensive MRI, CT systems

Portable: compact prototyping solution possible



Fast, affordable, portable system for detecting brain haemorrhage

Detection of cerebral haemorrhage within the first 1.5 hours after the onset is paramount for effective recoverable healing and prevention of permanent brain damage. However, detection using magnetic resonance imaging (MRI) or computed tomography (CT) can hardly be completed in this time frame due to high cost and complexity of the equipment limiting their readiness and availability. This invention relates to MEMS airborne ultrasonic transducer system to detect thermoacoustic generation of ultrasound wave caused by the RF-induced volumetric expansion of blood in the brain. The potential of thermoacoustic imaging method is based on 2.5-fold difference of volumetric heat expansion of blood and brain. Ultrasensitive detection of the ultrasound wave is achieved by a novel design of an airborne capacitive micromachined ultrasonic transducer (CMUT) that operates in collapse mode with electrical contact resistance (ECR) featuring capacitive and resistive sensing, hence acting as an impeditive micromachined ultrasonic transducer (IMUT). Unlike volumetric scanning systems for brain tomography, this system with the sole purpose of detection performs spectral scanning of the whole brain at once by sweeping modulation frequency, and collecting specific signals with a lock-in amplifier to determine constructive and destructive patterns caused due to the size of accumulated blood in the brain.

ODTÜ-38

Active Thermal Imaging with Multi-Frequency Current

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Medical Electro-Thermal Imaging

For breast tumour diagnosis, the method increases the temperature contrast of thermal images depending on the frequency of the applied electrical current.

Advantages

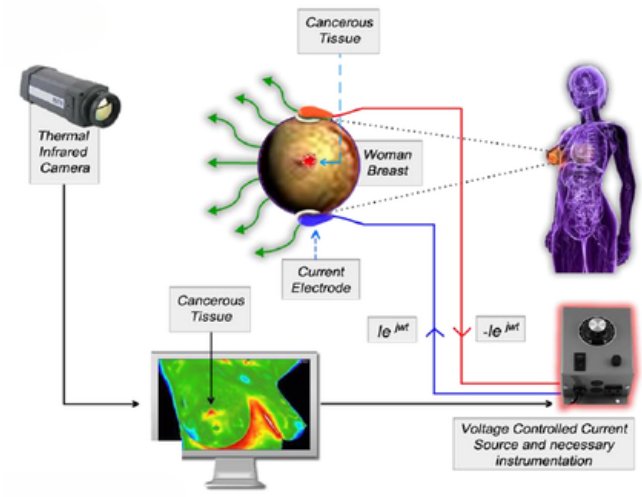
Reliable: Provides high spatial-resolution temperature distribution images with enhanced thermal contrast.

Harmless: Safe for the body, as it involves no ionising radiation.

Painless: Contactless imaging with no breast compression.

Early Diagnosis: Enables diagnosis of millimetre-sized deep tumours.

Suitable for Screening: A low-cost, portable, fast and real-time imaging method.



Electrical conductivity and thermal imaging combined

Mammography devices widely used in breast cancer diagnosis can give false-positive or false-negative results. The breast is compressed during mammography, causing discomfort, and a low dose of ionising radiation is applied.

As there is no gold-standard imaging technique for breast cancer diagnosis, alternative imaging methods are needed.

The invention images the temperature distribution produced in tissue by two different heat sources: external (electrical currents) and internal (metabolic heat generation, blood perfusion).
By using three different physical properties of tissue (electrical, thermal and diffusive), images with higher contrast than passive thermography are obtained.

Powering System for Constant Current Neural Stimulators

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Adaptive Powering System for Longer Operation Periods Between Charges

It is an invention that is aimed to be used in devices that perform constant current neural stimulation. It generates the correct supply voltage for the stimulator, reducing the average power consumption.

Advantages

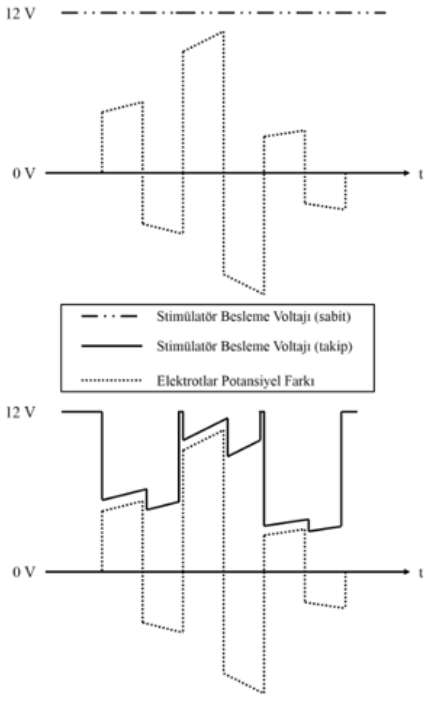
Efficient: Operation aimed to reduce power consumption

Battery: Ability to operate with variable battery voltage

Recharging: Longer periods between charging time

Piezoelectric: Ability to operate with piezo energy harvesters.

External Components: Least number of external components



Powering system that enables longer periods of battery usage.

Constant current neural stimulators stimulate neurons with constant current with the help of electrodes. Said neuron-electrode interface may show high impedance characteristics. For this, the stimulator circuit needs a high supply voltage. However, this is not always the case. If the neuron-electrode interface has a low impedance value or the current flowing through the electrodes is reduced in direct proportion to the amount of charge that must be transferred to the neurons, the supply voltage required for the stimulator will also decrease. In this case, if the stimulator circuit continues to be driven with a high supply voltage, unnecessary power loss will occur.

The invention creates the correct supply voltage for the stimulator by tracking the voltage of the neuron-electrode interface through which a constant current is passed, thus preventing unnecessary power loss. This way, the system aims to increase the low efficiency, which is a problem of constant current stimulators.

ODTÜ-48

Electroactive Chemiluminescence Compounds For Blood Detection In Forensic Science

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Chemiluminescent molecules for latent bloodstain and metal ion detection

Advantages

Useful: High sensitivity toward iron ions, thereby certain and convincing proof of bloodstain traces in crime scene.

Visible: High chemiluminescence quantum yield.

Efficient: Easy synthesis with the smaller number of steps

High performance: The potential for the detection of bloodstain, metal ions as well as trace amount of hydrogen peroxide in biological processes.

Sensitive: Quite high sensitivity.

National, fast, on-site and reliable detection platforms

This invention focuses on the easy synthesis of new chemiluminescent molecules with the potential use for lateral bloodstain detection in forensic, metal ion detection in analytical chemistry and trace hydrogen peroxide detection in biological processes.

This invention defines facile two-step synthesis of new chemiluminescent molecules to overcome the poor solubility and low chemiluminescence efficiency disadvantages of luminol. In the case of responding towards iron ions, the resulting chemiluminescent molecules provide more reliable and certain proof for bloodstain detection in crime scene investigation.



ODTÜ-54

Single PDMS Layered Pumpless Microfluidic System

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Personalized Cellular Treatment Based Microfluidic System for Childhood Infertility

This invention focuses on a new technology offering high quality image in micro sizes with single PDMS layer; and pumpless flow via resistance circuit.

Advantages

High image quality: Ability to be examined under microscope during culture due to single PDMS layer

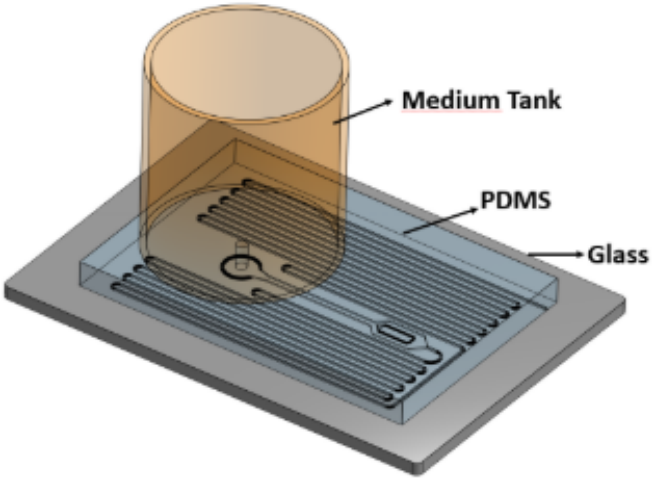
Pumpless Flow: The feature of providing the flow rate in required speed range by resistance circuit

Convenient: Design in which secretory factors of supporting cells can be integrated

Visible: Monitorability of changes in size of testis and condition in organ chamber during in vitro culture

Useful: Small size takes up less space in the incubator

High performance: The potential to expand the spermatogonial stem cell pool within a low volume of testis



Mobile, cheap, reliable, personalized treatment-based organ culture platform

This technology is based on the contribution of the secretory potential of the supporting cells in immature testicular biopsy strips in vitro. This invention aims to maintain and differentiate the sperm precursor stem cells in the testis by providing an appropriate flow rate by resistance circuit, obtaining high quality images during organ culture and ensuring a proper diffusion via 750 µm wide organ chamber.

Microfluidic testicular organ culture systems are in vitro testicular maturation-based platforms which aim to find a solution to permanent infertility in male patients due to gonadotoxic cancer treatments such as childhood chemo-radiotherapy. One important problem in these platforms is that the width of the organ channel prevents the diffusion of the medium to the central regions of the organ. Also, the systems do not have the features of providing high image quality and pump-free fluid flow at the same time during culture. With this invention, the 750 µm wide organ chamber, which is fed through the medium channel on both sides, is defined as a new testicular organ culture platform with the presence of resistance circuit that can provide the required fluid flow rate on a single PDMS layer. This new system can be used for in vitro maturation of the prepubertal testis and induction of spermatogenesis in vitro.

ODTÜ-60

Fiber Loop Ringdown Spectroscopy (FLRDS) Fiber Optic Sensor And Sensor Applications For The Detection Of Sars-cov-2 Viruses From Human Breath

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Sars-cov-2 Fiber Optic Breath Sensor

Detection of SARS-CoV-2 viruses with high precision simultaneously and non-destructive

Advantages

Non-desructive and simultaneous measurement

Real time measurement

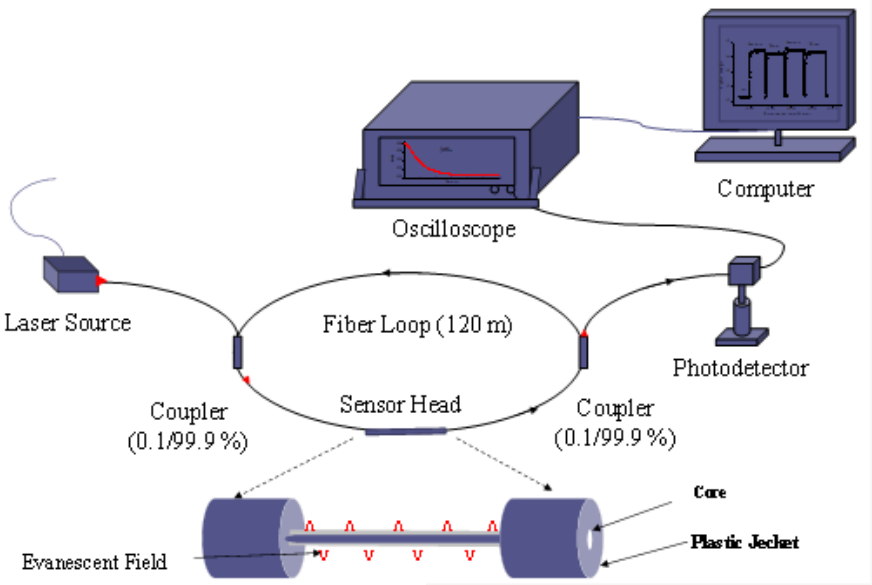
High precision

Immunity to electrical interference

High sensitivity

It will provide detection of SARS-CoV-2 viruses deadly effective all around the World with simultanous and high precision measurement

A piece of fiber from the fiber loop will be etched and high sensitive sensor heads will be fabricated. Followingly, this sensor heads will be coated by using several chemicals. The refractive index around the sensor head will be change due to interactions of coated chemicals with SARS-CoV-2 viruses. This ultra high sensitive technique is based on sensitive measurement of the chenage of evanescent field around the sensor head.



ODTÜ-68

Membranes and Functional Films of Aligned Nanorods via Tangential Flow Deposition

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An easily scalable method of forming anisotropic films of aligned nanorods

Advantages

Tunable and controllable functional properties: Film properties can be controlled using easily adjustable fabrication parameters.

Scalable production: Films via flow deposition can be formed in various geometries and scales.

Material variety: Any nanorod shaped material that can form a stable sol in water or an organic solvent can be used in formation of aligned nanorod films.

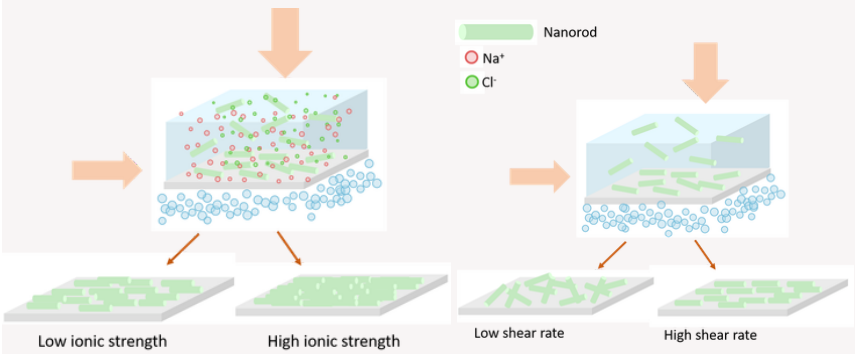
Economical: The fabrication method is low-cost as it merely relies on liquid flow and filtration.

Benign for water and human health: The method allows fabrication using aqueous sols only, thereby avoiding use of potentially harmful or toxic organic solvents and high energy consumption.

Fabrication of funcitonal films or layers with a controllable, designable and scalable technique

Nanorod shaped materials (e.g. cellulose nanocrystals, metal hydroxide nanotubes, etc.) in suspension can show alignment in shear direction under flow.
Factors such as flowrate, nanorod concentration, surface charge and ionic strength can be used to control the extent of alignment and the distance between the nanorods.

Nanorods are filtered through a porous support under tangential flow and aligned in the flow direction, and later can be physically or chemically stabilized. In this manner, supported of free-standing anisotropic films can be formed and their mass transfer, optical, magnetic, electrical properties can be adjusted through the extent of alignment.



ODTÜ-72

Induced Current Magnetic Resonance Electrical Impedance Tomography (ICMREIT) Pulse Sequence Based on Bipolar Gradient Pulses

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Induced Current Impedance Tomography

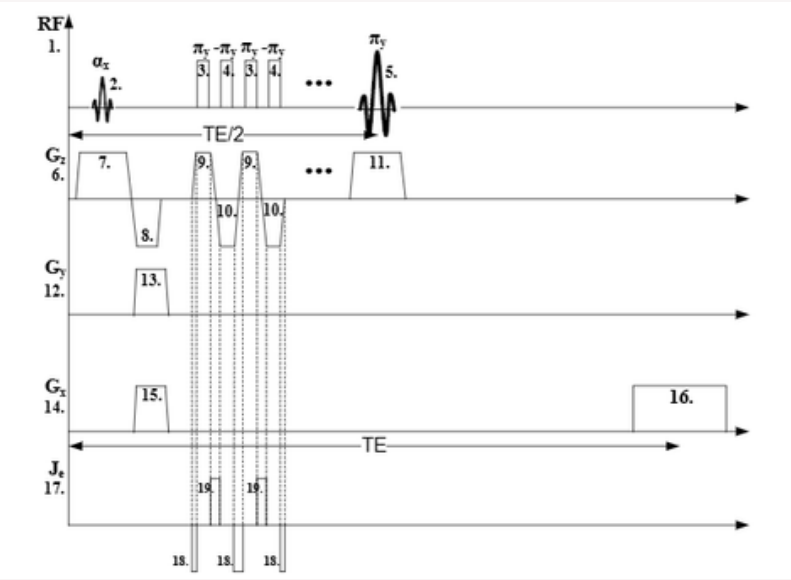
ICMREIT is realized by using the readily available gradient coils of magnetic resonance imaging (MRI) scanners without the need of additional equipment.

Advantages

- Realization of ICMREIT with gradient coils of MRI scanners.
- Realization of ICMREIT without the need of additional equipment.
- Contactless induction of eddy current in the body.
- Overcoming application diffculties of classical MREIT due to electrodes.
- A remedy for imaging tissues with high impedance.

Realization of ICMREIT with MRI gradient coils

Gradient coils are excited with time varying electrical current which induces eddy current in the object to be imaged. The secondary magnetic field created by the eddy current accumulates phase in MR images. Using the secondary magnetic field measurements, current density and conductivity images could be reconstructed.



A Nano/Micropatterned Cellular Nucleus Deformation Based Cancer Diagnostic System

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Micropattern Induced Nuclear Deformation for Diagnosis (MINDD)

This diagnosis system is based on a simple physical surface design which is able to discriminate healthy and cancerous cells without use of any chemicals or expensive equipment.

Advantages

Easy: The application is easy and needs no expertise to operate.

Accessible: The target consumer group is small, hospitals and primary care physicians.

Fast: Takes 4-24 hours to get the result.

Mobility: Has the potential to be converted into mobile form coupled with an intelligent phone.

Affordable: Plastic chip and polymer substrate allows low cost production of the detection chips.

Mobile, simple, fast, on-site, and cheap cancer diagnosis platform

The invention is about a cellular diagnostic system which is composed of micro/nano patterned surfaces that can be integrated into a microfluidics device which reveals the nuclear shape deformability of the cells; which can be imaged with the help of an optical system and can be quantified with a software algorithm.

In this system, nano/micropatterned polymer surface leads to nuclear deformation of cells due to the following factors and it enables a non-expert to discriminate cancerous and healthy cells using an algorithm developed.

Smart Active Counter and Online Monitoring System

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IVMERAD

Ability to display the measurement of the device that measures ionizing radiation in an online traceable system

Advantages

Personal dosimeter, handheld detector, patient follow-up detector for discharge process control, etc. combining the features of devices in a single device.

Easy data tracking with database and mobile application support.

With its portable and light structure, it does not interfere with the freedom of movement of the actively working personnel (Nurse, radiology specialist, etc.).

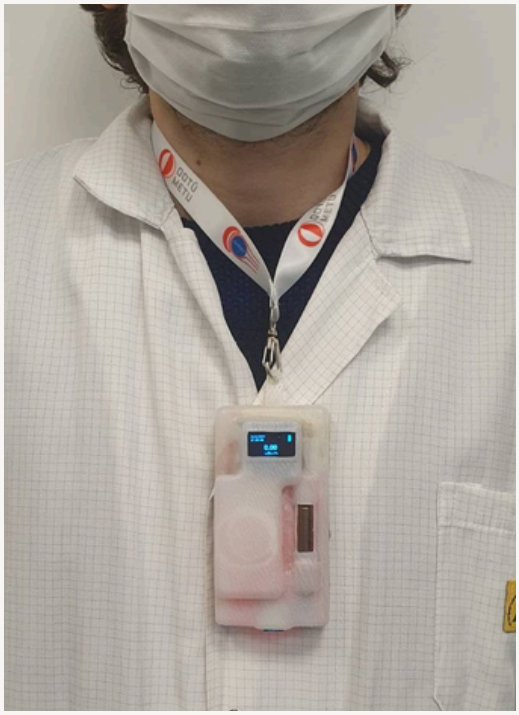
Fast adaptation for both corporate and individual use without the need for infrastructure installation.

Up-to-date and low cost thanks to the selection of widely used electronic parts and Technologies with a proven history.

Carried the internet of things technology to the field of radiation safety.

The most critical technical feature behind the invention is that it carried the internet of things technology to the field of radiation safety.

The radiation meter, which has the ability to use flexibly with an affordable cost, can share the radiation measurement with both individuals and institutions without the need for a new infrastructure setup.



ODTÜ-128

Colorectal Cancer Tumor Segmentation and Grading

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SEG-Grade-Cancer

The invention is the first system capable of automatic tumor segmentation and grading in colorectal cancer histopathology.

Advantages

Detecting and locating tumors at the pixel level

Estimating the grade of the detected tumors

Tumor segmentation and grading system in colorectal cancer histopathology

The input of the method is a whole slide image acquired with a digital scanner, and the output is a pixel-level segmentation of the tumor regions detected on the image and their grades (grade 1, 2 and 3).

Once the digital image of the biopsy sample is acquired, it is scaled and segmented to make it processable. Each segment is fed into a deep artificial neural network (DPN) model. The DPN model detects tumors and their grades at the pixel level on the input image. The results obtained from each segment are combined to produce a segmentation and grading result for the whole image.

The Design of Hybrid-Architectured Promoter Variants Through The Integration of Activation Elements in Coordination with the HAP1 And HAP2/3/4/5 Transcription Factors to Alcohol Dehydrogenase 2 (ADH2) Promoter Variant

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The Design Of Alcohol Dehydrogenase 2 (ADH2) Promoter Variants

Providing a basis for glycerol or ethanol inducible safe-clean-green r-protein production processes

Advantages

- Sustainability
- Low toxicity
- High efficiency
- Regulatable
- Low cost

Development of highly efficient recombinant protein production under strong promoters

The distinct integration of the DNA sequences of the first and second upstream activation elements of S. cerevisiae CYC1 promoter that are in coordination with the HAP1 and HAP2/3/4/5 transcription factors, respectively, to P. pastoris ADH2 promoter variant



ODTÜ-155

Unipolar Slice-Selective Gradient Pulse-Based ICMREIT Pulse Sequence

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Induced MR Impedance Tomography

The invention enables ICMREIT to be performed in an optimised way using selective 180-degree radiofrequency pulses and a slice-selective unipolar gradient waveform.

Advantages

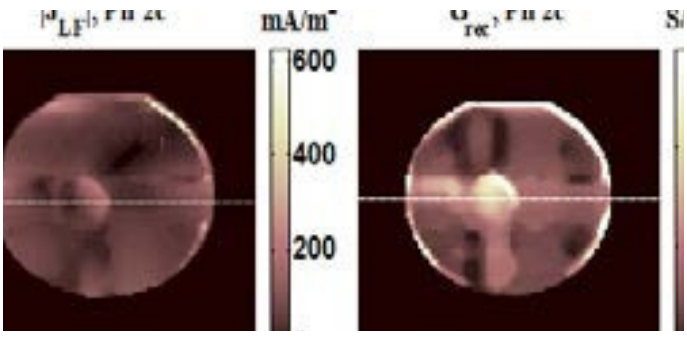
Slice-selective excitation: ICMREIT is performed via slice-selective gradient coils.

Targeted signal: Only spins in the excited slice are used.

Optimised excitation: Unipolar excitation provides optimised imaging.

Low artefacts: Artefacts caused by RF and gradient pulses are reduced.

No extra hardware: Applied without adding hardware to MR scanners.



ICMREIT optimised with a slice-selective gradient

With the developed technology, the slice-selective gradient is excited with a unipolar current, inducing eddy currents in the imaged object. Using 180° RF pulses applied in sync with the gradient current, the phase related to the eddy current is accumulated in the MR images. Current density and conductivity images are then reconstructed from the MR phase images. The method uses hardware already present in MR scanners, with no additional hardware required.

Position Detection in Surgical Branches with Fiber Bragg Grating-Based Optical Sensors

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3D Optical Surgical Navigation

The exact coordinates of the target region are determined in real time with Fiber Bragg Grating-based optical sensors and overlaid on CT/MRI images for monitoring in 2D or 3D.

Advantages

Safety: Greatly reduces C-arm fluoroscopy shots and thus the radiation exposure of patients and staff.

Speed: Continuous real-time feedback shortens operation time.

High success: Instrument coordinates are known even in tissue or bone areas invisible to the eye.

Uninterrupted tracking: Position tracking is unaffected by changes in tissue or body position.

Visual flexibility: Data can be presented in 2D/3D on a monitor or special glasses.

Real-time navigation with continuous feedback to the surgeon

Fiber Bragg Grating-based optical fibers, whose reflectivity changes with strain, are integrated into surgical instruments to obtain the position and orientation of the instrument in space. This real-time data is registered with the patient's CT, MRI or other imaging data using a dedicated algorithm. The registered data is transferred in real time to a monitor or 3D glasses via a computer interface, giving the surgeon continuous feedback and immediate guidance to the target point and direction of advance during surgery and biopsies.

Amperometric Determination of Lactate Dehydrogenase with an Electrochemical Sensor

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LDH-Sense – Rapid LDH Sensor

An electrochemical sensor enabling rapid and sensitive amperometric determination of lactate dehydrogenase (LDH) using a gold electrode modified with the conductive polymer PANI-b-PAA.

Advantages

Rapid detection: Amperometric determination of LDH significantly shortens analysis time.

High sensitivity: The PANI-b-PAA-modified gold electrode enhances the NADH signal for reliable detection.

Point-of-care analysis: Measurements can be made at the bedside, reducing the need for central laboratories.

Low cost: Economical, user-friendly measurement without expensive spectrophotometric analysers.

Clinical applicability: Usable for diagnosis, progression monitoring and evaluating treatment response.

Point-of-care LDH measurement without expensive devices

The sensor has a three-electrode structure consisting of a gold working electrode, a silver reference electrode and a counter electrode. The working electrode surface is modified with the conductive polymer PANI-b-PAA, synthesised by RAFT polymerisation, to increase electrochemical activity and signal sensitivity. NAD, lactate and LDH solutions are applied to the modified electrode, and the NADH oxidation signal is monitored at constant potential. The amperometric response allows the LDH concentration in the sample to be quantified. The sensor is suited to clinical diagnosis, disease monitoring and cancer biomarker detection.

Self-Powered Cochlear Implant

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Next-Generation Cochlear Implants

A cochlear implant that can be fully embedded in the skull and generates its own energy; inspired by the ear's natural working principle, it reduces battery dependence and aesthetic concerns.

Advantages

Low cost: An economical solution based on inexpensive MEMS technology.

Fully implantable: No external device; all components can be embedded in the skull.

Energy harvesting: The system generates its own energy from acoustic vibrations.

Sound quality: Mimics the ear's natural working principle for better hearing.

Simple structure: More compact, as no processor or microphone is needed.

A cochlear implant that generates its own energy

Today, hearing is restored for people with hearing loss using cochlear implants, which consist of an external sound processor worn behind the ear, an implant placed in the skull and electrodes stimulating the nerves in the cochlea. Daily battery changes interrupt continuous hearing, and the external unit causes aesthetic discomfort. The invention converts eardrum vibrations at different frequencies into electrical signals that stimulate the relevant nerves, eliminating the need for a separate sound processor and implant unit. The required energy is harvested from the kinetic energy of the vibrations, so no battery is needed; and because the system sits entirely inside the body, aesthetic concerns are removed.

Encapsulation of Genetic Molecules in a Mesoporous Silica/PEG Hybrid Structure

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Nucleic Acid Carrier Nanoparticles

Developed for the treatment of cancer and genetic diseases, the hybrid vector structure and single-step production process enable efficient use of mesoporous silica vectors in RNAi.

Advantages

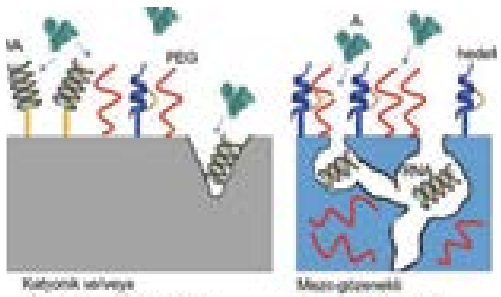
Simple production: Simplifies RNAi vector production: controlled, efficient production with less material in a short time.

Targeting: Surface active groups are used only for targeting and required functionalisation.

High stability: Homogeneous PEG and PEI distribution improves resistance in blood and cell-membrane passage.

Controlled loading: Pore volume and nucleic acid amount are tunable; drug molecules can be co-delivered.

pH-controlled release: Nucleic acid release is controlled by pH change without complicating the material.



Hybrid silica/PEG vector produced in a single step for RNAi

The invention is a carrier nanoparticle system in which genetic molecules (nucleic acids) are encapsulated in a hybrid structure of mesoporous silica and polyethylene glycol (PEG). Because PEG and PEI are distributed homogeneously throughout the structure, the vector's resistance to degradation in the bloodstream increases and passage through the cell membrane becomes easier. The single-step process simplifies RNAi vector production. Pore volume and the amount of loaded nucleic acid can be controlled, drug molecules can be co-delivered with nucleic acids, and release is controlled by pH change.

Photosensitizers Absorbing in the Near-Infrared (NIR)/Red Region

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Targeted Photodynamic Therapy Agents

Next-generation photodynamic therapy agents that absorb in the near-infrared (>700 nm) and are decorated with groups targeting specific cancer types.

Advantages

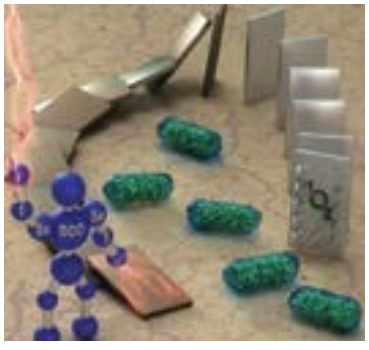
Targeted: Agents functionalised with targeting groups can be activated in specific cancer types.

Deep tissue penetration: NIR absorption allows the agents to reach deep tissues.

High efficiency: High singlet oxygen generation efficiency.

Minimal side effects: Non-toxic in the dark, so effects on healthy tissue are minimal.

Biocompatibility: Water-soluble and photostable.



Non-toxic, water-soluble and photostable PDT agents

Photodynamic therapy (PDT) is used to treat various cancers thanks to its minimally invasive nature and far fewer side effects than current treatments. However, its clinical use is limited by the poor tissue penetration of the light that triggers singlet oxygen generation and by a lack of selectivity for cancer cells. The invention provides photosensitizers that absorb in the near-infrared, offer high singlet oxygen generation efficiency and are decorated with groups targeting specific cancer types. Near-infrared light enables deeper tissue penetration, as it causes no autofluorescence and minimal interference from biomolecules.

Biodegradable and Bioactive Implant for Craniofacial Bone Defects

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Resorbable Craniofacial Implant

A porous implant produced by rapid prototyping or lyophilisation that gradually dissolves in the body and is replaced by new tissue, eliminating the need for a second surgery.

Advantages

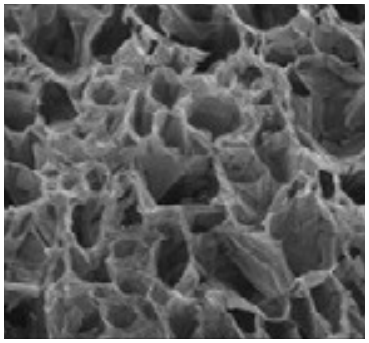
Biodegradable: Gradually dissolves in the body and is replaced by new tissue.

Porous structure: Porous architecture supports tissue ingrowth.

Antibiotic-loaded: Loaded antibiotics reduce the risk of infection.

Growth factor: Accelerates tissue integration and healing.

No revision surgery: Eliminates the need for a second operation.



An implant that accelerates tissue healing with growth factors

The invention relates to a porous implant, produced by rapid prototyping or lyophilisation, that closes craniofacial defects, fractures and cracks and gradually dissolves in the body as new tissue forms. It offers an alternative to metallic, non-resorbable implants and can be produced by two different methods. Antibiotics loaded into the structure prevent infection, while growth factors improve integration with the tissue. As no revision surgery is needed, the risks, trauma, pain and cost of a further operation are avoided.

Reducing Electrical Crosstalk in CMUT Arrays

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Diamond-Shielded CMUT

A capacitive micromachined ultrasonic transducer (CMUT) that reduces electrical crosstalk with an individually addressable Faraday cage for each array element and a self-discharging diamond lightning rod.

Advantages

Crosstalk suppression: Up to 6.7 dB lower crosstalk in transmit mode.

Receiver performance: Up to 51% lower parasitic capacitance for higher SNR.

Dielectric protection: The diamond lightning rod discharges accumulated charge for reliable operation.

Mechanical strength: A diamond (BNCD) membrane offers a more responsive, robust structure.

Manufacturing yield: XeF2 dry etching suits industrial mass production.

Faraday cage grounded in transmit, floating in receive

The invention dynamically switches the state of the Faraday cage of each CMUT array element: the cage is grounded in transmit mode and floating in receive mode. This suppresses crosstalk while preserving receiver sensitivity. Hazardous charge that builds up in floating mode is safely discharged by a diamond lightning rod with high field-emission efficiency. XeF2 dry etching prevents membrane stiction without damaging diamond/oxide materials.

Microparticles Capturing Bacterial Cells with High Capacity

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Bacteria-Capturing Microparticles

Functional microparticles with the highest known bacterial capture capacity that selectively separate bacterial cells from blood and other biological fluids.

Advantages

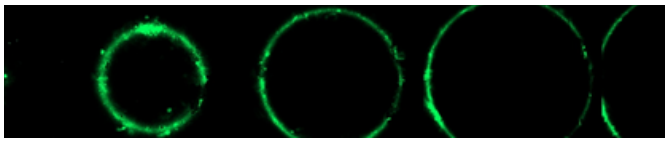
Universal capture: Selectively captures many different bacterial species.

High capacity: Among the highest bacterial capture capacities of any material.

Selectivity: Selectively separates bacteria from complex matrices such as blood.

Easy access: Scalable production from inexpensive microspheres via simple chemistry.

Low cost: The materials used are relatively low cost.



A material that facilitates the diagnosis and treatment of bacteremia

The invention is based on coating the surfaces of micron-scale, non-porous microspheres with synthetic affinity ligands for bacterial cells using simple chemical methods. The microsphere size enables selective separation of bacteria from complex matrices such as blood. A capture capacity of 10^9 CFU/g is achieved for 200 µm microspheres. The invention can separate bacteria from blood and other aqueous fluids where bacterial contamination is a concern, for both diagnostic and therapeutic purposes.

Multilayer Acoustofluidic System and Manufacturing Method

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Stackphore Acoustophoresis Chip

Multiple microchannel layers connected in series and/or parallel, produced monolithically in a single print together with actuator slots and drain channels, without adhesives.

Advantages

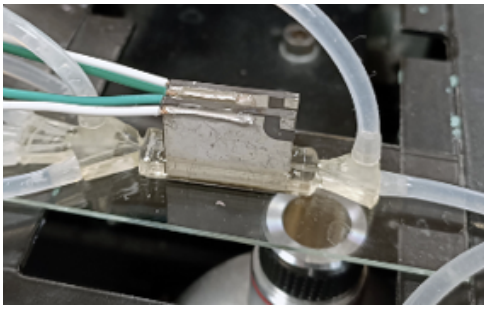
Short production time: Single-print production with no bonding or assembly.

Low cost: No modular parts, adhesives or extra processing.

Repeatable production: Self-aligned actuator slots prevent misalignment.

Short analysis time: Parallel layers increase sample throughput.

Easy integration: Multi-step processes combine on one chip; tubing ports are built into the body.



A multilayer acoustophoresis chip produced in a single print

The invention shortens chip length by stacking channels on top of each other. In series, separation, focusing, trapping, washing and concentration run sequentially on one chip; in parallel, throughput increases or different samples are processed simultaneously. The body is printed in one step by stereolithography (SLA). A self-aligned pair of piezoelectric actuators generates acoustic radiation force in all layers, and conical drain channels empty uncured resin during printing. Applications include cell separation, diagnostics and removing microplastics from water.