Quark®

Research and Development in Slovenia

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"Materials are conquering the world". News from the Centre of Excellence:

Advanced Materials and Technologies for the Future, the Centre of Excellence NAMASTE.

The scientific results of the CoE partners are considered excellent. It is a particular strength of this CoE that it has an excellent balance between fundamental and applied research.

From the "Evaluation report" of the external expert (July 2011)

The Centre of Excellence NAMASTE is a multi-disciplinary and trans-disciplinary consortium of research institutions and industry, who have decided to merge academic, technological and business expertise, skills and equipment in order to achieve major scientific and technological progress as well the transfer of results to industry. The working area is related mainly to inorganic, non-metallic materials as well as organics and composites and their implementation in electronics, optoelectronics, photonics and medicine. More specific topics are ceramic 2D and 3D structures; materials for overvoltage and EM protection; materials, micro- and nano-systems for sensors; soft composites for optical, electronic, photonic and sensor applications; and bioactive, biocompatible and bioinert materials.

Prof. Dr Marija Kosec, Director.

Strategic goals: continuity in research excellence, knowledge dissemination and technology transfer, and multi-disciplinary interconnections.

The consortium consists of three research institutions with eleven research groups, three non-profit organizations, and thirteen companies from different regions of Slovenia.

The key issue for success is the scientific excellence of the research partners, the technological and business excellence of the industrial partners, and above all the confidence between the partners, particularly industry and academia, that is built on positive experiences. The last of these is the most important. The Centre of Excellence NAMASTE therefore carefully tries to reinforce existing or build new connections based on common projects where members of the Centre of Excellence NAMASTE coming from academia and industry work together on a daily basis, by organizing training schools, strategic conferences, visits to industrial partners, etc. Among the most successful events was the Workshop on Material Characterisation, which had a large number of participants from industry together with students, and the last strategic conference with almost equal numbers of presentations from industry and research labs. In addition to the increased interest between those two groups, i.e., industry and research, we also note an increased level of communications within the industrial community. For more information visit http://www.conamaste.si.

This is the second presentation of the Centre of Excellence NAMASTE in Quark. This time we present several selected activities of our partners from the research institutions and industry, primarily those that were not reported in the previous issue.

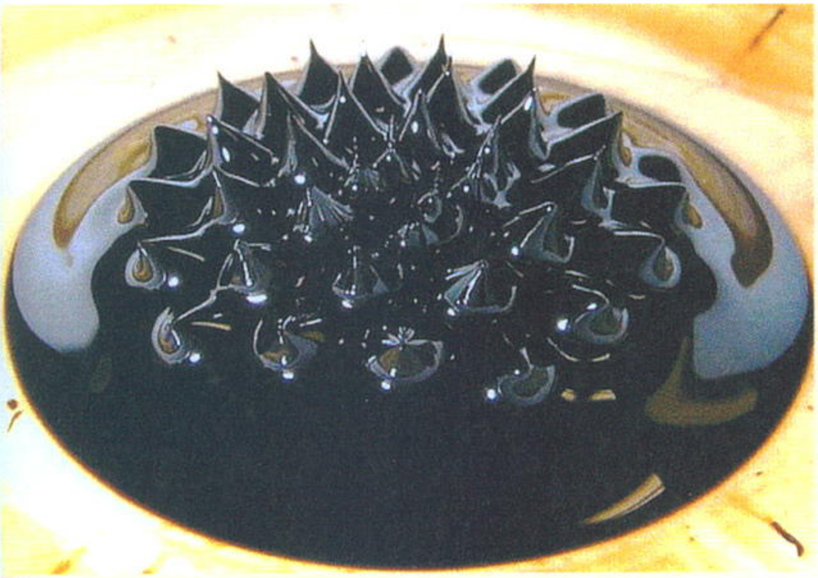


Figure 1: Magnetic fluid.

Nanofluids for applications in magnetic hyperthermia

Centre of Excellence NAMASTE
Faculty of Chemistry and Chemical Engineering, University of Maribor
Asst. Prof. Irena Ban

The Department of Inorganic Chemistry at the Faculty of Chemistry and Chemical Engineering covers a range of research fields focusing on the investigation, synthesis and characterization of nanosized, magnetic materials for biomedical applications, such as magnetic resonance imaging, magnetic targeted drug delivery, and magnetic fluids for hyperthermia.

This scientific excellence is supported by new equipment, owned by the Centre of Excellence NAMASTE, which provides the necessary foundation for carrying out the research. The Head of the Department and the research group in the Laboratory of Inorganic Chemistry is Prof. Miha Drofenik.

The main research areas are:

- Synthesis of inorganic magnetic nanoparticles for the preparation of magnetic fluids,
- Synthesis of inorganic compounds by sonochemical reactions,
- Hydrothermal synthesis of hexaferrite magnetic nanoparticles.

It is well known that an increase in tumour temperature decreases the tumour's resistance to chemo- and radiation therapies. The localized magnetic hyperthermia exploits the greater sensitivity of the tumour cells when heating to about 42-45 °C. The treatment of the tumour cells, where any damage to healthy cells can be avoided, can be realized by using magnetic nanoparticles with controlled Curie temperatures. Magnetic-fluid hyperthermia involves the introduction of nanoparticles as mediators into the tumour tissue and heating them with an alternating magnetic field (AMF). The generated heat can be controlled using nanoparticles with an adaptable Curie temperature. For example, coated Cu_xNi_{1-x} alloy particles, which should be biocompatible, have a Curie temperature (T_c) in the medically suitable range and efficiently absorb AMF energy below the T_c.

Several techniques are used for the preparation of magnetic nanoparticles that are suspended in magnetic fluids. The most frequently applied techniques in our laboratory are: mechanochemical synthesis, chemical co-precipitation by the microemulsion method and sonochemical synthesis.

The main object of the project is to prepare and optimize the magnetic fluids based on magnetic particles and an important step of the investigation proposed in this program is focused on the surface engineering of the nanoparticles.

Research group of the Faculty of Chemistry and Chemical Engineering, University of Maribor and the Centre of Excellence NAMASTE.

R&D breakthrough in the field of ZnO-based varistor ceramics

Centre of Excellence NAMASTE
Jožef Stefan Institute
Prof. Slavko Bernik

A group of researchers from the Jožef Stefan Institute (JSI) is successfully continuing its research in the field of ZnO-type varistors based on low-doped varistor ceramics in collaboration with industrial partners from VARSI and Iskra Zaščite, and also within the Centre of Excellence NAMASTE, which provides a new, high-quality R&D framework.

Research on ZnO-based varistor ceramics started at the institute about 35 years ago, soon after the first reports in the literature about the current-voltage non-linearity in doped ZnO ceramics. In collaboration with researchers from industry the transfer of know-how resulted in the industrial production of varistors in Slovenia, which started in 1981. Since that time the collaboration continued with numerous successfully realized projects and resulted in world-wide-recognized, top-class, energy varistors for low-, medium- and high-voltage applications in overvoltage protection, produced by the VARSI company. These varistors are also used in surge-protection devices (SPDs) produced by Iskra Zaščite.

ZnO-based varistor ceramics - ZnO doped with typically 7 to 12 wt.% of oxides of Bi, Sb, Co, Mn, Ni and Cr - are characterized by a high current-voltage (I-U) non-linearity and energy-absorption capability. Hence, they are widely used for overvoltage protection at voltages ranging from a few volts up to several 100 kilovolts. Varistor ceramics are highly resistive up to the so-called break-down voltage, at which point it switches, in a matter of nano-seconds, into a highly conductive state so that the current increases by several orders of magnitude for a small change in voltage. While the electrical characteristics in the pre-break-down region are controlled by electrostatic barriers at the grain boundaries, each ideally with a break-down voltage of about 3V, at high currents the conductivity of the ZnO grains is important. The size of the ZnO grains determines the number of grain boundaries for a given thickness of ceramic and its break-down voltage. Hence, control of the grain-growth and microstructure development is essential for the successful preparation of various types of varistors. For good current-voltage characteristics of the varistor ceramics only non-ohmic grain boundaries and

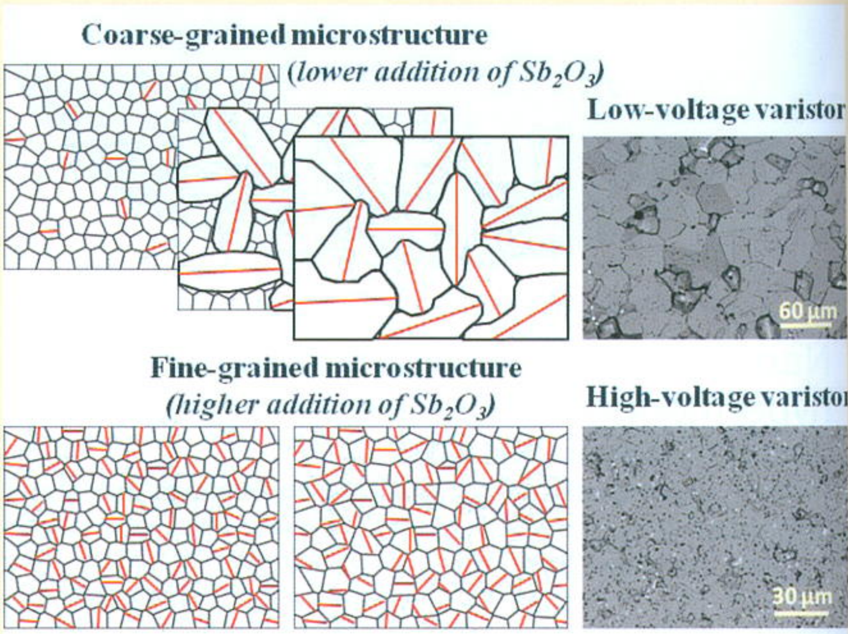


Figure 1: Inversion-boundary (IB) induced grain-growth mechanism enables the tailoring of either coarse- or fine-grained ZnO-based ceramics for low additions of IBs-triggering dopants (Sb_2O_3).

highly conducting ZnO grains of the appropriate size for a certain break-down voltage are essential.

In fine-grained ceramics for high voltages Sb_2O_3 is typically added, while in coarse-grained ceramics with a low break-down voltage TiO_2 is usually the dopant for the grain-growth control. Both dopants result in the formation of the spinel phase in reaction with ZnO. While in the case of Sb_2O_3 the inhibition of the grain growth is generally attributed to the reduced grain-boundary mobility caused by the Zener pinning effect of the spinel grains at the grain

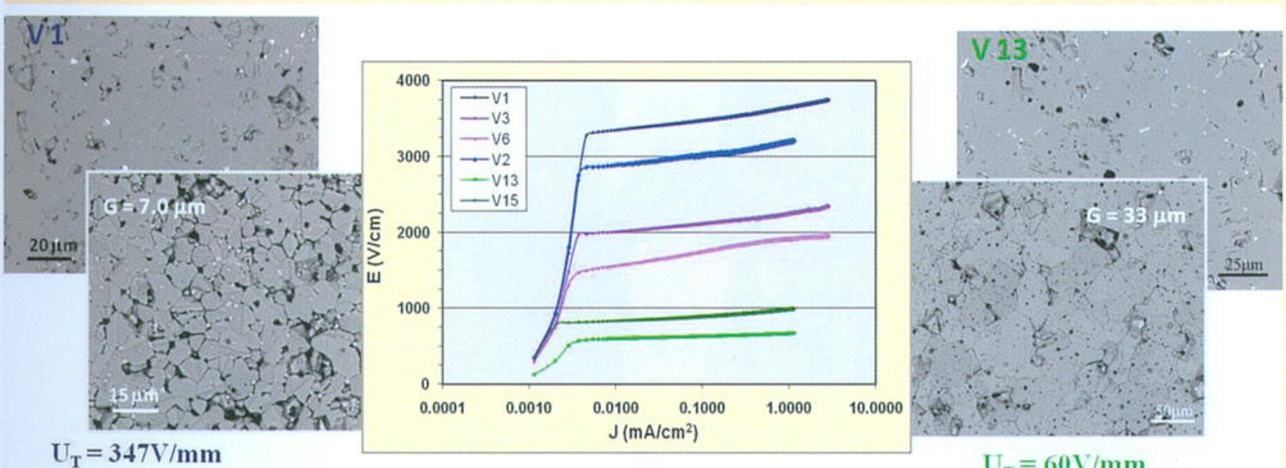


Figure 2: Microstructures and current-voltage characteristics (E vs. J) of low-doped varistor ceramics with the addition of 3-4 wt. % of varistor dopants to ZnO, sintered at 1200°C for 2 hours.

Research group working on ZnO-based varistor ceramics: from left to right Asst. Prof. Slavko Bernik, Dr Nina Daneu, PhD student Matejka Podlogar, Dr Aleksander Rečnik.

each other and completely prevail in the microstructure. The number of grains infected with IBs can be controlled with small amounts of the IBs-triggering dopant (Fig. 1). At lower additions of Sb_2O_3 fewer grains are infected with an IB and can grow larger before they collide with each other, which results in coarse-grained ceramics. However, at larger additions of Sb_2O_3 more grains are infected with the IB and can grow very little before they impinge on each other, which gives fine-grained ceramics. Based on an understanding of the true mechanism that controls the grain growth in varistor ceramics, the group from the IJS developed varistor ceramics having only 3 to 4 wt. % of varistor dopants added to ZnO with an excellent I-U nonlinearity and break-down voltages ranging from 60V/mm to 350V/mm, all with Sb2O3 as the additive for the grain-growth control (Fig. 2) and sintered at 1200oC for 2 hours. In contrast to the classical varistor ceramics with an about 3-times higher addition of dopants and a large amount of secondary phases (they are not important for the electrical characteristics and only hinder them), low-doped varistor ceramics contain only minimum amounts of secondary phases (Fig. 3). Besides the ecological benefits, low-doped varistor ceramics also means saving on raw materials and significant cost reduction in the range from 0.5 to 1.4 per 1 kg of varistor mixture at current prices. The discovery of the researchers from the JSI set trends for the optimization of the compositions of varistor ceramics and the development of a new generation varistors of all types.

boundaries, enhanced grain growth with the addition of TiO_2 was never properly explained. However, both dopants result in the formation of inversion boundaries (IBs) in the ZnO grains; in the case of Sb_2O_3 the IBs are present in each ZnO grain of the varistor ceramics, while during the addition of TiO_2 only in some, typically extremely large, grains.

Researchers from the JSI discovered that IBs play a key role in grain growth and microstructure development, while the role of the spinel phase is subordinated. Grains that are infected with an IB in the early stage of sintering preferentially grow at the expense of normal grains until they collide with

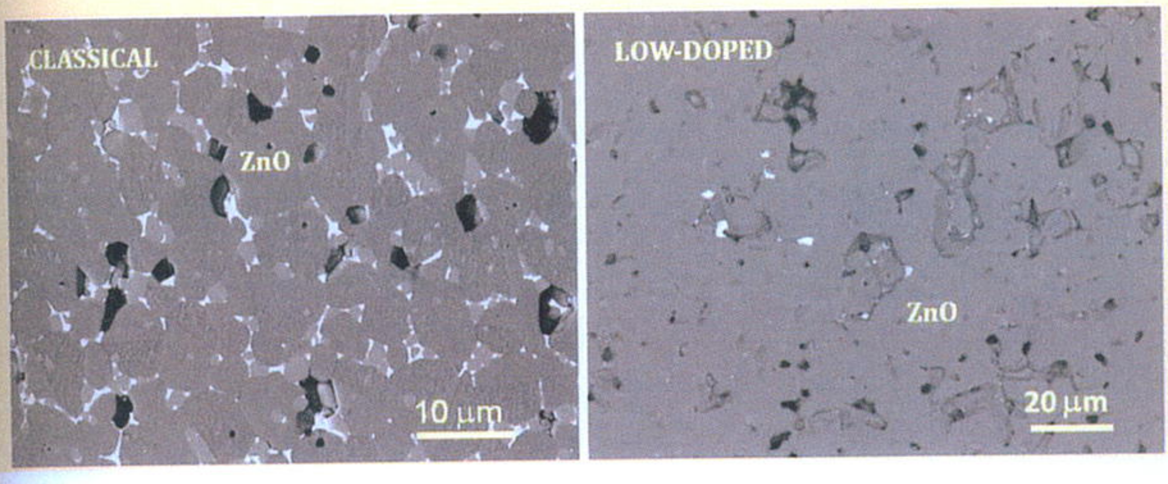


Figure 3: Microstructures of classical varistor ceramics (10 wt. % of varistor dopants) and low-doped varistor ceramics (3 wt.% of varistor dopants), sintered at 1200oC for 2 hours. Both materials have a break-down voltage at 200V/mm and a coefficient of nonlinearity equal to 40. Note the difference between the samples in terms of the amounts of secondary phases.

An electromagnetic absorption material for use in architectural coatings

Nanotesla Institute
HELIOS Ltd.

Asst. Prof. Andrej Žnidaršič†,
Dr Branka Mušič,
Dr Peter Venturini

The most important functions of paints are aesthetic and the protection of substrates. Nowadays, it is important to offer functional coatings to our customers. One field of activities in the field of functional coatings is oriented towards the development of advanced materials for decorative and functional applications. In this sense, our current interests are in many areas of surface science, including multifunctional, ceramic coatings. For this reason the Helios Group collaborates with the Kolektor Group, Nanotesla Institute from Ljubljana, which is the R&D centre that builds on significant expertise in the field of nanomaterials and composites, microwave applications and magnetism as well as having years of industrial background and substantial investment in state-of-the-art equipment.

Major changes in wireless technology give us new possibilities for the development of electromagnetic composite systems. The everyday usage of different devices emits electromagnetic radiation and, as a result, the amounts of electromagnetic radiation are continuously increasing. In the European Pre-standard ENV 50166-2:1995 - Human exposure to electromagnetic fields - High frequency, it states that electromagnetic fields interact with the human body and other systems through a number of physical mechanisms.

Therefore, the need to protect people and devices from harm and to prevent something from being detected by other instruments is spawning a world of activity in the development of novel, EM-wave-absorption materials. An ideal EM-wave absorber should possess light weight, high EM-wave absorption and multi-functionality. Electromagnetic protection coatings are interactive, responsive coatings and can offer advances in coatings, such as absorbing electromagnetic waves and providing protection from radiation. The purpose of our work was to investigate the electromagnetic-absorber properties of a resin compact containing ferrite powders. The putties were made from spinel structure ferrite powders with a defined synthesis process, particle size and surface area.

Here, the bandwidth is defined as the frequency width in which the reflection loss is less than −10 dB, which indicates that 90 % of the EM waves are absorbed. This shows that by changing the thickness of the material with the spinel ferrite structure, the position and the attenuation-peak frequency can be easily manipulated in terms of the frequency range. We can conclude that composite materials with a large fraction of the spinel phase/structure can be used as electromagnetic wave absorbers in the lower GHz range.

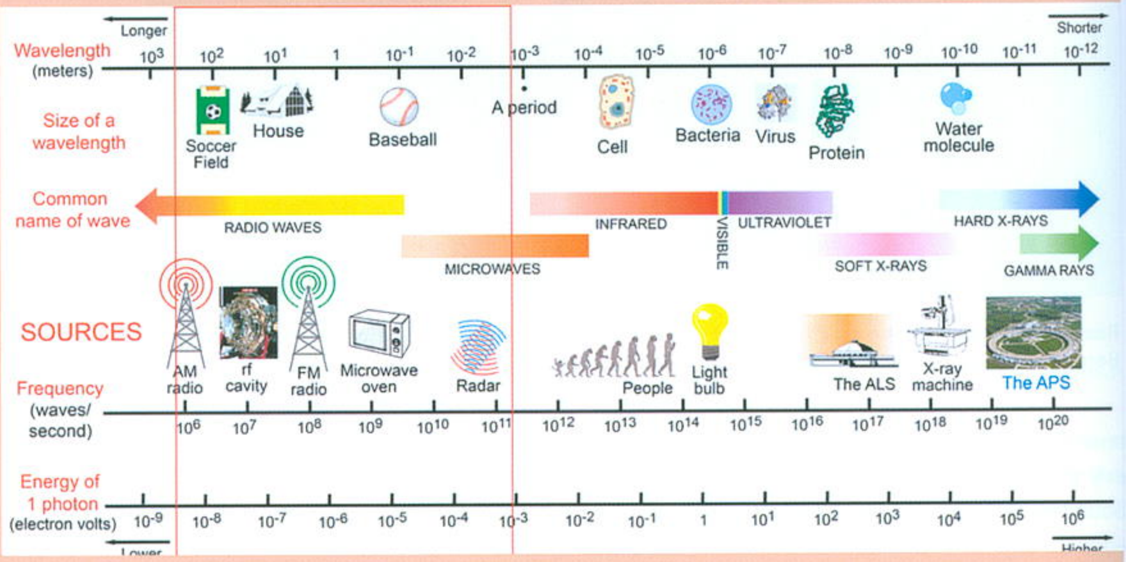


Figure 1: Electromagnetic spectrum.

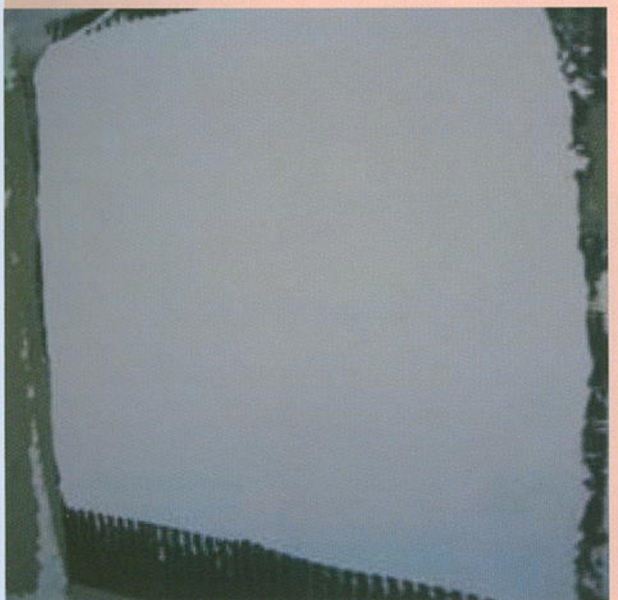


Figure 2: Image of the applicative putty, thickness 5 mm.

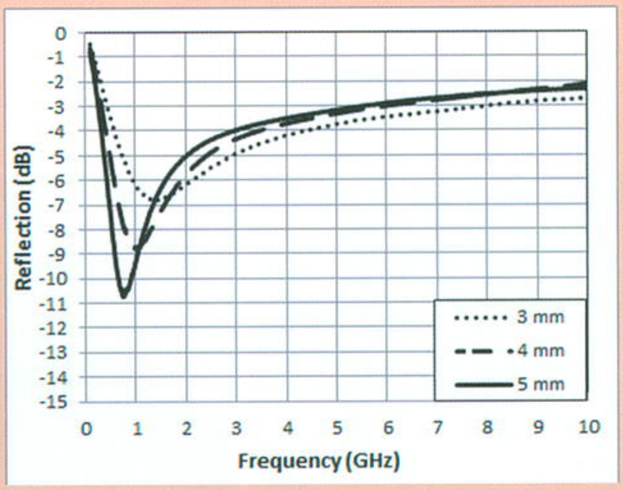


Figure 3: Reflection curves for different thicknesses of absorption layer.

Gas discharge tubes Iskra Zaščite

Iskra Zaščite Ltd.
Centre of Excellence NAMASTE*
Dr Robert Rozman

Iskra Zaščite is today one of Europe's leading suppliers of surge-protection devices (SPDs) for power, data and telecommunications. One of the most important elements in SPDs is the gas discharge tube (GDT or gas arrester). To improve the flexibility in SPD production, we decided to develop our own GDTs.

In general, the GDT or gas arrester consists of two electrodes that are separated by a ceramic tube, the interior of which has been completely sealed and filled with an appropriate mixture of gases. In the presence of low voltages on the electrodes the GDT acts as a perfect insulator, while with the occurrence of surges the GDT begins to conduct an electrical current. To achieve repeatability of the production it is very important to have a knowledge of gas and plasma physics, the physics of materials and vacuum techniques. In addition, high-tech equipment is very important for the development and manufacture of GDTs. For the purpose of the development and production of GDTs we recently updated our laboratories with the construction of new clean-room facilities and a new, modern vacuum furnace.

In our GDTs the first electrode is a metal body and the second electrode is inserted through the insulator. Such a GDT is essentially different from the usual GDT with a ceramic body, which globally accounts for a more than 99% share. The advantage of a GDT with a metal body in comparison to the usual configuration, where the body is ceramic, is mainly in the larger areas of the electrode with the same external dimensions. The larger areas of the electrodesleadtohigher current capabilities. In addition to this new geometry, the work within the Centre of Excellence NAMASTE was focused on finding the optimal materials and the proper gas mixture for the GDT. To define the materials and gases we made a large set of samples, which we tested at a high-current surge generator. The final results show a large reduction in size for the GDT in comparison to the state of the art. With this innovation we achieve a very small size of the GDT for high-current surges, which allows significant savings with respect to the installation space compared to an ordinary GDT.

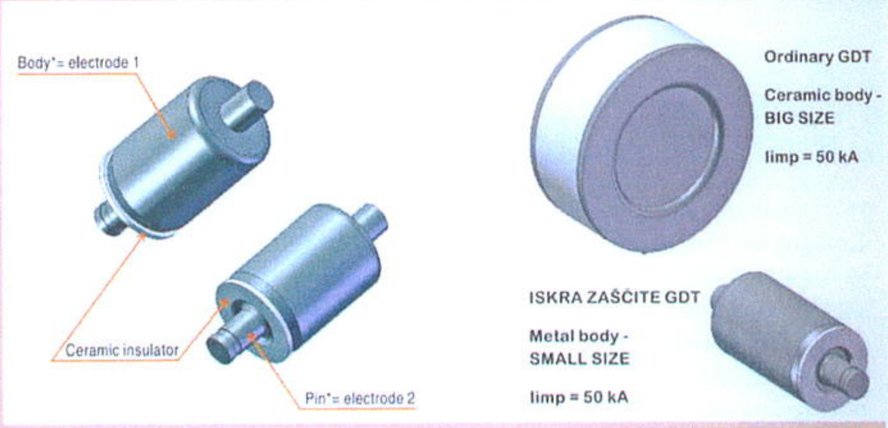


Figure 1: New patented construction of the GDT and a size comparison.

The main disadvantage of a GDT is the ability to extinguish the arc current in the presence of high follow currents. Therefore, the project includes the development of a special design of GDT, which will be able to extinguish the follow current of up to 25,000 A. This will lead us to a new SPD application where the GDT can be independently used between the line and the neutral (L-N).

Research group working on the development of gas discharge tubes (GDTs): from left to right, Dr Robert Rozman, M. Sc. Andrej Pregelj, France Brecelj and Beno Pehani.

Liquid-Crystal light shutters for personal protection

Jožef Stefan Institute
Centre of Excellence NAMASTE
Balder Ltd

Prof. Janez Pirš,
M. Sc. Bojan Marin,
Bernarda Urankar,
Dušan Ponikvar

The technology for liquid-crystal applications has made an important breakthrough in the past ten years. The new, high-resolution LCD display panels for computer monitors and TV display panels have made liquid crystals the key technology for display applications. However, a number of non-display applications have immerged as well.

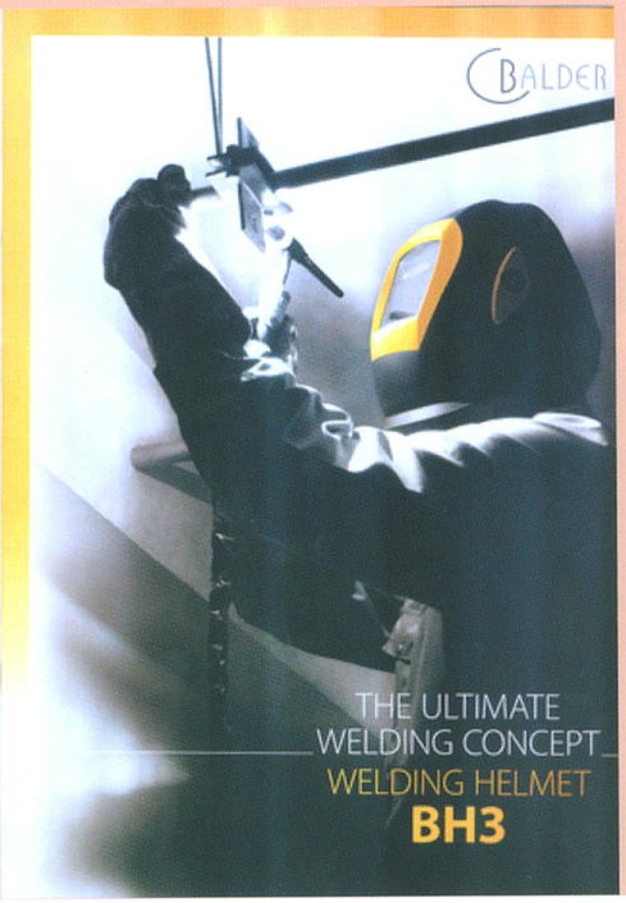
A typical example of this is LCD optical light shutters that allow for electrical control of the transmitted light based on the electrical and optical anisotropy of these materials. The most widespread application is automatic LCD protective light filters for personal protection in welding. With the difference from, e.g., regular high-definition TV screen having 2 million (1920 x 1080) display pixels (local light shutters) allowing for displaying images, the LCD protective light filters have only one such switching element, controlled by two electrodes. Compared to a standard display pixel (of the, e.g., TV screen) the LCD light switching protective filter must be able to:

- reduce the incident light by 1000 times more than a display pixel of a TV screen
- provide passive protection against harmful IR- and UV-light generated during the welding process
- selectively detect the welding light and modulate the transmitted light accordingly

Such extreme performance can be achieved only by:

- two LCD light shutters in tandem with a built-in optical compensation layer,
- a much higher driving electric field,

an additional passive optical band-pass filter transmitting incident light only in the visible spectral range.



As is evident from the figure, such a protective automatic optical filter is in fact a multilayer laminate comprising two LCD cells with additional optical compensation layers, four polarizing filters and a protective passive optical filter that reflects harmful infrared and ultraviolet light generated during the welding process.

The protective welding helmet with a built-in automatic LCD light-switching filter significantly improves the working conditions for the welder. It provides the welder with complete protection as well as normal vision before, during and after the welding, without continuous "lifting and lowering" of the protective helmet. So the welder has both hands free and can perform his/her work much more efficiently - and much better.

In the course of a number of its research projects (NATO SfP, EU-FW5, as well as ARRS and TIA), the Jožef Stefan Institute (IJS) has developed an improved the LCD light-shutter concept for personal protection applications. A number of original technical solutions (5 granted international patents) allow the IJS spin-off Company Balder Ltd to offer its new product line "ADC-plus" protective welding filters on the world market (3M, Honeywell, etc.) as the only automatic welding filters in the world that can be labelled with the prestigious marking DIN Plus 1/1/1/1 or CE 1/1/1/1 (maximal optical quality) according to the international standard EN 379. On the grounds of the high performance of these products the International Standard Organization (ISO) invited the Jožef Stefan Institute and Balder Ltd to actively participate in its expert group ISO/TC94/SC6/WG2 and WG4 preparing the new ISO Standard: "Occupational Eye and Face Protection". Within CoE NAMASTE a number of improvements is expected.

DIN-Plus 1/1/1/1, CE1/1/1/1 - quality certificate

Chemical Sensors and their Applications in Traceability and Safety Systems

Faculty of Electrical Engineering, University of Ljubljana
Centre of Excellence NAMASTE
Prof. Anton Pleteršek,
Prof. Janez Trontelj

The R&D activities of the Laboratory for Microelectronics (LMFE) are based on the market potential of non-contact food traceability, control, and the recording of storage conditions by monitoring temperature, humidity, shock, CO_2, chemicals, etc. For instance, a good example is monitoring the temperature and humidity in grain silos and performing a real-time analysis of the logged data. Monitoring individual staff members by usage of hand disinfectant on a continuous basis is again a good example. There are a number of other applications that will require highly selective sensors, for instance, for blood pressure by mobile applications. For any mobile and continuously operating application the final device should be as compact as possible and also offer a long battery life.

To this end, we have evaluated metal-oxide MOS-based sensors from different manufacturers in an integrated system and verified its operation in a laboratory environment. A lot of progress was made toward capacitive-based polymer sensors. Polymer-based sensors are promising because of their reduced power consumption and have therefore been the focus of much attention. The challenges in their design and fabrication are in their higher sensitivity to ambient humidity, selecting the most suitable polymers and the need for additional micromachining steps in their fabrication.

The most widely available commercially are metal-oxide semiconductor sensors based on tin dioxide (SnO_2) films. Their advantages are the low sensitivity to humidity and easy availability on the market. Their great disadvantage, however, is their large power consumption, due to the need for elevated temperatures during proper operation.

Therefore, the LMFE research is focused on developing low-cost, more sensitive, more selectively sensitive and micro-power-consuming chemical gas sensors. As polymer sensors are preferred because of their low power consumption due to the lack of heating, unlike resistive sensors which are heated, LMFE began to develop these sensors.

For proof-of-concept we have developed an analogue front end (AFE) for a resistive and capacitive-type polymer-based chemical sensor. It is designed to sense the change in resistivity or capacitance only. An absolute measurement is, therefore, not a major task; it is more important to acquire changes, and the total change in a predefined time frame. This time frame depends on the application and has to be selectable by the customer. An application may trigger the AFE to start logging or may permanently scan the sensor and process information, verifying and logging data to the internal memory. As polymer-based sensors are very sensitive to humidity, we have developed two sensing methods. The first one uses a capacitive sensor that is sensitive to chemical vapour only, and the second, that uses two sensors combined into a differential architecture, where both are equally sensitive to humidity while only one sensor is highly sensitive to the selected vapour.

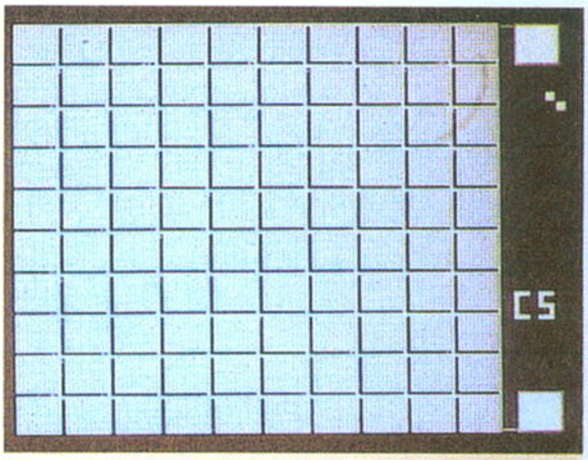


Figure 1: Capacitive sensor, developed in the Laboratory for Microelectronics, LMFE.

The continuous development of new chemical sensors is necessary. An important message also comes from the economic issue, i.e., only robust, reliable, rapid-recovery and low-cost solutions will be acceptable for a high-consumption market.

The LMFE currently investigates the development of low-power, resistive micro-sensors, based on a MEMS SnO_2 micro detector, placed over the thin nitride/oxide membrane, as shown in Figure 2.

The low-power analogue chemical sensors are still not commercially available. This is particularly so for sensors that are highly selectively sensitive to a specific chemical substance and insensitive to environmental conditions, such as humidity and temperature.

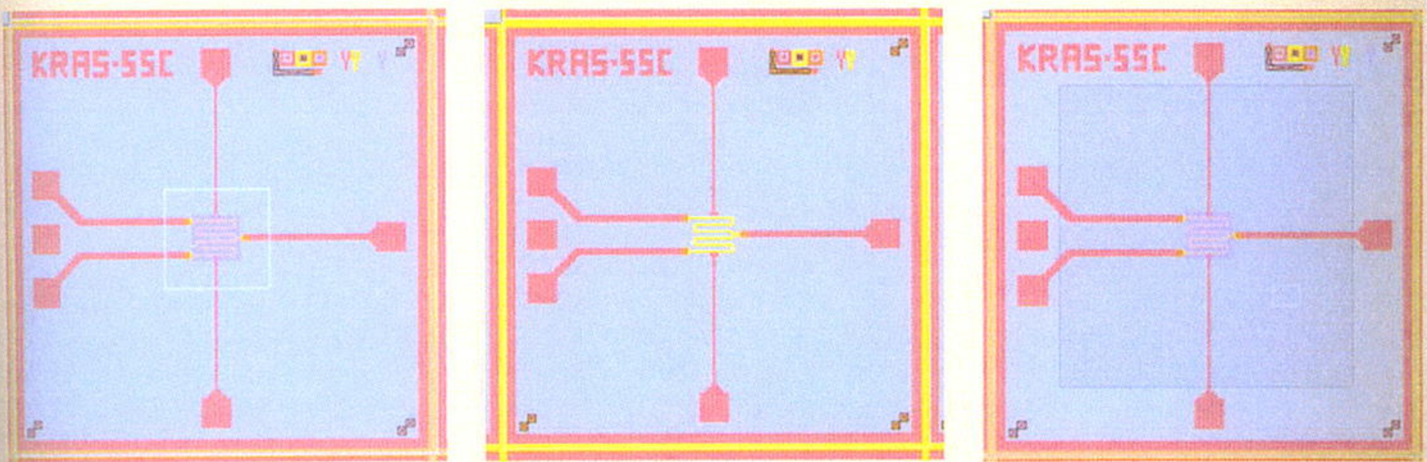


Figure 2: Mask set for low-power resistive chemical sensor that requires only 1mA current at a 3V supply.

Electrocaloric Materials/ Advanced Materials and Technologies for the Future

Centre of Excellence NAMASTE
Jožef Stefan Institute
Dr Hana Uršič

In the framework of the project "Advanced Materials and Technologies for the Future" the topic of electrocaloric materials is studied. The electrocaloric effect is described as a reversible temperature change of the material under an applied electric field at adiabatic condition. In other words, the material heats up or cools down due to an increase or decrease of the applied electric field, respectively. The electrocaloric effect is of great importance for applications in new-generation cooling and heating devices, which would be friendlier to the environment and would contribute to a reduction in power consumption. In this work group high-resolution calorimetry, dielectric spectroscopy and measurements of polarization are carried out on relaxor and ferroelectric bulk ceramics, thick and thin films in order to determine the magnitude of the electrocaloric effect. The studied materials are lead-based, such as $Pb(Mg_{1/3}Nb_{2/3})O_3$, $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ and $(Pb,La)(Ti,Zr)O_3$ and also environment-friendly lead-free materials, for example, $K_{0.5}Na_{0.5}NbO_3$-$SrTiO_3$. The development of new electrocaloric materials may open up new opportunities and ideas for further applicative tasks in cooling and heating applications.

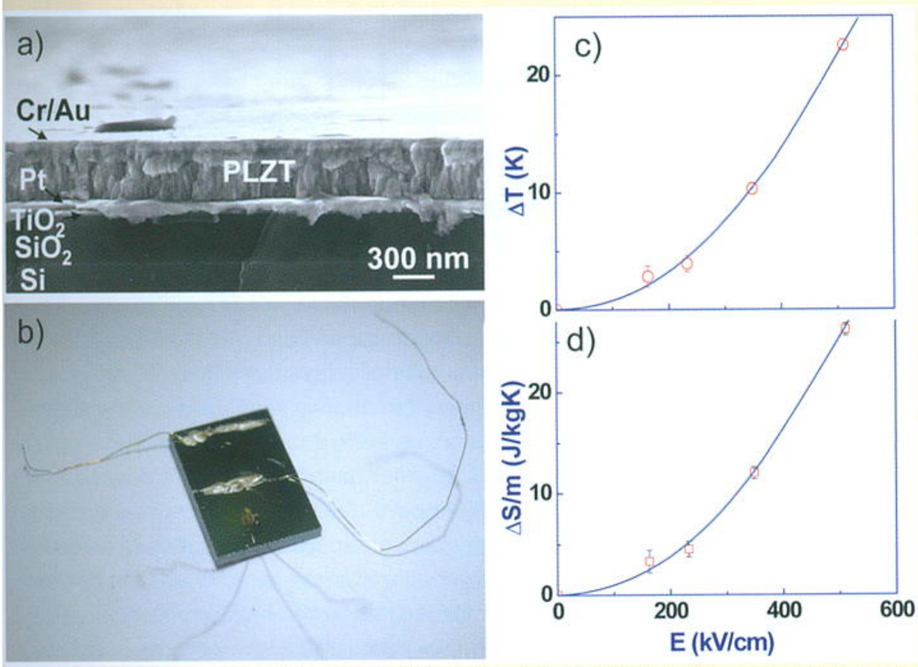


Figure 1: Microstructure of $(Pb_{0.88}La_{0.08})(Zr_{0.65}Ti_{0.35})O_3$ (PLZT) thin film on platinized silicon substrate (a) photograph of the thin-film sample with the electrical contacts (b) the temperature change (c) and entropy (d) vs. applied electric field measured using direct electrocaloric measurements. (By courtesy of Prof. Barbara Malič)

R&D of scaffolds: medical devices market waiting for a new boost

Jožef Stefan Institute
University of Maribor
Educell Ltd.
Centre of Excellence NAMASTE

Prof. Janez Štrancar

The significant increase in age-related diseases accompanying the aging of our population makes tissue engineering one of the fastest-growing sectors in the developed world. Unfortunately, this faster development is hindered by an incomplete understanding of the complex phenomena of cell-material interactions called biocompatibility. Current R&D activities mainly depend on trial-and-error bases, instead of relying on a knowledge-driven optimization of scaffold stability, porosity and degradation dynamics, as well as an elimination of the cell-stress response to different properties of the material surfaces. It is, therefore, not surprising that despite large investments, promising results remain sporadic.

Within the informal cooperation between the research groups of the Centre of Excellence NAMASTE, Jožef Stefan Institute, University of Maribor, a foreign research group at Politechnica di Torino as well as the biotechnological companies Educell d.o.o. (Ljubljana) and Di.pro (Torino) we focused on the systematic research of scaffolds made from biomaterials. With the application of newly developed biophysical techniques such as fluorescence and Raman micro-spectroscopy as well as optical micromanipulation, breakthroughs are expected in the understanding of the time-evolution of cell-material interactions and especially the response of both material and cells to each other. Phenomena like material degradation and restructuring as well as cell differentiation are very relevant and have an economic impact in the further developments of scaffolds and tissue engineering.

This intense research already provided an important result: through understanding the complex formation of scaffolds by freezing and crosslinking, we just recently developed a completely new protocol, which enables efficient sterilization together with porosity control, stability/degradability optimization, while speeding up the classical production protocol by almost four times. Such an achievement now opens up new opportunities for exploring the cell-material interaction in a much more defined and controlled way.

Virtual Electromagnetic Compatibility Lab Project

Centre of Excellence NAMASTE
Institute TC SEMTO – Technology centre for circuits, components, materials, technologies and equipment for electronic
Jožef Perne, B. Sc.

Centre of Excellence NAMASTE defines the scientific and technological aims for the materials being researched. It deals with specific sensor applications, protective elements in electrotechnics, actuators and others. The process of vertically connecting materials with elements and products is clearly defined. The demands for electromagnetic compatibility and demands for resistance, robustness and safety have to be taken into consideration in order to achieve optimal results. Predefined goals in the fields of electromagnetic compatibility elements, parts and products can be achieved by target researches and the development of materials.

The virtual electromagnetic compatibility (EMC) laboratory project improves the environment for measurements or tests and enhances problem-solving skills by connecting the knowledge, equipment and procedures in the field of EMC.

The aim of the project is to provide a database with measurements and capabilities of all the leading laboratories in the fields of EMC and security. This database could be then forwarded to potential users. The database would include information about the availability and utilization of equipment, measurement procedures and the capacity of measurements. Additional information about a certain laboratory would be filled with user experiences, their problem-solving skills, resistance to EMC interferences, stress-tests resistance and security tests. With the shared knowledge of the laboratories and their personnel, the end-user will be able to, not only characterize their problem, but also to solve it.

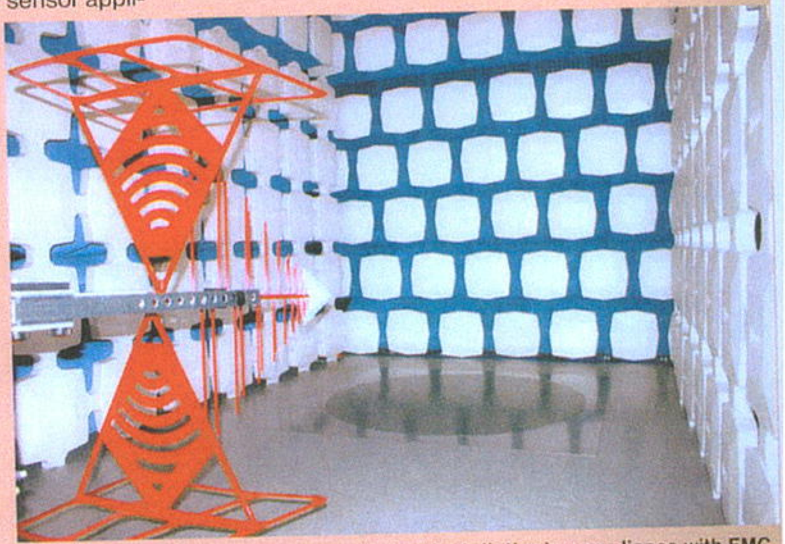


Figure 1: Chamber for assessment of an installation's compliance with EMC standards in the SIQ institute.

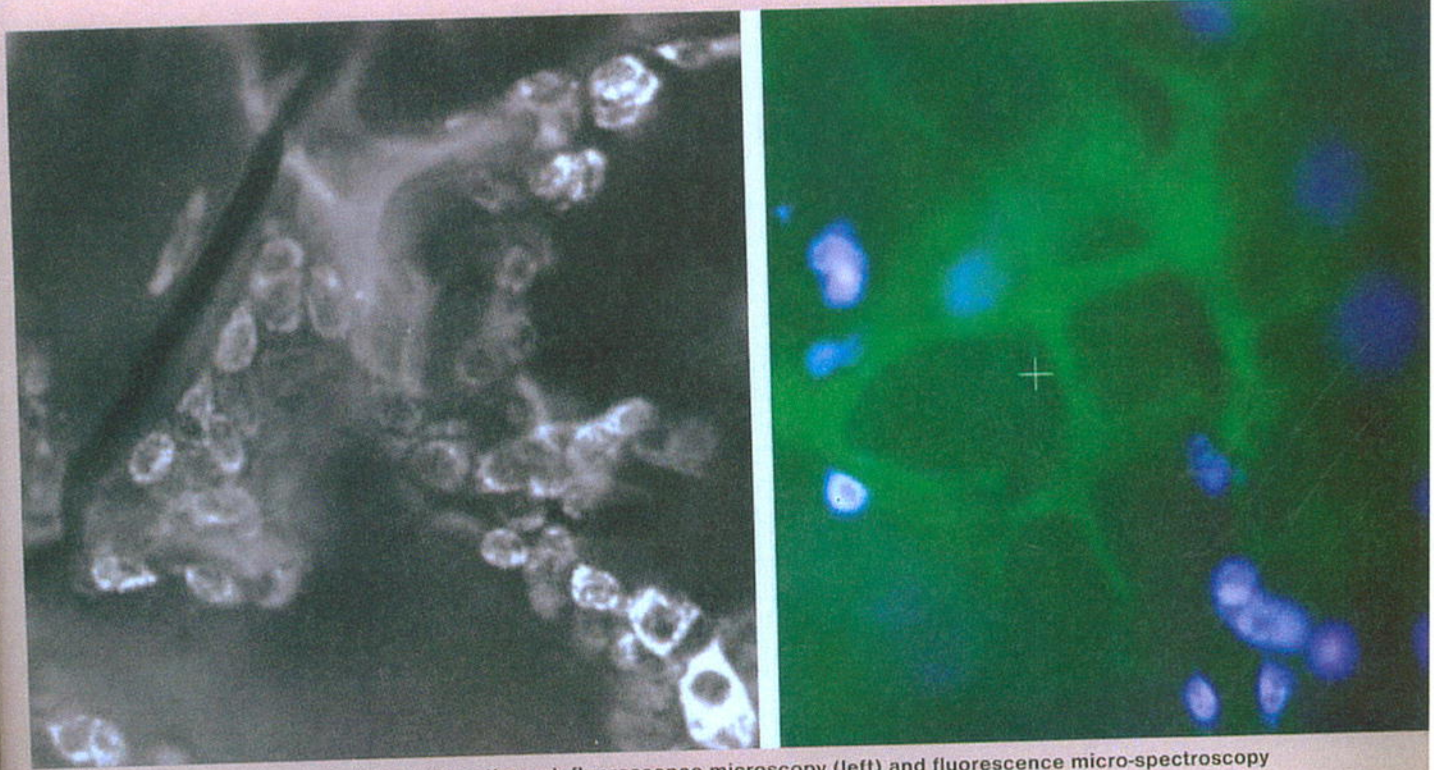


Figure 1: Exploring cell-material interactions through fluorescence microscopy (left) and fluorescence micro-spectroscopy (right), where color-coded signal reveals the local molecular environment changes, both in the material and the cell.

REPUBLIC OF SLOVENIA
MINISTRY OF EDUCATION, SCIENCE, CULTURE AND SPORT

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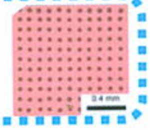
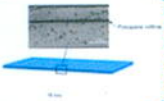
OPERATION PART FINANCED BY THE EUROPEAN UNION
European Regional Development Fund

Prototype of a piezoresistive pressure sensor made from LTTC ceramics

Ink-jet printing of suspensions
For example: TiO_2 structure



New material for the manufacture of cavities in LTCC structures



Low-doped varistor ceramics for the development of low-, medium- and high-voltage varistors

Different types of varistors

Development of prototypes based on magnetic composite materials for RFID applications

Connecting research institutions and industry to stimulate scientific, technological and business excellence

With **knowledge and experience** we study upcoming, fresh and interesting ideas for the market

RRP1
Ceramic microsystems

RRP2
Overvoltage and electromagnetic protection

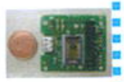
RRP3
New materials and technologies for advanced sensor systems

RRP4
Soft composites for optic, electronic, photonic and sensor applications

RRP5
Advanced bioactive, biocompatible and bioinert materials

RRP6
Project of new opportunities

UNOS measurement system for the detection of hazardous substances in the air

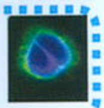


Ti-bolometer with antenna

Antimicrobial activity testing under real conditions

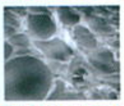
Nanoparticle tracking in cells by PIXE

Nanoparticle tracking in living cells by FMS



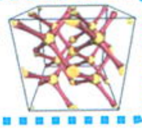
Nanoparticle detection in air - PCT WO/2010/050904)

Biopolymer scaffolds biocompatibility testing

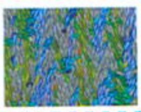


Liquid drop as a microresonator (Nature Photonics Cover)

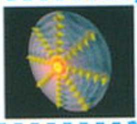
Blue-phase colloidal photon crystals



Main-chain liquid-crystal elastomers



The first 3D Liquid Microlaser



Elastomer composites with nanowires

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