SPANISH NATIONAL RESEARCH COUNCIL (CSIC)

Technologies Portfolio

SPANISH NATIONAL RESEARCH COUNCIL (CSIC)

IT & Electronics

Microchips with surface molecular Multifunction

Researchers from the Spanish National Research Council at the Barcelona Microelectronics Institute (IMB-CNM) and the University of Barcelona (UB) have recently developed by using microelectronics combined with soft lithography techniques a method for obtaining surface multifunctionalized planar-arrays microparticles. The method also includes the particles liberation from the substrate without any modification on its molecular multifunctionalization. Both, particles and multiplexing molecular fabrication are low cost processes. The technology permits the use of a high range of materials and very different and complex functionalization arrays. Its high versatility does it very suitable as sensor and / or molecular actuators as in chemical, as well in biological and medicine applications.

Industrial partners are being sought to exploit the existing know-how through a patent licence agreement.

An offer for Patent Licensing.

Low cost Chips for Smart Theragnostics

The high level of flexibility and versatility of chemical and biological sensors or actuators based on the developed technology is only possible due to the use of microelectronics combined with soft lithography techniques.

The technology permits the fabrication of 2D-planar molecular arrays in a single microparticle (3um x 3um), doing it very suitable for a high range of applications such as treatment and diagnostic of diseases like cancer, as well as, fast lesion recovery techniques (pots surgery). Moreover, the integration in the same particle of active elements does it feasible to be used for theragnostics, a treatment strategy that combines therapeutics with diagnostics; and its small size and biocompatibility allows its use with living cells.

The particles are fabricated on an array and could be interconnected and worked together as a system. This application could be very suitable for disease that needs also a "Smart Theragnostic System".

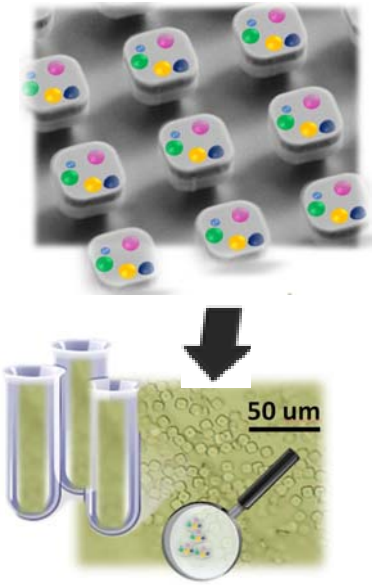

Image Above: *SEM Image composition of an array of multifunctionalized planar micromolecules.* ***Image Below:*** *Micromolecules dispersed on a solution after being separated from array. The on surface multifunctionalization of the molecule keeps undisturbed.*

Main Advantages

- Low-process steps, easy and low cost fabrication.
- Very versatile because we can obtain 2D-planar molecular arrays in a single microparticle.
- Biocompatible arrays /chips.
- The individual multifunctionalized particles could be interconnected and acts as a system.

Patent Status

Spanish Priority Patent Status

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Materials

One-pot reaction for the coating of nanoparticles with organic radicals.

CSIC has developed a simple one-step method performed at room temperature for the preparation of gold nanoparticles with a high coverage of organic radicals. The product obtained is purer and has a better performance.

Industrial partners are being sought to exploit the existing know-how through a patent license agreement.

An offer for Patent Licensing

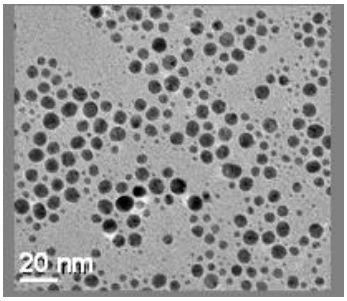
Low-cost, simple and controllable.

A number of methods have been developed to tune the particle dimensions; the most commonly used procedures involve two-phase synthesis and subsequent digestive ripening, a seeding growth strategy or a combination of both approaches, nevertheless simple procedures for obtaining large nanoparticles with high coverage of spin labels are required.

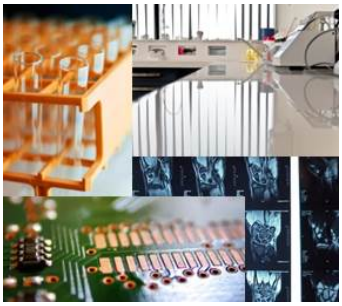
The main difference of this method is that it avoids the need to perform three consecutive reactions like: the formation of the nanoparticles protected by the suitable stabilizer; the exchange of ligands to incorporate the organic radicals and the heat treatment in the solid state to increase the particle size.

In addition to obtain a high coverage of organic radicals at room temperature, the new method makes possible the formation of nanoparticles of a relatively large size (approximately, 7 nm in diameter). Furthermore, the material obtained had magnetic properties due to the high density of radicals on its surface.

The synthesis is simple, reproducible and is made from commercially available materials.



Nanoparticles TEM image.



Multiple applications.

Main advantages and applications

- Simple method: one-pot reactions that result in substantial improvement in the performance.
- Easily reproducible
- Low-cost: room temperature process.
- Potential uses of the material produced: catalysis, fabrication of magnetic devices, biosensors and contrast agents for MRI, among others.

Patent Status

Spanish patent applied for with possible international protection.

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High performance polarization agent for Dynamic Nuclear Polarization applications

CSIC and the Autonomous University of Barcelona have developed a very effective polarizing agent for obtaining free radical hyperpolarized pyruvic acid solutions that improve the signal enhancement of Nuclear Magnetic Resonance.

Industrial partners are being sought to exploit the existing know-how through a patent license agreement.

An offer for Patent Licensing

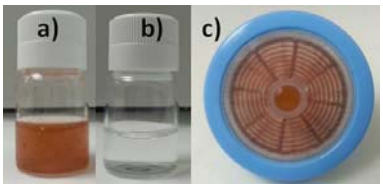
New possibilities for *in vivo* applications

This is a change in the method of use of organic radicals applied in Dynamic Nuclear Polarization (DNP).

The current techniques consist of dissolving the suitable organic radical in the compound to be polarized. This solution is frozen and subsequently irradiated to achieve the polarization of the radical and, then, it is transmitted to the compound. Thus, the combination radical-compound-solvent is mixed with water and transferred to the NMR equipment to carry out the spectrum. The disadvantage of this method lies in the permanence of the radical in the mixture and the interference that it generates in the process due to its paramagnetic condition. Furthermore, the presence of solvents in the final mixture, causes difficulties in the implementation in *in vivo* experiments.

In order to avoid the use of solvents and removing the polarizing radical from the mixture that goes to the MNR equipment, a new organic radical has been synthetized. The new radical is a derivate from 1,3-bisdifenilen-2-phenylallyl and is soluble in pyruvic acid and water.

Comparative tests between the new radical and those from the market indicate a significant improvement in the spectrum obtained by hyperpolarization.



a) Sample before filtering, b) sample after filtering and c) filter state after filtering.

Main advantages and applications

- The use of vitrifying agents is not necessary.
- Radical rapid dissolution.
- Higher level of polarization.
- Polarization time is reduced.
- Substantial increase in the resulting signal.
- Stages of the reaction purified by precipitation.
- Uses: DNP polarizing agent; potential application for *in vivo* experiments.

Patent Status

Spanish patent applied for with possible international protection.

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SPANISH NATIONAL RESEARCH COUNCIL (CSIC)

Nano Bio

Device to induce hyperthermia in cells through magnetic nanoparticles

The research group led by Dr Domingo Barber at the National Center for Biotechnology (CNB-CSIC), has developed an instrument to generate a controlled alternating magnetic field to induce hyperthermia in cells through magnetic nanoparticles. Companies interested in a patent license are being sought.

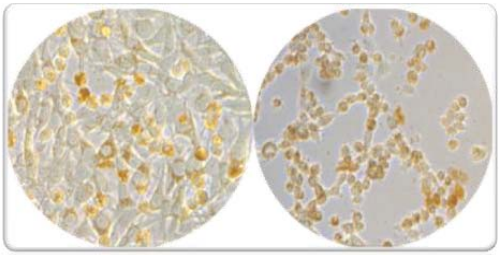
An offer for patent license

Precise control of the temperature reached by the nanoparticles inside the cells

Magnetic hyperthermia is used as additive therapy with other cancer treatments. The main problem for hyperthermia therapy research is having an instrument that allows a precise control over the magnetic field applied to the nanoparticles and the temperature reached by them inside the cells.

This patented hyperthermia device allows a controlled application of the alternating magnetic field and therefore, the temperature of the nanoparticles.

A prototype has been constructed and tested for research on cancer cell lines. It has been shown that after one hour hyperthermia treatment at 45ºC, the viability of the cells treated by the magnetic field together with magnetic nanoparticles was reduced around 40%, while the control cells treated with magnetic particles or magnetic field alone did not show a significant decrease on their viability.



Microscopic images showing Panc02 murine pancreatic adenocarcinoma cells treated by magnetic nanoparticles (left) or by magnetic nanoparticles together with alternating magnetic field (right), generated by the patented device for 60 min., with frequency of 250 Khz (right). Pictures were taken 3h after the treatments.

Main innovations and advantages

- A unique and "non contact" based method for a precise measure of the temperature reached by the nanoparticles inside the cells (up to 0,01ºC).

- Frequency and amplitude of the magnetic field can be automatically programmed by the scientist. It allows changes in different parameters such as frequency, amplitude, PCM (pulse code modulation), and a mixture of them, all being digitally controlled in real time.

- Friendly use software for data capture, representation and analysis to control the parameters of the magnetic field and the nanoparticles temperature.

- Compact equipment of easy and friendly use. It does not require any parts exchange if working in a wide range of frequency and potency, making it the perfect instrument for hyperthermia research.

- It can also be used on Material Science for analysis of the heating properties of the materials and nanoparticles (SAR curves).

Patent status

Spanish Priority Patent has been filed

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MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Method to fabricate 3D-Nanostructures with height gradient

Researchers from the Spanish National Research Council at the Institut Català de Nanociencia i Nanotecnologia (ICN-CSIC) have recently developed a new technique to fabricate a matrix of nano pillars that presents controllable height gradient. The matrix can be made by semiconductor or polymer material. This technology can be used for optical devices in reflection or transmission modes and as biosensors for the mechanical study of tumoral cells.

Industrial partners are sought to collaborate and/or exploit the existing know-how through a patent licence agreement.

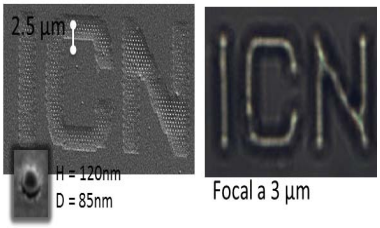
An Additional degree of freedom for 3D Nanofabrication

Nowadays conventional methods of nanofabrication such as reactive ion etching are used to create 3D nanostructures, however they permit the variation of transversal geometry of structures but not their height that keeps homogeneous.

The process currently developed is based on metal-assisted chemical etching and permits the creation of a matrix composed by 3D nanostructures. It allows height gradients in arbitrary direction that are controlled during the etching process by using a metallic and nano-perforated layer that works as catalyst and a localized modulation of the etching velocity over the bulk substrate.

The method developed has been used to fabricate 3D nanostructures with height gradient in silicon and also in polymeric material.

The additional degree of freedom for 3D nanofabrication also permits to achieve devices with gradient of effective refraction index that are of interest in optics, particularly as 3D-lenses with very short focal distance (~3μm), polarizators and light multicoupler in waveguides. Furthermore the method is also useful for the creation of devices that present gradient in the elastic constant, that can be applied on cell co-culture substrates because induces durotaxis for mechanical study of tumor cells.



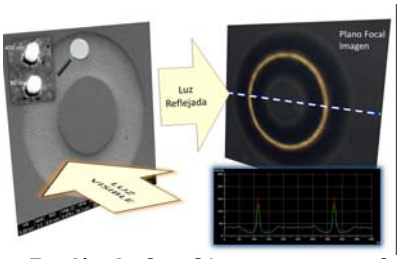


Fig.1) Left: *Silicon matrix of Nanopilars with different heights.* ***Right****: Focal plane Image of Nanopilars (at focal distance 3 microns).*

Main Advantages and Applications

- High versatility to generate 3D nanopillars with height gradient based on semiconductor and polymeric material.
- Allows fabrication of nanostructures with different kinds of gradients such as height, refraction index and mechanical properties.
- Highly useful in optics, in particular in devices which needs light focus and collimation in arbitrary forms and at very small distances (microns).
- Also able to generate elastic constant gradient which is very useful on cell co cultures for the mechanical study of tumoral cells.

Patent Status:
Priority Spanish Patent

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Device to assess the cell barrier integrity through impedance spectroscopy for nanomedicine screening platforms

Researchers from the Institute of Microelectronics of Barcelona (IMB-CNM) of the Spanish National Research Council CSIC and the Biomedical Research Centre Network (CIBER) have developed a device that allows real time monitoring of cell cultures that are present in cell barrier in-vitro models. The device is based on transendothelial /epithelial electrical resistance (TEER) measurements. This device is very usable for studies of new drugs that have to pass through different cell barriers; for example in many different neural diseases treatments, diabetes or cancers.

An offer for Patent Licensing and/or R+D collaboration.

Quantitative and real-time Monitoring of Cell Barrier

The device is formed by a microfluidic system that better reproduces the *in vivo* cell barrier conditions than those performed in static *in vitro* ones. Furthermore, the system has implemented an interdigitated electrode system for TEER monitoring that allows optical inspection techniques. The monitoring is quantitative and in real time, which facilitates the use of the device for pharmacologic assays where the control of the integrity of the cell barrier is a hallmark.

The device is easily scalable into different geometries and for using different cell types. Moreover the microfluidic system is reusable (only the culture membrane requires disposal), which minimizes the material costs for its use in laboratories.

Therefore, the device permits to closely mimic *in vivo* conditions, being useful for the study of different physiopathologic diseases and allowing the development and validation of therapies for their treatment.

The prototype has already been validated by using endothelial cells from the brain of a mouse.

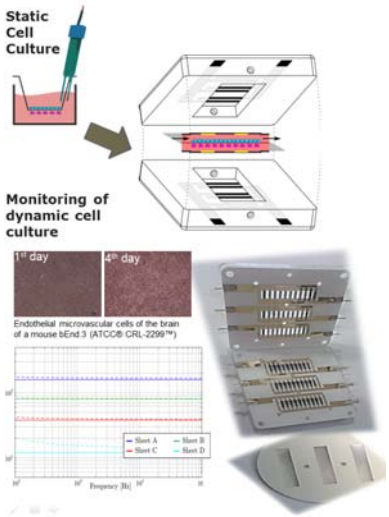

Fig.1) Top: *Static Cell Culture of epithelial barrier.* ***Middle****: Examples of endothelial cell cultures. Schema of the developed microfluidic chamber for dynamic cell culture..* ***Bottom:*** *Developed prototype for the dynamic cell culture monitoring (shear stress).*

Main Advantages

- The device allows a quantitative motorization of cell cultures by using impedance spectroscopy measurements.
- The device allows the optical monitoring of cell cultures, thus facilitating the usability of the device.
- It allows real time monitoring of barrier cell culture such as blood-brain (epithelial and endothelial) permitting the in-situ control of barrier integrity. This characteristic is very interesting for control without affecting cell physiology in the study of new drugs that should cross the barriers.
- The microfluidic design of the device includes and permits the application of a perfusion system (shear stress), indispensable for the culture of endothelial cells.
- The system is modular, dismountable and allows easy access to the cell culture chambers. This facilitates the handling and the post-experimental analysis of the different cell types.
- It also allows co-cultures of different cell types.

Patent Status

European Priority Patent

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Smart Bi-Multifunctional NanoParticles

Researchers from the Spanish National Research Council at the Institut Català de Nanociencia i Nanotecnologia (ICN-CSIC) and the Autonomous University of Barcelona (UAB) have recently developed a one-step and low cost procedure to produce metalorganic multifunctional nanoparticles. The nanosystem can act as smart nanocarrier due to the particle capability to be functionalized also on their surface. This versatility makes it very suitable in Nanomedicine for therapy and diagnostic treatment of diseases like cancer, malaria, Parkinson and/or Alzheimer.

Industrial partners are being sought for patent license agreement.

Multifunctional Nanosystem for Theragnostics

The developed nanoparticle-based device presents different functional elements whose physical and chemical properties can be easily controlled. On one side the nanoparticle composition (metallic ions plus organics ligands) confers to the nanoparticle optical, magnetic and catalytic properties that make it very feasible to technical and medical application like theragnostics, a treatment strategy that combines therapeutics with diagnostics.. On the other side the particles can be also be functionalized on their surface, what increases the nanosystem versatility. The bi-multifunction permits that the nanosystems developed could be used in a very wide application range such as smart nanocarrier, drug delivery system, catalyst, biosensors, biomarkers, contrast agents, and applied in fields like nanomedicine, electronics and/or environmental monitoring.

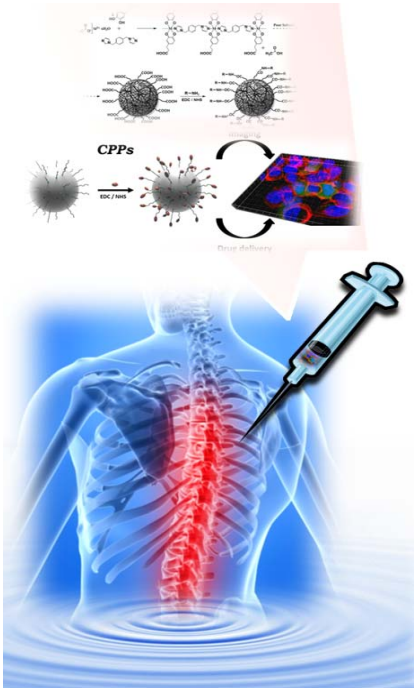

Fig. 1) *Multifunctional nanoparticles and their application in teragnostics.*

Main Advantages and Applications

The main application of the smart bi-multifunctional nanoparticles is the nanomedicine, in the theragnostics of a wide range of diseases such cancer, malaria, Parkinson and/or Alzheimer, but also in the environmental field for water monitoring and treatment.

Main Advantages:

- Low cost and one-step method to fabricate nanoparticles (from 40 nm to microns)
- Controllable surface charge and hydrophobicity.
- Easy dispersion in dissolvent (organic and water-based dissolvent).
- High stability of the nanoparticles in solid state, with magnetic, optical and catalytic properties.
- High versatility to dock any molecule and/or biomolecule on the surface of the metalorganic nanosystem in covalent and also in reversible form.
- Biocompatible nanoparticles that also present high resistance to extreme pH conditions and controllable thermal stability up to 150 °C.
- As catalyst is heterogeneous, separable and reusable.
- Responds to electromagnetic fields, pressure and pH changes (sensors).

Patent Status

International PCT

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Life

Digital system for stereotaxic Biopsies

CSIC, along with IFAE (Barcelona) and Parc Taulí Hospital (Sabadell) has developed a digital system for the real-time steering of needles employed in the acquisition of biopsies. Its use provides better precision, and higher speed, is more reliable, and thus causes a few trauma and more comfort in patients. The device emits and detects X rays and processes them to generate the stereotaxic images in real time.

Partners interested in a patent license are sought.

Real time images for Biopsies

State-of-the-art stereotaxic surgical techniques to perform biopsies use two static images from which the 3D coordinates of the injury to be analyzed or extracted can be calculated. However, steering of the needle by static images to guide its insertion rule out real-time repositioning to reach the injury without failure. Neither tissue elasticity nor changes in position of the injury due to previous biopsies can be taken into account, which adds to the inaccuracy of the final result.

A research group of CSIC has developed a new digital system capable of solving these problems by employing X-rays for the acquisition of the images. This new guiding technique makes it possible to obtain real-time, and fast images of the sample to be extracted, causing less pain to the patient.

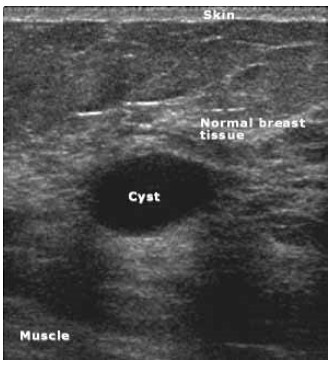

Fig.1) Biopsy of a mammary gland.
Fig. 2) Commercial equipment to obtain stereotaxic biopsies.

Much reliable and less invasive Biopsies

The technique allows using short-time markers to enhance image quality and can thus be employed for very small or low-contrast injuries.

The system employs two complete sets of generation, detection and processing of X-rays, together with the appropriate tools for positioning and production of the image once it has been processed. The technique results in a minor trauma and more comfort for the patient, since reliable and accurately located biopsy samples are retrieved faster by the medical staff.

Main Applications and Advantages

- Direct conversion of photons allows a minor X-rays radiation dose received by patients.
- The system´s axis can be displaced between two different directions, so that a single detector can be used to obtain images.
- This method of acquisition of biopsy samples is cost-efficient and more patient comfortable.
- Contrast and short-life markers can be used to enhance the image and take samples of very small or low-contrast injuries.
- Real-time stereoscopic records ensure the reliability of lesion location and biopsy extraction.
- The register process of biopsies is easier for the medical staff.

Patent Status

Patent granted in Europe, USA and Canada

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Bio

Autonomous and disposable test strip for point-of-care assays

CSIC is developing a measurement platform for biological parameters that integrates a fuel cell responsible of the generation of the power required for the detection and reading-out of the test. The device is autonomous, disposable, biodegradable, easy-to-use, and cost-effective.

We are seeking companies interested in licensing the technology.

An offer for Patent Licensing

A fully integrated paper platform

The limited sensitivity of current colorimetric-based assays makes it difficult to obtain quantitative results or to perform successful multi-analyte testing unless an external reader or additional bench-top instrumentation is used.

The present technology comprises the integration of microfluidics, organic electronics and silicon technologies to push forward performance and functionality of current lateral flow tests.

A complex in-vitro diagnosis is performed through a paper strip that pretreats (filter, concentrate, mix) a biological sample and performs electrochemical detection of several target analytes providing results in a short time in an embedded display. The device is powered by a micro fuel cell embedded within the platform.

Main advantages and applications

- Full autonomy.
- Disposable and biodegradable (paper-based substrates).
- Low- cost production.
- Easy-to-use (operated by unskilled hands).
- Short time response (within minutes).
- Multi-analyte electrochemical detection.
- Integrable and scalable technology.
- Small dimensions.

Patent Status

Patent applied for in USA, Europe and China.

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SPANISH NATIONAL RESEARCH COUNCIL (CSIC)

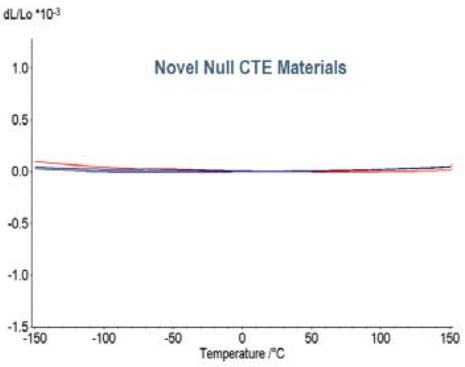
Aeronautic and Space

Ultrastable ceramic nanocomposites in a wide range of temperatures

CSIC has developed a new family of ceramic materials that combine tailored thermal expansion coefficient (CTE), including null and negative CTE in a wide range of temperatures and enhanced mechanical, electrical and thermal properties. These materials are particularly suitable for structural components requiring high dimensional stability with temperature or a fixed thermal expansion coefficient for its joining with another element with the same coefficient, thus avoiding a possible thermal expansion mismatch.

Preparation of lithium aluminosilicates and tailored CTE nanocomposites

CSIC developed a new and simple preparation process of lithium aluminosilicates with negative thermal expansion coefficients that requires inexpensive precursors (kaolin powders, lithium carbonate, etc.) and employs conventional and well known, within the ceramic industry, thermal and mechanical treatments. The result of this preparation procedure is an economic material with excellent thermal properties that combined with positive thermal expansion second phases allows the manufacture of composites with tailored, including null, CTE. Using this approach ceramic nanocomposite materials with non-oxidic second phases and showing a CTE lower than $1x10^{-6}$ K^{-1} in the temperature range (-150 °C +150 °C) can be obtained by a simple process that comprises conventional sintering methods, thus opening the possibility of manufacturing components with complex shapes and large dimensions.



The patent portfolio also includes materials with only oxidic components and tailored thermal expansion coefficient, including materials with zero thermal expansion. These materials can be used in oxidizing atmospheres at elevated temperatures while maintaining excellent mechanical properties.

Innovative aspects and potential applications

- The main asset of this new class of ultrastable materials is the use of simple and inexpensive procedures of synthesis and processing of lithium aluminosilicate powder.
- The resulting nanocomposites have no glassy phase, therefore feature excellent mechanical properties compared to commercial glass-ceramics and have a controlled CTE in a wider temperature range than any other known material.
- Additionally, the optional use of carbon nanofibers gives the composites, excellent electrical properties, which allow their machining by means of Electro Discharge Machining (EDM) techniques. Some of the fields in which these materials might be applied are: Extreme Ultraviolet Lithography (masks, mirrors and wafer stages), Space and Earth Observation Systems (mirrors) and Concentrated Solar Power (Receivers).

Patent Status

4 Spanish patents, 2 US patents and 1Chinese patent granted. Other patents in Europe, USA, China and Japan are pending.

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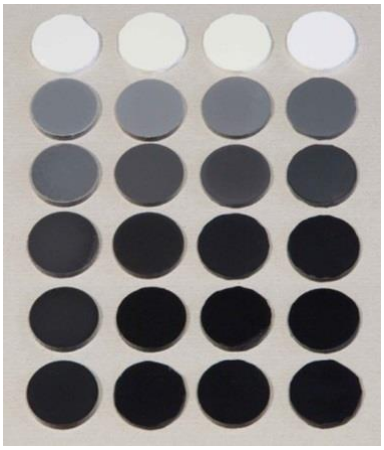
Materials

Zirconia-alumina nanocomposites for jewellery and ornaments

A research group of CSIC has developed a new family of zirconia-alumina nanocomposite materials that feature excellent mechanical properties (outstanding values of bending strength, toughness, hardness…) and a complete palette of grey colours. The final colour of the ceramic material is obtained by means of adding diamond nanoparticles and can be tailored in a simple and precise way just adjusting the content of diamond nanoparticles and the sintering temperature. Partners interested in a patent license are being sought.

The use of zirconia in jewellery and ornaments

The excellent mechanical properties as well as the good chemical stability and biocompatibility featured by zirconia materials have promoted its use in many applications. However, in sectors where aesthetics are a key aspect such as jewellery or decoration the use of zirconia materials has been traditionally restricted due to the narrow range of colours attainable, which varies from white to ivory depending on the kind of atmosphere in which the sintering is performed and the type of oxidic stabilizer used.



Set of samples of zirconia-alumina composites showing a wide range of grey colors attainable

Extended color range while maintaining the mechanical properties

In order to provide a greater variety of colours in zirconia materials different approaches have been used. However, these methods can lead to the generation of defects and the subsequent loss of mechanical properties in the resulting material.

The developed technique overcomes the aforementioned problems combining a wide range of colors together with excellent mechanical properties.

Main applications and advantages

- Wide range of metallized grey colors. In CIE L*a*b color system, L* lightness parameter ranging from 40 to 98.
- Homogeneous coloration
- Excellent mechanical properties: flexural strength greater than 1,500 MPa and toughness values higher than 14 MPa · $m^{1/2}$

Patent Status

Spanish patent has been filed

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Nanostructured titanium coating for orthopaedic implants

A group of CSIC and the GIBI group of Complutense University of Madrid have developed nanostructured coatings for orthopaedic implants. Due to the dimensions of the nanostructures, osteoblasts adhere and proliferate whereas bacteria adhesion is seriously impeded. Partners interested in a patent license are being sought.

Titanium orthopaedic implants to improve patient quality of life

Every year, orthopaedic implants improve the quality of life of millions of patients. Metallic alloys such as stainless steel, Chromium-Cobalt and overall Titanium are used to manufacture devices like total joint prostheses, fracture fixation elements and external fixators owing to their biocompatibility and good mechanical properties.

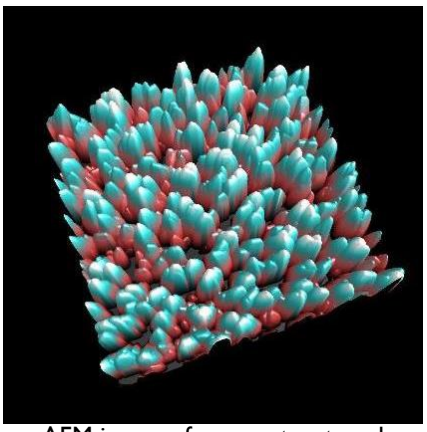
However, there is a certain risk of infection (between 0.5% and 5% depending on the application) that affects tens of thousands of infected every year and may imply subsequent surgical operations.

Knee prosthesis radiograph

Reducing the risk of infection with nanostructures

In order to achieve anti-infectious properties, a wide variety of strategies has been developed, such as fabricating bacteria repelling and non-stick surfaces, using intrinsically bioactive materials with antibacterial properties, preparing biomaterials that deliver antibacterial drugs, or functionalizing surfaces with molecules that interfere with the formation of bacterial biofilm.

The developed technique is based on manufacturing a nanostructured coating onto a medical grade surface using a physical vapour deposition technique. It does not require the use of chemical compounds, it is scalable and environmentally friendly.



AFM image of a nanostructured surface onto a medical grade substrate

Main applications and advantages

- The coating is made using a physical vapour deposition technique with no chemicals involved and it takes place in a single step at room temperature.
- The bacteria biofilm formation is inhibited as a result of the specific dimensions of nanostructures, i.e. without using any antibacterial drug.

Patent Status

Spanish patent has been filed

For further information

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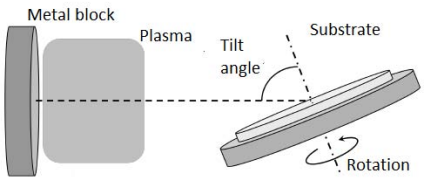
Nanostructure coating made of plasmonic black metal

A research group of CSIC has developed a nanostructured coating with high absorption of visible light. Sputtering at glancing angle (GLAD) combined with a rotating substrate technique is used. This allows a high degree of scalability, efficiency, size control and reproducibility. Partners interested in a patent license are being sought.

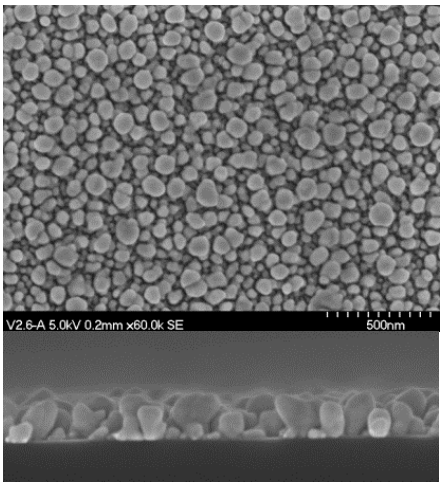
Black metal light absorption

Black metal is a type of material with a high absorption in a wide region of electromagnetic spectra, in this case in the visible region (from 400 to 750 nm). Light absorption in metallic structures at submicrometric and nanometric scales is based on localized plasmon resonances. In order to achieve a wide range of wavelengths absorption a certain size distribution of surface structures is needed.

Noble metals are the most used ones in black metal applications owing to their more intense resonances and smaller losses. Among them, gold is the most used metal due to its high resistance to oxidation.



Sputtering at glancing angle (GLAD) diagram with rotating substrate



SEM (Scanning Electron Microscopy) images of a gold nanostructured coating on a Silicon substrate. Upper area shows a top view and lower area shows a cross section

Sputtering at glancing angle with rotating substrate

The developed technique is based on the use of sputtering at glancing angle (GLAD) with a rotating substrate. Sputtering has well-known technical and environmental advantages. The process is performed under ballistic regime in which atomic shadowing effects appear. This is a condition for the creation of nanostructured coatings.

The coating is composed by noble metal nanostructures (usually gold) with diameters smaller than 50 nm and a diameter distribution standard deviation large enough to obtain a black metal behaviour in the visible region.

Main applications and advantages

- A modified version of the widely used in industry sputtering technique is applied, without harsh environment residues generation and in an energetically efficient way: one step manufacturing at room temperature
- Applicable to any type of substrate and to large surfaces
- Over 85% of absorption between 400 nm and 700 nm when silicon substrates are used
- Applications in radiative heat exchangers, solar energy absorption materials, photovoltaic cells electrodes, separators to avoid cross effects among optical devices, thermal light emitters, biosensors electrodes, catalytic devices and near infrared detectors

Patent Status

Spanish patent has been filed

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