



European  
Commission

# research<sup>★</sup>eu

RESULTS MAGAZINE

N°37  
NOVEMBER 2014

SPECIAL FEATURE

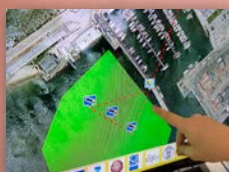
## CLOSE-UP ON NANOTECHNOLOGY



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**Published by**

The Community Research and Development Information Service (CORDIS) managed by the Publications Office of the European Union  
2, rue Mercier  
2985 Luxembourg  
LUXEMBOURG  
[cordis@publications.europa.eu](mailto:cordis@publications.europa.eu)

**Editorial coordination**

Zsafia Toth

The *research\*eu results magazine* is published by the Community Research and Development Information Service (CORDIS) and managed by the Publications Office of the European Union. Content is prepared using several sources, including CORDIS, the Research Information Centre, ERC, as well as original material collected specifically for this publication.

The *research\*eu* magazines are free of charge.

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ISSN 1831-9947 (printed version)

ISSN 1977-4028 (PDF, EPUB)

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# EDITORIAL

*by the editorial team*

## UBIQUITOUS NANOTECHNOLOGY

When it first earned public recognition in the early 2000s, nanotechnology was mostly a niche market. It started out with a few applications such as cosmetics, food products, textiles and automotive bumpers, but quickly expanded to other sectors. Recently, the growing market reached the frantic pace of 3 or 4 new products being released each week.

Decision-makers worldwide were quick to acknowledge this tremendous potential — although not without apprehension. In 2004, right after the US Congress came up with its '21st Century Nanotechnology Research and Development Act', the European Commission adopted its communication 'Towards a European Strategy for Nanotechnology' which aimed to institutionalise R&D efforts with a coherent strategy.

The document notably underlined nanotechnology's capacity to address the challenges faced by society through novel applications for the likes of health and biology, ICT, energy production and storage, manufacturing and environment protection.

This was 10 years ago. Since then, the EU has invested some

EUR 3.5 billion in nanotechnology-related projects, both to develop new products in strategic fields and to ensure all potential uses are subjected to thorough safety controls and measures. As we are now at the dawn of Horizon 2020, we decided to focus this magazine on some of the latest EU research achievements under the FP7-NMP programme. This makes for a truly horizontal 'special' section, with themes including art conservation, electronics, water purification, clothing, building and construction and nanosafety.

These specials include two interviews. The first is with Sabine Paulussen, who presents the outcomes of NANOPUR and its new membrane technology to improve the efficiency of water purification. Then, Prof. Piero Baglioni introduces NANOFORART, a project with ambitions to help restorers in their difficult mission to preserve ancient works of art.

The special section is followed by the usual thematic sections on biology and medicine, social sciences and humanities, energy and transport, environment, IT and telecommunications, industrial technologies and space.

For any question, please feel free to contact us at [editorial@cordis.europa.eu](mailto:editorial@cordis.europa.eu)



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**Focus on**  
Will hydrogen bring about a revolution in our lifestyles?



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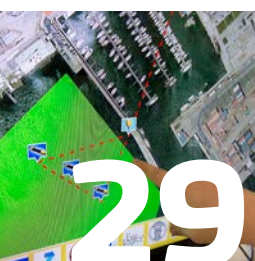
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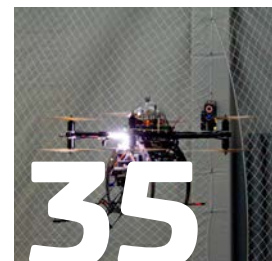
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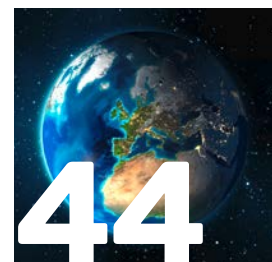
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**SPECIAL FEATURE****CLOSE-UP  
ON NANOTECHNOLOGY**

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INTERVIEW

**HIGH FLUXES  
FOR WATER FILTRATION**

Combine water scarcity with an ever growing population, and society is faced with a major question: how can we increase the productivity of water filtration systems while maintaining the highest standards for drinking water purity? The NANOPUR project is offering a solution in the form of a novel membrane, which should be rolled out within the next two to five years.

As European citizens, our daily use of running water has become increasingly mechanical. Not only do we drink water from the tap in all confidence, but we never really question its origins or quality. So far, available technologies have been satisfying in this regard: behind the scenes, filtration and sanitation processes clean water to remove traces of micro-pollutants and viruses, so that used water can become

drinkable once again. Thanks to these processes, which include membrane-based filtration, the likes of pharmaceutical products, endocrine disrupting compounds, pesticides and industrial chemicals can safely be extracted from treated water.

But are current technologies really efficient? According to Sabine Paulussen, coordinator of the NANOPUR (Development of functionalized nano-structured polymeric

membranes and related manufacturing processes for water purification) project, concentrations of several micro-pollutants in surface water are still exceeding 'Human health limits' (HHL), indicating the need for robust drinking water treatment to safeguard consumers from potential health risks.

Another problem lies in membrane fouling: Today, membrane processes rely on size exclusion. The pores of filtration membranes are very narrow,





which translates into very limited water fluxes. This means the filtration process is not as efficient as it could be, and with society's growing needs

*"We are aiming for energy consumption 500 times lower than that of reverse osmosis processes, for a similar retention of viruses and micropollutants."*

for fresh water and increased water scarcity, these limitations can become a problem.

With the aim of tackling these issues, the NANOPUR project is developing artificial membranes which combine the selectivity of biological membranes with the mechanical strength and productivity of state-of-the-art artificial ones. The project promises selectivity vis-à-vis pathogens of up to 99.99999% and towards micropollutants of up to 99%, along with higher permeability and reduced energy consumption.

Sabine Paulussen explains what makes the new membranes so innovative, and discusses future steps towards their commercialisation.

★ **What are the main objectives of the project?**

**Sabine Paulussen:** The NANOPUR project aims to develop nano-structured and nano-functionalised membranes able to remove viruses and organic micropollutants from water, either for 'Point of entry' (POE) or 'Point of use' (POU) applications.

The key concept is to overcome the frustration arising from the seemingly unbreakable linkage between increased retention and lowered water flow through the membrane when it comes to producing safe and pure drinking water. The membranes that are being developed under the NANOPUR project are characterised by improved retention of viruses and micropollutants, while high fluxes can be applied and maintained by reducing the fouling propensity of the membranes.

For this aim, nano-structured, low-fouling membranes are being developed by bottom-up synthesis, for a better control of porosity, pore size distribution, hierarchical orientation of the pores, surface roughness and surface energy. Simultaneously, ligands for supramolecular recognition, in particular 'Molecularly imprinted polymers' (MIPs) are being developed and immobilised onto the newly developed membranes for an effective capture of viruses and micropollutants.

★ **What do you expect in terms of performance compared to existing technologies?**

Today, membrane processes (reverse osmosis) are already applied for the removal of micropollutants and viruses, but they rely on size exclusion. Given the small size of viruses and especially organic micropollutants, membranes with very narrow pores have to be used, giving rise to high process pressures and low water fluxes through the membrane. In addition, frequent cleaning procedures are needed. The NANOPUR concept is providing an efficient solution to overcome these problems.

Moreover, we are aiming for energy consumption 500 times lower than that of reverse osmosis processes, for a similar retention of viruses and micropollutants.

★ **What were the main difficulties you faced in the development of these membranes?**

The main difficulties were related to increasing the water flux through the membranes while maintaining their pore size and the connection between the membrane and the affinity ligands/MIPs. Both issues were at least partly tackled by applying atmospheric plasma technology to modify the surface energy of the membranes, including their pore network, and to generate functional groups at the surface. The latter can serve as anchorage points for MIP immobilisation.

★ **How promising are the results obtained so far?**

We actually managed to immobilise MIPs onto functionalised membranes while showing very good retention of some specific micropollutants. What's more, these results are obtained without the need to apply any pressure.

★ **When do you expect this technology to hit the market?**

The project ends in April 2015, and we have high hopes of seeing the technology commercialised within the next two to five years.

★ **What are the next steps for the project, and do you have any follow-up plans after its end?**

Over the next six months, we will focus on testing the newly developed membranes at pilot scale. The membranes will be used for the treatment of realistic waste waters contaminated by micropollutants.

**NANOPUR**

- ★ Coordinated by VITO in Belgium.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/project/rcn/103429\\_en.html](http://cordis.europa.eu/project/rcn/103429_en.html)

**SABINE PAULUSSEN**





## TAKING SOLID-STATE DEVICES INTO A NEW DIMENSION

EU-funded scientists have found a new way to make solid-state devices smaller and more efficient. The technique uses self-assembled defect-free nanowire structures made of gallium arsenide (GaAs) that are grown on a silicon (Si) substrate.

There are other major routes that can push the Si semiconductor technology beyond its limits. The integration of low-cost Si with other high-performance materials and the use of new nano-scale device structures are under extensive investigation. At such scales, the quantum-physical effects become important and provide advanced functionalities for photonic and electronic units.

*“Project achievements included an optically-pumped nanowire laser, emitting infrared light by using surface passivated GaAs and AlGaAs core-shell nanowires.”*

The EU-funded project III-V NWS ON SI (Self-assembled growth of III V semiconductor nanowires on Si for future photonic and high electron mobility applications) merged these two routes in a bid to allow the race for miniaturisation to continue and develop powerful devices. Scientists worked on integrating compound semiconductor nanostructures — based on materials in groups III-V — on Si.

Focus was placed on direct band-gap semiconductor nanowires of the GaAs family that are materials of high-optical activity and high-electron mobility. They also enable precise tuning of many intrinsic properties through heterostructure and band-gap engineering with related alloys. Their one-dimensional geometry offers the possibility to exploit the awesome potential of quantum-physical effects and for them to be integrated on very dissimilar substrates, such as Si.

Scientists employed the molecular beam epitaxy method to fabricate crystalline semiconductor materials. Based on this, completely catalyst-free indium (In)Ga and GaAs nanowires were grown on Si with superior

morphological and compositional homogeneity. By employing diverse nanometrology techniques, structural, optical and electronic nanowire properties were characterised and tuned to get devices with exceptional functionalities.

Project achievements included an optically-pumped nanowire laser, emitting infrared light by using surface passivated GaAs and AlGaAs core-shell nanowires. Furthermore, project members developed nanowire-based tunnel diodes integrated on Si that can be used in tunnelling field-effect transistors. Finally, a core-shell nanowire heterostructure that incorporates modulation doping led to

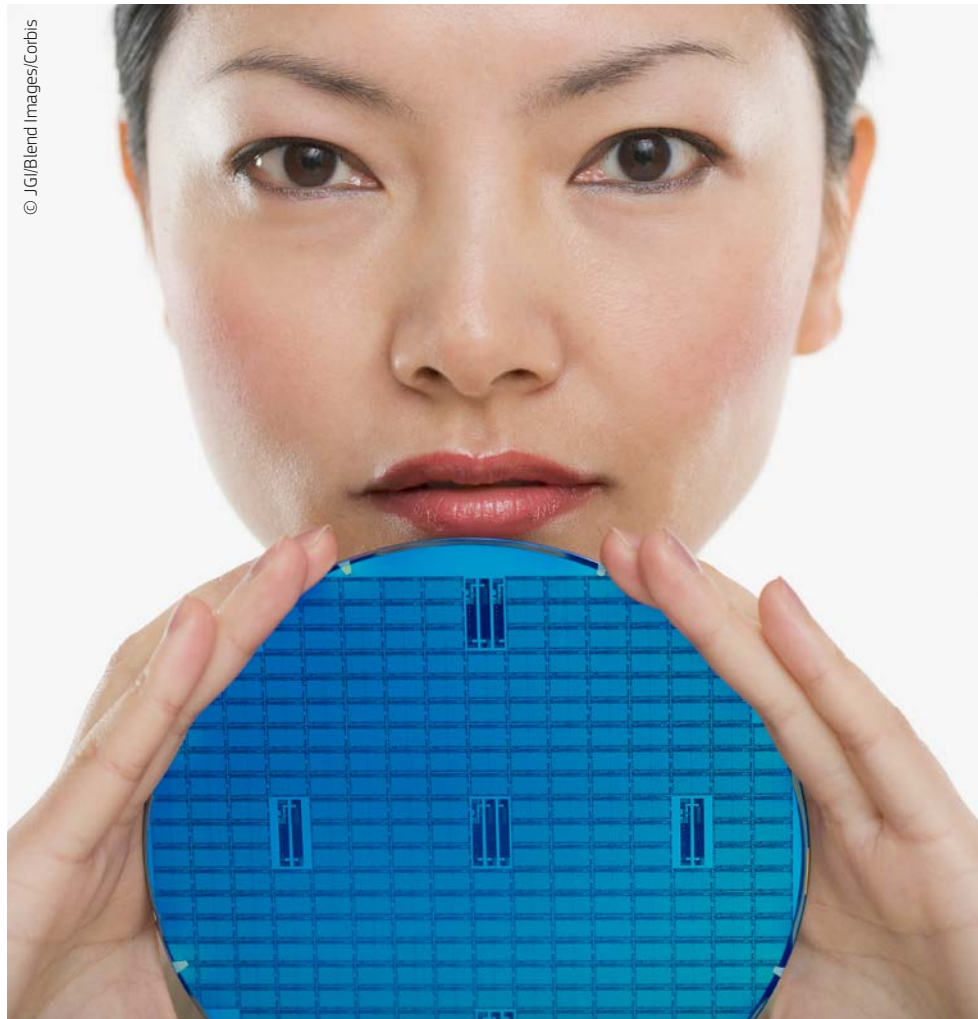
much higher electron mobilities compared to the state-of-the-art.

The project findings play an important role in Europe's drive toward ultra-small, high-efficiency solid-state devices. These can find application in a range of different fields such as integrated nanophotonics, light emitters and absorbers, sensing, and information and communication technology.

### III-V NWS ON SI

- ★ Coordinated by the Technical University of Munich in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/93132\\_en.html](http://cordis.europa.eu/project/rcn/93132_en.html)

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# NANOMATERIALS TO PRESERVE ANCIENT WORKS OF ART

Little would we know about history if it weren't for books and works of art. But as time goes by, conserving this evidence of the past is becoming more and more of a struggle. Could this all change thanks to the NANOFORART project? In an effort to overcome the limitations of traditional restoration techniques, the team has developed promising nanomaterials which are expected to hit the market soon.



© NANOFORART

For many people, discovering an unknown city or country rarely comes without its share of art museums and exhibitions. Unique work of arts are indeed an integral part of what makes culture and history so fascinating, and their trade weighs quite heavily in today's economies. In 2013, the global art market generated some EUR47.42 billion, according to the European Fine Art Foundation.

This all explains why art conservation is becoming more and more of a concern. The most ancient works of art are increasingly suffering the ravages of time, while traditional restoration techniques pose serious problems in terms of physico-chemical compatibility with substances contained in artefacts and toxicity. The materials commonly used for restoration, such as coatings of synthetic polymers or inorganic materials, have a different composition than that of the original artefacts which causes them to alter their main properties.

This is where the NANOFORART (Nano-materials for the conservation and preservation of movable and immovable artworks) project comes in. The three-year project, which ends this month, has developed advanced nanomaterials for preventive conservation of works of art. In this exclusive interview for the *research\*eu results magazine*, Prof. Piero Baglioni sheds light on the main benefits of these new products, the advances made by his team and the expected commercialisation date, and expands on what's to come under Horizon 2020.

## ★ What are the main objectives of the project?

**Prof. Piero Baglioni:** The lack of physico-chemical compatibility between restoration materials and artefacts, along with the former's toxicity, were the two main aspects that prompted us to propose the NANOFORART project. At the time, we had been working on the development of effective conservation methodologies since the 1990s, and our activity had

already been acknowledged within both scientific and conservation communities.

Our main aim was to improve the methodologies already developed in the lab and partly tested in several conservation workshops across the world, and make them available on a large scale. This involved nanomaterials that are physico-chemically compatible with the components of works of art, and are either not toxic or have a significantly reduced toxicity level compared to traditional restoration materials like solvents.

## ★ What's so innovative about the solutions you propose?

The advanced nanomaterials we have been working on allow for a more precise control of the restoration intervention, for example controlled cleaning can be carried out using micro-emulsions and chemical hydrogels instead of traditional cleaning methods. The approaches we propose are more reliable than traditional ones, and in some cases allow for a gradual and slower (safer) restoration process.

Overall, the new methods also guarantee stability of the treated artefacts over the long term, as opposed to 'quick' traditional interventions that might have some drawbacks, making later interventions necessary.

## ★ How do you explain the lack of advances in conservation techniques?

To give an example, let us consider a wall painting or an easel painting: from a physico-chemical point of view, the painting is typically a layered structure, the surface layers usually being the painted part. Moreover, the materials are usually porous or exhibit a complex composition — they can be classified as composite materials, which means that you need materials science and colloid and surface science to understand and eventually rescue these materials from possible degradation processes.

Properly addressing conservation issues therefore requires a transfer of knowledge from these fields to professionals coming from the humanistic and artistic fields. Such transfer of knowledge is not straightforward. It requires much dedication and strict cooperation mechanisms between many different interdisciplinary groups and institutions.

Before NANOFORART, such interactions existed but almost exclusively to develop advanced diagnostic techniques for the characterisation of works of art and their degradation processes. While being essential, these diagnostic techniques cannot be considered as an exclusive method for fulfilling this task. We could compare preservation of cultural heritage to medicine, where the works of art play the role of the patients: diagnostic techniques are fundamental to understanding the disease (degradation processes), but must then be complemented by the development of medicines (advanced restoration materials) to cure the patient (restore the work of art).



© Prof. Piero Baglioni

**PROF. PIERO BAGLIONI**

These are the main reasons that so far have slowed down advances in conservation techniques.

★ **What were the main difficulties you faced in the development of these new materials?**

Actually, if one has the right knowledge, there are no major difficulties in the development of new materials. The main difficulty lies in the fact that optimising the developed materials is time consuming and requires very in-depth knowledge of multidisciplinary fields. The number of degradation processes affecting a large variety of works of art requires the development of new methodologies and materials, whose formulation poses significant challenges in terms of human resources.

★ **What do you expect in terms of performance compared to existing technologies?**

The new materials we developed are significantly different from traditional methods. They are tailored to the conservation task and take advantage of concepts and solutions provided by advanced materials and colloid sciences, and more generally nanosciences.

These materials are able to resolve degradation issues while respecting the physical chemistry properties of the original artefacts, which is key to the long-term stability of the treated works of art and their availability to future generations.

There are plenty of examples showing how traditional materials can be detrimental to works of art, for instance wall paintings treated with acrylic and vinyl polymers that seriously damage the painting and in many cases have led to the loss of painted surfaces.

★ **What are the most promising materials you developed?**

The project has been successful in producing and effectively testing several new materials for the conservation of works of art, four of which hold much promise.

The first is the dispersion of calcium hydroxide nanoparticles in short chain alcohols for the consolidation of wall paintings, plasters and stone. These reinforce the artefacts without altering their physico-chemical properties.

The second is the dispersion of alkaline nanoparticles in either short chain alcohols or water for the pH control of

movable works of art such as paper, parchment and leather. These materials are extremely useful for limiting the acidic and oxidative degradation of manuscripts and archival/historical documents.

We also came up with nano-structured cleaning fluids such as oil-in-water microemulsions for the removal of dirt and unwanted coatings on works of art. One of the main advantages in using these fluids is that they exhibit a depressed eco-toxicological impact with respect to traditional solvent blends, while still providing high cleaning effectiveness.

Finally, we developed containers such as chemical gels for the delivery and controlled release of the cleaning fluids on water-sensitive surfaces such as paper, parchment and leather. These gels can be applied without leaving residues on the surface of artefacts, as opposed to traditional 'gel-like' thickeners.

★ **When do you expect this technology to hit the market?**

Dispersions of nanoparticles of calcium hydroxide for the consolidation of wall paintings, plasters and stone are already available to conservators worldwide under the trademark Nanorestore®.

Nanoparticles for the pH control of movable works of art (e.g. paper, wood, canvas) have been branded under the trademark Nanorestore Paper®; gels and microemulsions for the cleaning of wall and easel paintings have been branded as Nanorestore Gel® and Nanorestore Cleaning®. These technologies will be available soon.

★ **What are the next steps for the project, and do you have any follow-up plans after its end?**

We are still faced with a gap in preservation strategies and materials for modern and contemporary works of art such as acrylic paintings, plastic sculptures and composite works that include metal, textiles, polymers, etc. For instance, post-1940 artists used and experimented with materials that are radically different from the ones used in classic art, thus they cannot be preserved using the currently available methodologies. These artefacts often exhibit extremely fast degradation processes, and there is a risk that some of this heritage will be lost within the next 100 years if effective solutions are not found.

This is the reason why we are proposing a new project within the Horizon 2020 call named 'Nanorestart' (Nanomaterials for the REStoration of the works of modern ART, to highlight the new start with respect to classic art conservation) that aims to conserve modern/contemporary works of art. In order to address this challenge, we have created a unique partnership that groups research institutions and materials science experts together with high-profile museums, conservation centres and experienced professionals in the field of modern art preservation. Leading industrial partners have also been involved to provide the scalability of the restoration materials we will develop, and the transfer of technology to meet market needs.

#### NANOFORART

★ Coordinated by CSGI in Italy.

★ Funded under FP7-NMP.

★ [http://cordis.europa.eu/project/rcn/101376\\_en.html](http://cordis.europa.eu/project/rcn/101376_en.html)



# KNOWLEDGE-BASED TESTING FOR NANOMATERIALS

Engineered nanomaterials are becoming ubiquitous, yet assessing their risks to public health and the environment is lagging behind. EU-funded scientists developed a prioritised research agenda to produce an intelligent testing strategy.

Nanomaterials have at least one dimension on the scale of atoms or molecules (nanoscale). They exhibit unique properties very different from their bulk forms due to their large surface areas relative to their volumes. These useful properties may, unfortunately, also impose unusual risks to humans and the environment.

*“ITS-NANO delivered a research agenda highlighting short-, mid- and long-term priorities to facilitate risk assessment and identification of high-risk materials.”*

As the number of nanomaterial-based products on the market continues to grow rapidly, developing a knowledge-based and standardised testing strategy is imperative. Responding to this urgent need, EU-funded scientists initiated the project ITS-NANO (Intelligent

testing strategy for engineered nanomaterials).

Partners sought to establish a roadmap for development of advanced tools and databases that help assess risks through knowledge-based decisions. For this purpose, researchers combined comprehensive physico-chemical, exposure and modelling data with focused experimental testing.

To ensure accurate and reliable grouping and ranking systems, research into new approaches for grouping and ranking is required. A research agenda was therefore established and prioritised by ITS-NANO partners.

Scientists considered both present needs and gaps as well as mid-term and future priorities. They laid the foundations for a robust intelligent testing strategy that will yield accurate answers to appropriate questions in a timely and cost-effective way.

ITS-NANO delivered a research agenda highlighting short-, mid- and long-term priorities to facilitate risk assessment, identification of high-risk

materials and implementation of suitable risk-mitigation strategies. In addition, the plan was generated to gradually decrease reliance on experimental testing while increasing the use of computational models with availability of more data.

The project's intelligent testing strategy has already been taken up by two Seventh Framework Programme projects. Eventual international agreement on intelligent testing of engineered nanomaterials will lead to appropriate certification and regulation policies. Thus, ITS-NANO has made an important contribution to ensuring protection of public health and the environment while sustainably introducing new products to market.

## ITS-NANO

- ★ Coordinated by the Heriot-Watt University in the United Kingdom.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/project/rcn/102987\\_en.html](http://cordis.europa.eu/project/rcn/102987_en.html)
- ★ Project website: <http://www.its-nano.eu>





## NANOANTENNAE FOR DISEASE-RELATED SIGNALS

EU-funded scientists have developed highly sensitive and specific detectors of disease-associated proteins. Technology paves the way to simple blood tests that identify the onset of important diseases for more effective treatment.

Untangling the biological pathways mediating diseases has enabled scientists to identify numerous disease-specific biomarkers for detection in bodily fluids such as blood, serum and saliva. The EU-funded project NANOANTENNA (Development of a high sensitive and specific nanobiosensor based on surface enhanced vibrational spectroscopy dedicated to the *in vitro* proteins detection and disease diagnosis) made an important contribution to

diagnostic medicine with nanobiosensors consisting of metallic 'nanoparticles' (NPs) functionalised with bioreceptors specific to target proteins.

The metallic NPs act as optical nanoantennae and detect

the vibrational frequencies of the molecules of interest by matching their frequency. This enables them to increase the signal rather than dampen it. Determination of the spectral signatures of the protein biomarkers of interest

provided the basis for detection and identification. It also facilitated creation of a powerful database for future research and development.

The prototype nanobiosensors were able to robustly detect low concentrations of a target protein associated with cellular metabolism and oxidative stress. This protein is a potential biomarker of liver disease, cardiovascular pathologies and cancer. It was detected with great success in both serum and saliva at levels that are quite promising and competitive with other available techniques.

NANOANTENNA provided important proof of concept of detection of targeted biomarker proteins in bodily fluids at low concentrations with their nanobiosensors. *In vitro* detection paves the way to early diagnosis of major diseases for preventive and therapeutic treatment to improve patient outcomes. Two industrial partners plan to continue collaboration on development of the actual diagnostic device. With their combined experience and established cooperation, simple point of care diagnosis may be around the corner.

*"NANOANTENNA provided important proof of concept of detection of targeted biomarker proteins in bodily fluids at low concentrations with their nanobiosensors."*

### NANOANTENNA

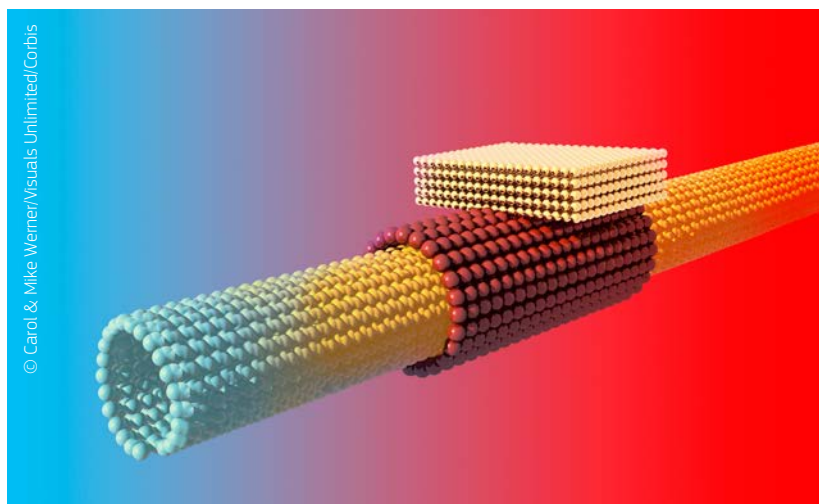
- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/project/rcn/92196\\_en.html](http://cordis.europa.eu/project/rcn/92196_en.html)
- ★ Project website: <http://www.nanoantenna.eu/>

## CARBON NANOTUBES TO COOL ELECTRONICS

Electronic devices dissipate heat that can compromise the function of the devices themselves. A novel on-chip thermal management solution exploiting carbon nanotubes will help scientists realise smaller and more powerful circuits.

Desktop computers use fans to cool electronic components. Miniaturising electronic circuits while increasing functionality requires the use of integrated thermal management technologies directly on individual silicon chips, ceramics and organic laminates. Thermal management is thus a critical enabling technology and EU-funded scientists working on the project THEMA-CNT (Thermal management with carbon nanotube architectures) set out to make sure the EU will have an advantage over American and Asian competitors.

THEMA-CNT developed cooling technology from carbon nanotube architectures and post-mounted them on silicon chips/wafers and ceramic packages. In some cases, the carbon nanotubes were even grown directly on the



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substrates. The technology is thus directly compatible with conventional silicon fabrication and micromodule packaging technologies, making it easy and inexpensive to commercialise.

Thermal management becomes even more complex and important in 'three-dimensional' (3D) stacking of silicon wafers and integrated circuits. 3D integration is the way of the future for





*“Thermal management is one of the most critical issues for today’s and tomorrow’s high-performance electronic devices.”*

greater density and functionality in smaller packages with shorter connection lengths. THEMA-CNT’s innovative cooling technology was demonstrated in such stacked, 3D systems (‘Through-silicon vias’ or TSVs) in which vertical interconnect access (via) passes completely through a silicon wafer. Copper-filled

vias are not feasible because copper expansion is greater than the surrounding silicon for the same amount of heat. This causes mechanical problems and even breakage that can be resolved with the use of carbon nanotubes instead of copper.

The team also studied the health and safety of carbon nanotubes contained within thermally conductive adhesives for consumer products. They found no increase in carbon nanotube exposure compared to control, confirming the safety of the test samples prepared by the consortium.

Thermal management is one of the most critical issues for today’s and

tomorrow’s high-performance electronic devices. The cost-effective, nanotube-based cooling devices developed within THEMA-CNT have enormous market potential. This could place the EU at the forefront of an important research and technology development area.

#### THEMA-CNT

★ Coordinated by the University of Oulu in Finland.

★ Funded under FP7-NMP.

★ [http://cordis.europa.eu/project/rcn/106050\\_en.html](http://cordis.europa.eu/project/rcn/106050_en.html)

★ Project website:  
<http://www.themacnt-fp7.com>

## MAGNETIC NANOPARTICLES MAKE ATTRACTIVE PARTNERS

EU-funded researchers have piloted a novel purification process to dramatically cut the cost of extracting specific biological molecules from complex mixtures — a boost to the competitiveness of Europe’s pharmaceutical, food and animal feed industries.

Biotechnology has led to new cutting-edge drugs, foods with health benefits and specialised animal feed. But extracting functional ingredients from mixes to produce such products can be costly — a high level of purity is needed.

For example, current separation processes to purify high-value proteins with health functions can eat up to around 80% of production costs, says Matthias Franzreb, an executive board member of the EU-funded MAGPRO2LIFE (Advanced Magnetic nanoparticles deliver smart Processes and Products for Life) project and an engineering professor at Germany’s Karlsruhe Institute of Technology. These processes include filtration, centrifugation and purification steps.

MAGPRO2LIFE has gone some way to cutting such costs by developing three pilot manufacturing plants to demonstrate the feasibility of a novel purification process for proteins that uses magnetic adsorbent micro and nanoparticles. The techniques developed during the project were based on research findings from NanoBioMag, another EU-funded project.

Since the end of MAGPRO2LIFE in June 2013, the partners have been working on the next stage — moving from pilot to factory production.

### How they did it

MAGPRO2LIFE’s researchers first developed a cheaper way to produce large quantities of magnetic nanoparticles. The nanoparticles have specific properties that allow them to adsorb particular biological molecules — only those that are the targets of a purification process.



The researchers also developed new smart functionalities for magnetic nanoparticles, extending the range of target molecules they can bind and consequently extract from a mix. This mix could be fermentation broths, plasma, milk, whey and plant extracts, for example.

MAGPRO2LIFE’s magnetic centrifuge, which combines the advantages of magnetic separation and centrifugation, was the first of its type developed for biotech applications, says Franzreb.

The process works as follows: the magnetic nanoparticles are put into a mixture where they quickly bind the target molecules. The magnetic centrifuge extracts the nanoparticles, along with their piggybacking molecules. After an intermediate washing step to get rid of any impurities, chemicals are used to separate the purified molecules from



## SPECIAL FEATURE

the nanoparticles, which are then ready to be used to manufacture a novel drug, food or feed product.

The magnetic nanoparticles can then be reused once they have been washed clean of any remaining molecules. 'Magnetic nanoparticles are pretty hard to create,' says Franzreb. 'Reusing them is a key way to bring costs down.'

### Pilot plants put theory into practice

The researchers demonstrated the magnetic extraction technique through three pilot plants, one each for food, pharma and feed production.

Solae, the project's coordinator, developed one pilot to extract valuable proteins left over from processing soy at the company's food production plant in Aarhus, Denmark. The proteins are being investigated for anticarcinogenic properties.

The technology, although still in the early stages, could be a game-changer for how proteins are separated, resulting in better functionality and nutrition, says Torkel Rhenman, Solae's chief executive at the time of the project. It could also lead to new speciality ingredients that cannot be economically produced with current technology.

'Achievement of these milestones is significant because this novel technology has never been applied in the food industry,' he adds. 'It could be very flexible in separating many different protein sources, producing proteins with unique properties and health benefits.'

The pharmaceutical pilot line was built at a laboratory of the UK's University of Birmingham, and resulted in the successful extraction of an antibody fragment from a mixture.

The feed production pilot, at the Karlsruhe Institute of Technology, targeted the direct extraction of an enzyme from a mix during fermentation but was not so straightforward — some other cells were separated along with the target enzyme. Franzreb is confident a solution can be found by improving the selectivity of the adsorbents and of the separator.

'MAGPRO2LIFE showed that the process is viable commercially,' he adds. 'Establishing new technologies for pharma and food processing is the long-term goal. These are multi-billion euro markets and even if a small share could be gained for magnet technology, it would have a substantial impact on competitiveness.'

*"The technology, although still in the early stages, could be a game-changer for how proteins are separated, resulting in better functionality and nutrition."*

#### MAGPRO2LIFE

- ★ Coordinated by Solae in Denmark.
- ★ Funded under FP7-NMP.
- ★ <http://ec.europa.eu/programmes/horizon2020/en/news/magnetic-nanoparticles-make-attractive-partners>
- ★ Project website: <http://www.food.dtu.dk/english/Core-activities/Research/Research-Groups/Fermentation-and-Purification/Projects/MagPro2Life>

## LONGER LIVES FOR OUTDOOR WOOD PRODUCTS

Wood has the potential to be a sustainable and competitive engineering material. Novel nano-based coatings and adhesives will enhance durability in outdoor applications while reducing maintenance and repair costs.



Wood is a renewable resource with a high strength-to-weight ratio and it can be produced in vast quantities. Scientists developed advanced eco-friendly water-based materials to enhance the service life of wood products with EU support of the project WOODLIFE (Extended service-life and improved properties of wood products through the use of functional nanoparticles in clear coating and adhesive systems). The team engineered transparent coating systems and wood adhesives to improve ultraviolet protection and mechanical properties respectively.

The formulations exploited molecular manufacturing of inorganic nanoparticles, nanoclays and composite organic-inorganic binders. Scientists designed the nanoparticles for absorption in the ultraviolet range,

homogeneous dispersion in water-based formulations and transparency in visible light.

Coatings were created with outdoor wood panels and window frames in mind. Oxide nanoparticles incorporated directly into the coatings or encapsulated in acrylic latex binders showed promising performance in field tests.

*"WOODLIFE coated wood panels have a predicted service life that is two to five times longer than that of reference systems."*





Polyvinyl acetate is a rubbery synthetic polymer which, as a water-based emulsion, is the most commonly used wood adhesive on the market. Scientists modified the formulation with colloidal silica and nanoclays to enhance durability when used for load-bearing beams. The systems passed important standardised tests of performance at elevated temperatures and demonstrated improved heat and moisture resistance.

Sustainability assessments demonstrated that both the coated wooden window frames and the wooden beams offer important environmental benefits compared to conventional systems. The coatings have a very low formaldehyde content and

the use of wood as a substitute for other building materials reduces carbon dioxide emissions significantly. Project outcomes have led to two patent applications.

WOODLIFE coated wood panels have a predicted service life that is two to five times longer than that of reference systems. Aside from commercialisation of the final products, production of water-borne and solvent-borne nanoparticles that can be used in ultraviolet protection has numerous potential opportunities. Marketing to the cosmetics, pharmaceuticals and plastics sectors could enhance the market position of partner companies. WOODLIFE outcomes

are thus expected to have important benefits for partner companies, global environmental health and the economic well-being of the wood-working, -coating and -adhesive industries.

#### WOODLIFE

★ Coordinated by SP Technical Research Institute of Sweden.

★ Funded under FP7-NMP.

★ [http://cordis.europa.eu/project/rcn/94752\\_en.html](http://cordis.europa.eu/project/rcn/94752_en.html)

★ Project website: <http://www.woodlifeproject.com>

## TOWARDS IMPROVED PROTECTIVE CLOTHING

An EU-funded project has developed and tested multi-functional textiles for use in the protective garments of emergency personnel.

For people working in emergency response situations, protective clothing is of paramount importance. However, these garments are currently bulky and

uncomfortable and lose their functional properties (such as flame retardancy or breathability) with repeated use.

The SAFEPROTEX (High-protective clothing for complex emergency operations) project was established to research and test multi-functional

*“Researchers developed a number of nanotechnology-based enhancements for textiles, including thermo-regulating fibres, colour-based temperature alert patches and 3D-knitted insulating materials.”*

materials for protective garments. The overall aim was to develop textiles that could protect wearers against multiple hazards without sacrificing comfort or garment longevity.

Researchers developed a number of nanotechnology-based enhancements for textiles, including thermo-regulating fibres, colour-based temperature alert patches and 3D-knitted insulating materials. Another major breakthrough was a surface treatment to improve the hydrophobicity (water-repelling), self-cleaning ability and antimicrobial properties of the fabrics.

Three prototype garments using these multi-functional textiles were produced: an extreme weather outfit, a wildfire outfit and an outfit for first response medical personnel. All three prototypes performed well and were highly rated by users in a laboratory, as well as in real-life testing.



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Based on these positive results, SAFEPROTEX will develop commercial applications for the textiles. These advances are expected to result in decreased casualties and lower operating costs in the field of emergency response and rescue operations.

#### SAFEPROTEX

★ Coordinated by MIRTEC in Greece.

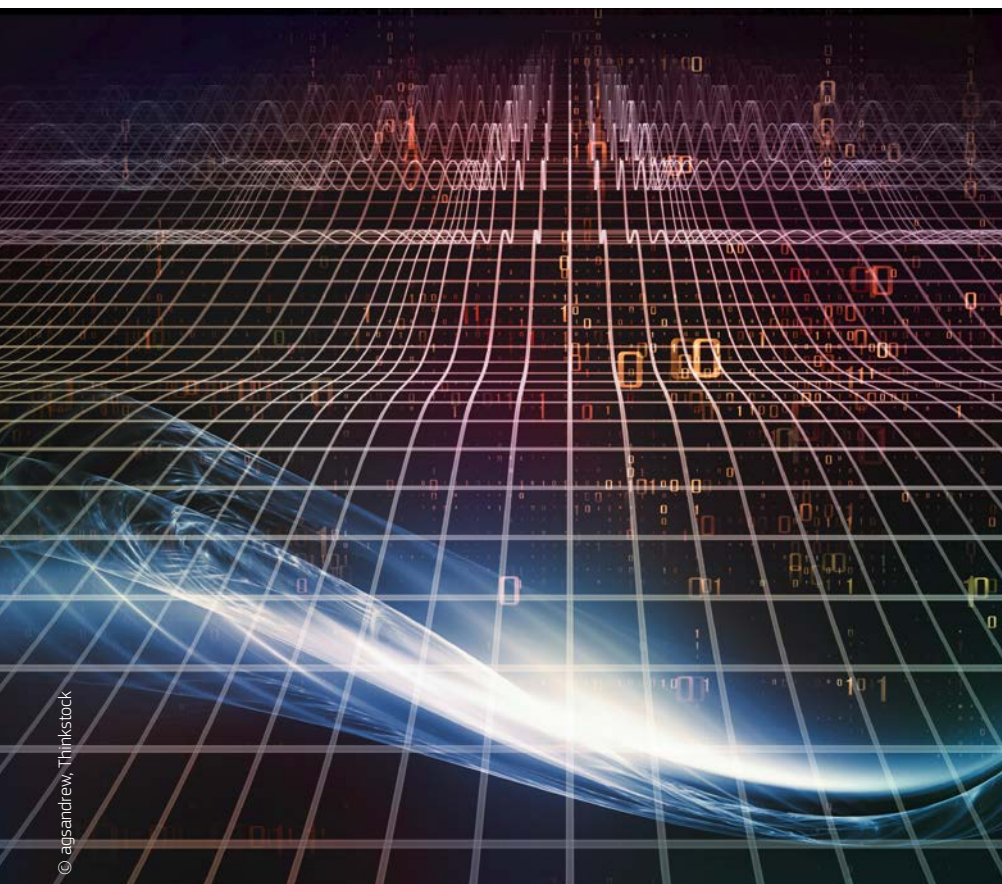
★ Funded under FP7-NMP.

★ [http://cordis.europa.eu/project/rcn/94210\\_en.html](http://cordis.europa.eu/project/rcn/94210_en.html)



## UNNATURAL MANIPULATION OF LIGHT

Metamaterials are man-made composites with electromagnetic properties not seen in nature. EU-funded scientists have demonstrated low-cost fabrication of low-loss materials acting in the visible range for a myriad of new applications.



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The unique properties of metamaterials stem from structural periodicity on much smaller scales than the wavelength of the light propagating through them. Microwave applications (wavelengths on the scale of one to 100 centimetres) are currently in a pre-commercial stage. Producing devices in the visible range (structures on the scale of nanometres), such as invisibility cloaks, presents a serious fabrication challenge.

For the first time, EU-funded scientists in nanochemistry, self-assembly and metamaterials joined forces on the project METACHEM (Nanochemistry and self-assembly routes to metamaterials for visible light). The goal was to provide a simple, low-cost manufacturing alternative to nanolithography. They also devoted

great effort to developing measurement methods required to demonstrate concept validity.

The team designed and synthesised tailor-made nanoparticles as optical plasmonic nanoresonators. These are surface plasmon-based structures exploiting the coherent bound oscillations of electrons and light on a metal surface. They were organised through self-assembly into dense, highly structured two- or three-dimensional networks. Plasmonic metamaterials have been difficult to fully exploit due to losses. Scientists addressed this issue in the conventional way, using loss-compensating active-gain media.

A number of applications, including advanced sensors, plasmonic nano-reactors and metamaterials with refractive indices not seen in nature,

*“Scientists demonstrated that metamaterials can be produced by low-cost bottom-up self-assembly methods.”*

were proposed. Knowledge and outcomes were disseminated through the project website, a training workshop, participation in international conferences and several brochures. The project also organised and participated in the last Metamaterials Conference 2013 as well as in a follow-up doctoral course.

METACHEM has provided a turbo-boost to exploitation of plasmonic metamaterials. Scientists demonstrated that metamaterials can be produced by low-cost bottom-up self-assembly methods. With increased efficiency through compensation of losses, the team addressed one of the most important barriers to real applications. Finally, advances highlighted their potential as components of sensors, nanochemical reactors, novel electromagnetic devices and many more, spawning exciting new avenues of research.

### METACHEM

- ★ Coordinated by CNRS in France.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/project/rcn/91805\\_en.html](http://cordis.europa.eu/project/rcn/91805_en.html)
- ★ Project website: <http://www.metachem-fp7.eu/>



BIOLOGY AND MEDICINE

# NEW HOPE FOR PATIENTS SUFFERING FROM RARE GENETIC DISEASE

Very few of us have heard of 'Alpha-Mannosidosis'. However, this rare genetic disease has affected the lives of hundreds of families across Europe and the world. Its first symptoms appear in early childhood and include hearing loss, progressive facial and skeletal deformity, mental retardation, multiple organ abnormalities and recurrent infections, while, in its most aggressive form, it could lead to an early death.

**D**ue to its rarity, the private sector has shown limited interest in Alpha-Mannosidosis, and — as is the case with most diseases of this type — there is no effective cure to date. But thanks to three successful research projects co-funded by the European Union — EURAMAN, HUE-MAN and ALPHA-MAN — patients and their families can hope that a successful treatment will soon be within reach. The projects have built upon a collaborative network of European scientists, clinical doctors, and the pharmaceutical industry. The initial laboratory and clinical tests have been positive and encouraging.

Alpha-Mannosidosis is caused by a genetic deficiency in the 'waste management' system of the patient's cells. Due to this dysfunction, which, according to epidemiologists, occurs in approximately 1 out of 500 000

live births, the body cannot process some sugars effectively. Hence, these sugars gradually accumulate inside the body cells, and, eventually, intoxicate and impair the cells. In aggressive cases of Alpha-Mannosidosis, the central nervous system starts to shut down, and the patients die during the early years of their childhood. The reason for the inability to process sugars is the lack of the necessary lysosomal enzyme (alpha-mannosidase), a protein essential for the proper functioning of the cell.

The main objective of the EURAMAN, HUE-MAN and ALPHA-MAN projects (ALPHA-MAN is co-funded by the European Union with EUR 5 900 000), is to treat the patient with the missing enzyme by introducing a biotechnologically derived human enzyme ('rhLA-MAN'), an equivalent to the missing enzyme, into the

bloodstream, which is then taken up by the cells and clears the sugars, hence countering the effects of the patient's genetic mutation. The results of the pre-clinical trials of this so-called 'Enzyme Replacement Therapy' were positive, and the teams engaged in the projects have moved on to the phase of clinical trials. Jens Fogh, CEO of the Danish biotech company Zymenex which is producing rHLAMAN, stated that the 'the goal of the clinical trials is to make a future therapy available for all Alpha-Mannosidosis patients'.

In 2011, nine patients aged between 7 and 18 years were recruited to a Phase 2 clinical trial from European hospitals and flown each week to Copenhagen, Denmark, to be treated at the Department of Clinical Genetics, Copenhagen University Hospital. Dr Allan Meldgaard Lund, who is the Principal Investigator and treating physician of the patients, appeared very optimistic given the first results. His team observed marked improvements in the patients' walking, their ability to climb stairs, lung function and cognitive capacity. Scientists are convinced that, since children suffering from the condition are born healthy, an early diagnosis and start of the treatment could significantly improve their chances of survival as well as their quality of life.

Moreover, the projects have also had the goal of creating a database containing essential clinical observations and measurements so as to enable a better understanding of an otherwise rare disease by utilising the experience of researchers across Europe. The Alpha-Mannosidosis database that has been developed within the HUE-MAN and ALPHA-MAN projects is now available online.

Furthermore, scientists also hope to achieve a better understanding of the ways in which the missing enzyme enters the central system from the patient's bloodstream, and ultimately lay the foundation for the large-scale production of an effective therapy. Paul Saftig, Director of the Biochemical Institute at the University of Kiel and coordinator of the HUE-MAN and ALPHA-MAN network feels that 'understanding the mechanisms of the delivery of the drug to the brain will also be of general interest for many neurological diseases'. Since Alpha-Mannosidosis belongs to a group of approximately 50 diseases, called 'lysosomal storage disorders', the conclusions of the EURAMAN, HUE-MAN and ALPHA-MAN projects could have a positive impact for thousands of patients suffering from similar conditions, including Gaucher, Fabry and Pompe disease.

*"Nine patients aged between 7 to 18 years were recruited to a Phase 2 clinical trial from European hospitals and flown each week to Copenhagen."*

#### ALPHA-MAN

- ★ Coordinated by the University of Kiel in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://ec.europa.eu/programmes/horizon2020/en/news/new-hope-patients-suffering-rare-genetic-disease>
- ★ Project website: <http://www.alpha-man.eu>

## GENETICS OF MULTIPLE MYELOMA REVEALED

'Multiple myeloma' (MM) is an incurable cancer affecting white blood cells. European researchers have isolated two genes and their proteins that can be targeted using antibodies for potential therapy.

The MMSC (Novel therapeutic antibodies for multiple myeloma) project aimed to identify candidate oncogenes — genes that can cause cancer — by screening for activity of their proteins.

Two genes have been isolated using 'small hairpin' (sh) RNA-based screening tools. shRNA molecules can be used to silence target genes and thus assess their function. The proteins from the translated genes can be targeted using monoclonal antibodies or small molecules, many of which are already used in chemotherapy.

An attractive candidate, the first gene is part of the 'Wingless' (WNT) pathway, first recognised for its role in carcinogenesis. Mutations of WNT are critical in breast and prostate cancer. This protein is also a 'Receptor tyrosine kinase' (RTK). RTKs are often over-expressed in a variety of tumours, leading to enhanced cancer cell survival and metastasis.

Several RTKs are expressed in MM and there is mounting evidence of their relevance in this disease. RTK-targeting therapeutic antibodies and small molecule inhibitors such as Herceptin, Cetuximab, Gleevec, Tarceva and Iressa have successfully induced death in cancerous cells where RTKs are overexpressed.

The second gene is also a kinase and part of the Hippo pathway. Inhibition of this kinase using shRNAs was able to trigger cell death in a large range of myeloma cells. Downregulation of this gene in an *in vivo* setting confirmed that it could be used to unravel mechanisms of cancer cell survival.

The results of the MMSC project have provided a firm knowledge platform for the development of targeted drug therapies for MM. Besides advanced research opportunities for pharmaceutical SMEs, MM patients also stand to benefit from improved life quality and outcome.



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#### MMSC

- ★ Coordinated by the San Raffaele Hospital in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/92166\\_en.html](http://cordis.europa.eu/project/rcn/92166_en.html)



## IMPROVED CARDIOMYOCYTES FOR TRANSPLANT

Cardiovascular disease constitutes a prime target for regenerative therapy. The differentiation of stem cells into functional cardiomyocytes is being extensively pursued to translate this approach into clinical practice.

Human embryonic stem cells' (hESCs) and 'Induced pluripotent stem cells' (iPS) are emerging as important sources for numerous types of differentiated cells. Their human origin, ease of isolation and prolonged survival in culture make them ideal candidates for use in regenerative medicine.

Work so far indicates that *in vitro* cardiac differentiation of hESCs and iPS produces immature cardiomyocytes similar to neonatal cells in phenotype. Accumulating evidence suggests that cardiomyocyte maturation is associated with thyroid hormones. Early in development, cardiomyocyte

*"T3-treated cells exhibited an increase in spontaneous beating with altered dynamics of the intracellular calcium ion levels — key factors for regulating heartbeat."*

precursors resist the premature effect of maternal thyroid hormones through mechanisms that resemble the *in vitro* cardiac differentiation of stem cells.

Seeking to address this issue, scientists on the EU-funded

T3D3 STEM CELLS (Thyroid hormone and development of cardiomyocytes derived from human embryonic and induced pluripotent stem cells) project decided to modulate the thyroid hormone pathway to obtain more mature cardiomyocytes. To this end, they evaluated the maturation impact of T3 hormone cardiomyocytes derived from either hESCs or iPS.

They measured a number of markers associated with cardiac differentiation to find that T3 did not affect cell size or organisation in these cells. However, T3-treated cells exhibited an increase in spontaneous beating with altered dynamics of the intracellular calcium ion levels — key factors for regulating heartbeat. Taken together, these findings suggested a more mature phenotype of the cardiomyocytes following treatment with T3.

Interestingly, researchers found that the presence of the thyroid hormone modifying enzyme 'Deiodinase 3' (D3) in hESC-derived cardiomyocytes was associated with the immature phenotype. During development, D3 breaks down maternal T3 to prevent early growth and maturation of the heart. When they used an inhibitor against the D3 enzyme in combination with the T3 hormone, an even greater maturation effect was seen.

Overall, the findings of the T3D3 STEM CELLS study underscored the importance of the thyroid hormone pathway in cardiomyocyte differentiation. Modulation of the pathway through hormonal stimulation or inhibition of modifying molecules could improve the maturation outcome of stem-cell derived cardiomyocytes.

### T3D3 STEM CELLS

- ★ Coordinated by the Imperial College of Science, Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/100085\\_en.html](http://cordis.europa.eu/project/rcn/100085_en.html)

## BLOCKING MALIGNANCY

Formation of new blood vessels called angiogenesis is vital for tumour malignancy. The hunt is on for new therapies to block angiogenesis as current therapies are limited in their success.

The current treatment for prevention of angiogenesis is the use of 'Vascular endothelial growth factor' (VEGF)-inhibitors. Unfortunately, most patients have innate resistance or acquire resistance over time to such inhibitors.

Prior research has highlighted the importance of the 'Hexosamine biosynthetic pathway' (HBP) in transforming the quiescent 'endothelial cell' (EC) into a proliferative state for angiogenesis. HBP is necessary for protein glycosylation. N- and O- types of glycosylation provide a short- and long-term regulatory link to nutrition.

Quiescent EC occurs in good nutritional circumstances. Ironically, shortage of oxygen (and energy) activates EC to revascularise damaged tissue, but this process is also seen during neovascularisation of malignant cancers. The EU-funded ANGIOGENESIS AND HBP (Glycosylation of angiogenic factors by the hexosamine biosynthetic pathway (HBP), a nutrient sensor with a novel metabolic-signalling role in angiogenesis) project looked at whether HBP co-regulates EC growth or quiescence by integrating nutrient availability with appropriate chemical signals.



Researchers investigated various elements of the HBP pathway. Expression of the UAP1 gene at the final step of HBP is the rate-limiting reaction. Inhibition of UAP1 expression resulted in massive decreases in EC sprouting. The researchers are developing knock-out mice to investigate this phenomenon further.

Work on O-glycosylation compared quiescent ECs with the proliferative state. Results showed a marked decrease in O-linked N-acetylglucosamine modified proteins and 'O-GlcNAc transferase' (OGT) in the angiogenic mode. Further work is needed to ascertain the roles of OGT in promoting autophagy when cell components are degraded during nutrient stress to provide energy. Autophagy is the process where

dysfunctional or unnecessary cellular components are degraded by lysosomes.

A unique type of O-glycosylation is required during VEGF signalling for EC quiescence or proliferation. Mediated by three isoforms of fringe proteins, radical fringe is expressed far more in ECs than the other two.

It appears that tip cells (leading cells of vascular sprouts) in nutritionally poor environments experience decreased N-glycosylation that, in turn, stimulates autophagocytosis.

The ANGIOGENESIS AND HBP project has laid down a substantial knowledge platform on which to base further research on this critical stage of cancer malignancy. The precise molecular details of pathways involved can

*“Further work is needed to ascertain the roles of OGT in promoting autophagy when cell components are degraded during nutrient stress to provide energy.”*

open up possibilities to develop new anti-angiogenic therapies.

#### ANGIOGENESIS AND HBP

- ★ Coordinated by VIB in Belgium.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/103610\\_en.html](http://cordis.europa.eu/project/rcn/103610_en.html)

## STEM CELLS USE FIRST AID KITS TO REPAIR DAMAGE

Neural stem cells — master cells that can develop into any type of nerve cell — are able to generate mini ‘first aid kits’ and transfer them to immune cells. This is the result of a study published today in *Molecular Cell*, and led by ERC grantee Prof. Stefano Pluchino, based at the University of Cambridge (UK).

Stem cells hold great promise as a means of repairing cells in conditions such as multiple sclerosis, stroke or injuries of the spinal cord because they have the ability to develop into almost any cell type. Now, new research conducted under the SEM\_SEM (SEcreted Membrane vesicles: role in the therapeutic plasticity of neural StEM cells) project shows that stem cell therapy can also work through a mechanism other than cell replacement.

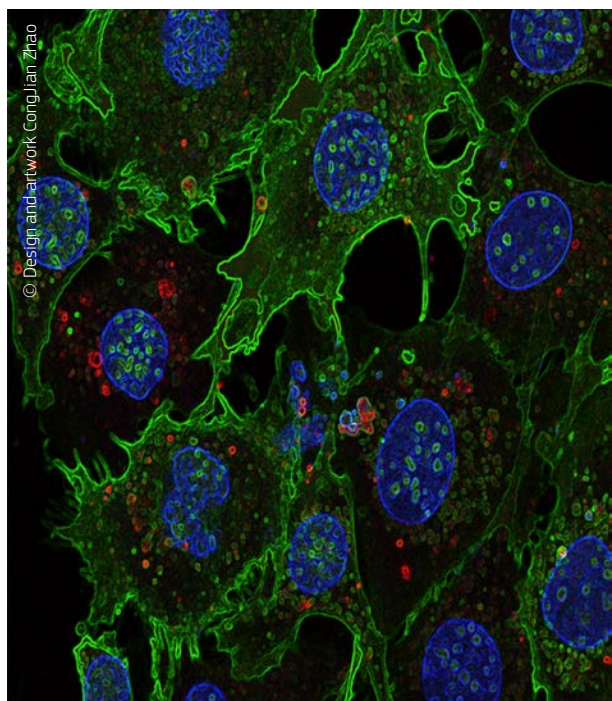
In a study published today in *Molecular Cell*, a team of researchers led by the University of Cambridge (UK), has shown that stem cells ‘communicate’ with cells by transferring molecules via fluid filled bags called vesicles, helping other cells to modify the damaging immune response around them.

Although scientists have speculated that stem cells might act rather like drugs — in sensing signals, moving to specific areas of the body and executing complex reactions — this is the first time that a molecular mechanism for this process has been demonstrated. By understanding this process better, researchers can identify ways of maximising the efficiency of stem-cell-based therapies.

Prof. Stefano Pluchino, who is the beneficiary of a 2010 ERC Starting Grant, said: ‘These tiny vesicles in stem cells contain molecules like proteins and nucleic acids that stimulate the target cells and help them to survive — they act like mini ‘first aid kits’. He added: ‘Essentially, they mirror how the stem cells respond to an inflammatory environment like that seen during complex neural injuries and diseases, and they pass this ability on to the target cells. We think this helps injured brain cells to repair themselves.’

Mice with damage to brain cells — such as the damage seen in multiple sclerosis — show a remarkable level of recovery when ‘Neural stem/precursor cells’ (NPCs) are injected into their circulatory system. It has been suggested that this happens because the NPCs discharge molecules that regulate the immune system and that ultimately reduce tissue damage or enhance tissue repair.

The team of researchers from the UK, Australia, Italy, China and Spain has now shown that NPCs make vesicles when





they are in the vicinity of an immune response, and especially in response to a small protein, or cytokine, called Interferon-g, which is released by immune cells. This protein has the ability to regulate both the immune responses and intrinsic brain repair programmes and can alter the function of cells by modifying the expression (and activity) of scores of genes.

Their results show that a highly specific pathway of gene activation is triggered in NPCs by IFN-g, and that this protein also binds to a receptor on the surface of vesicles. When the vesicles are released by the NPCs, they adhere and are taken up by target cells. Not only does the target cell receive proteins and nucleic acids that can help it self-repair, it also receives the IFN-g on the surface of the vesicles, which activates genes within the target cells.

The team, which is funded by the ERC and the Italian MS Society, used electron microscopy and superresolution imaging to visualise the vesicles moving between NPCs and target cells *in vitro*.

'Our work highlights a surprising novel role for stem cell-derived vesicles in propagating responses to the environment,' commented Pluchino. 'It represents a significant advance in understanding the many levels of interaction between stem cells and the immune system, and a new

molecular mechanism to explain how stem cell therapy works.'

Prof. Pluchino believes that being awarded an ERC grant has forced him 'to go well outside his comfort zone. Such high risk research often entails reflecting on new scientific approaches and perspectives and it implies new expertise'. He also emphasised that his ERC grant has enabled him to recruit a total of 8 promising post-docs and PhD students in his laboratory.

'These ERC grants are helping to keep people in the best EU research hubs, and this has no price,' he concluded.

*"Our work highlights a surprising novel role for stem cell-derived vesicles in propagating responses to the environment."*

*The article was written in cooperation with the University of Cambridge.*

#### SEM\_SEM

★ Coordinated by the University of Cambridge in the United Kingdom.

★ Funded under FP7-IDEAS-ERC.

★ <http://erc.europa.eu/erc-stories/stem-cells-use-first-aid-kits-repair-damage>

## IMMUNE DYSFUNCTION LINKED TO MOOD DISORDERS

Accumulating evidence suggests that the neural and immune systems are tightly intertwined. With this in mind, European researchers investigated the novel hypothesis that immune dysfunction could be the triggering event in mood disorders.

An abnormal immune activation is emerging as central to the development of mood disorders. A chronic state of inflammation in certain brain areas involved in mood regulation could cause mood imbalance as a result of hormonal or metabolic disturbance. For example, immune activation could impair the catabolism of tryptophan, an important precursor of the neurotransmitter serotonin.

The EU-funded MOODINFLAME (Early diagnosis, treatment and prevention of mood disorders targeting the activated inflammatory response system) study was designed to test the underlying hypothesis that many mood or psychiatric disorders are triggered by increased susceptibility to inflammation. Their objective was to study immune dysfunction in psychiatric patients and mouse models of disease and develop brain and



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blood scans for assessing immune dysfunction.

A large number of patient samples were analysed. Results linked mood disorders with increased numbers of monocytes expressing both pro- and anti-inflammatory genes as well as high levels of pro-inflammatory cytokines. All this data validated the overall immune dysfunction pattern in patients with mood disorders.

Interestingly, an activated state of monocytes negatively determined the outcome of anti-depressant therapy.

Work in animal models of depressive-like behaviour further corroborated these findings. Animals exhibited activated inflammatory responses and an abnormal tryptophan metabolism. Scientists identified three major pathways that were implicated in the aberrant immune-endocrine interface. This

abnormal communication led to structural and functional deficits of important brain regions.


*“Results linked mood disorders with increased numbers of monocytes expressing both pro- and anti-inflammatory genes as well as high levels of pro-inflammatory cytokines.”*

Regarding therapeutic strategies, part of the MOODINFLAME work entailed the screening of various non-steroid anti-inflammatory drugs in the animal models. The PSYCH-AID project, which is an EU-funded continuation project of MOODINFLAME will continue the investigation of such drugs in patients with mood disorders.

Overall, the outcome of the study has the potential to change the way psychiatric disorders are treated. The generated diagnostic tools will be of enormous help down this path,

facilitating the screening of patients with mood disorders for immune dysregulation.

#### MOODINFLAME

- ★ Coordinated by the Erasmus University Medical Center in the Netherlands.
- ★ Funded under FP7-HEALTH.
- ★ [http://cordis.europa.eu/project/rcn/89344\\_en.html](http://cordis.europa.eu/project/rcn/89344_en.html)
- ★ Project website: <http://moodinflame.eu/>
- ★  <http://bit.ly/1psYMHP>

## PARTNER CHOICE IN THE MOUSE WORLD

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Choosing a mate is a complex decision, even for a rodent. Researchers have investigated what lies behind partner selection in mice, particularly when more than one species is available.

Keeping species separate and distinct is down to a combination of diverse reproductive barriers. They occur prior to zygote development, as well as in post-zygote development, where genetic incompatibility renders hybrid fitness lower than its counterpart derived from more closely related parents.

Behavioural mechanisms are also responsible for species isolation. One in particular involves assortative mating strategies where animals mate preferentially with members of their own species.

Aware of the lack of information on neural mechanisms involved in mating choice, the EU-funded project MCM (Neural mechanisms underlying mate preference and selection in mice) investigated the behavioural mechanisms behind ‘mouse attractiveness’.

Researchers observed two different sub-species of house mice, *Mus mus domesticus* (*domesticus*) and *Mus mus musculus* (*musculus*). To measure female preference, two paradigms were devised — a full contact situation where females were allowed to mate and to compare, and a limited contact trial where females could only smell the males. The latter cancelled out the effect of male behaviour on the females. In both cases, musculus females showed preference for their type of male.

However, if females were given no choice in the matter as there was only one male, they mated readily with both species. This suggests that the decision is based on a comparison of the options available rather than absolute preference.

Fostering experiments showed that early post-natal life experience has an impact in that musculus females raised in their normal species environment were firmly homospecific. However, raised in a domesticus situation they preferred the first male encountered. Early life experience of musculus females then, when in line with genetic self-identity, overrides sampling order effects, ensuring robust assortative choice.

Brain mechanisms in play were shown to be centred around regions that are important in reward, including the nucleus accumbens and areas involved in olfactory processing, such as the medial amygdala. By exposing adopted and control musculus females to musculus males, the researchers found differential activation of neurons in the Islands of Calleja that are implicated in olfactory memories.

Evolutionary biology and neurobiology of behavioural patterns both play a significant part in speciation. Bridging the gap will increase understanding of the important decision-making processes in mate selection.

#### MCM

- ★ Coordinated by the Calouste Gulbenkian Foundation in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/92378\\_en.html](http://cordis.europa.eu/project/rcn/92378_en.html)



SOCIAL SCIENCES AND HUMANITIES

# HOW RESEARCH CAN HELP PLURALISM ACROSS EUROPE

Europe has always been a blend of cultures and communities, with a regular churn of people across the continent. Yet the mix can be complex, and some find the changes difficult. While there may be no perfect way to manage Europe's ethnic and religious diversity, the European Union (EU)-funded research project ACCEPT PLURALISM has developed a guide to help deal with the challenges as they arise.

The project team looked at whether European societies have become more or less tolerant over the past 20 years. It examined the different ways tolerance is defined, as well as how it is applied in norms, institutional arrangements, public policies and social practices. 'It is about how countries become culturally diverse; how they remain democratic, peaceful and cohesive; and what is socially acceptable and tolerable,' says ACCEPT PLURALISM (Tolerance, Pluralism and Social Cohesion. Responding to the Challenges of the 21<sup>st</sup> Century in Europe) project coordinator Anna Triandafyllidou, a professor at the Robert Schuman Centre for Advanced Studies at the European University Institute in Florence, Italy.

The project's findings, the events it organised, and the 56-page handbook it produced to deal with potential conflicts can all help improve everyday life in plural communities. 'We looked at how tolerance is practiced in everyday life and at the workplace,' she adds. 'We examined issues like training teachers to be sensitive to the different cultural and religious points of view, and we gave examples of what different solutions might be available when conflicts arise,' comments Triandafyllidou.

The guide, entitled 'Handbook on Ideas of Tolerance and Cultural Diversity in Europe', is targeted at schools. It is expected to raise the awareness of teachers, students and local policy-makers or civil society actors about the conflicts that ethnic and religious diversity bring and the ways to resolve them.

The researchers also produced a Tolerance Indicators Toolkit to score country performances, evaluating the policies and practices for dealing with cultural, religious and ethnic diversity challenges — thus providing a way to compare EU Member States. The results are expected to help policy-makers, local and regional authorities, NGOs, media and schools.

Furthermore, the project team looked at the meanings of tolerance in a variety of contexts. The researchers not only reviewed past empirical research and scholarly theoretical literature, but also conducted original research in 15 countries. The results revealed the complexity of the issue. 'It is not always clear what is or is not tolerable in any given context,' explains Triandafyllidou. 'The different histories of different groups and countries lead to multiple understandings about what is acceptable,' she adds.

The project was particularly focused on rising tensions with marginalised Muslim communities. 'There is an increasing intolerance, in particular towards Muslims. There is a view that liberal societies need protection against religions, particularly Muslims,' says Triandafyllidou. In addition to Muslims, the project looked at two other minority groups: the Roma and blacks. Triandafyllidou notes that 'while each of these groups is very diverse, they all felt stigmatised.'

The project team found, for example, that the communities that protested the loudest about immigration were sometimes those with the fewest immigrants. Indeed, there is even a rising fear of immigration in parts of Eastern Europe where there is a net migration loss. 'This counters the thesis that there is a threshold for how much immigration a community can have,'

says Triandafyllidou. 'The issue, for many people, is more about the religious or cultural traditions, and we found that if a community is ethnically more homogenous, then it is harder to accept newcomers,' she concludes.

#### ACCEPT PLURALISM

- ★ Coordinated by the European University Institute in Italy.
- ★ Funded under FP7-SSH.
- ★ <http://ec.europa.eu/programmes/horizon2020/en/news/how-research-can-help-pluralism-across-europe>
- ★ Project website: <http://accept-pluralism.eu/Home.aspx>
- ★  <http://bit.ly/1nROW9m>

## CAN INTERACTIVE COMPUTER GAMES HELP RESOLVE SCHOOLYARD CONFLICTS?

EU-funded researchers recently sought to harness the popularity and teaching potential of computer games to help children think about and handle conflict. The new games can be used by school teachers all over Europe.

From scuffles in the schoolyard to bullying in the workplace, conflict can have a truly damaging effect not only on personal development and happiness, but also on the collective wellbeing. Improving conflict resolution skills at an early age could therefore have a positive effect on interpersonal relations, creating a happier, more confident generation and a society more at ease with itself.

*"Village Voices was voted the best learning game in Europe at the 2013 Serious Game Awards."*

This is why EU-funded researchers recently sought to harness the popularity and teaching potential of computer games to help children think about and handle conflict. The recently completed SIREN (Social games for conflict REsolution based on natural iNteraction) project developed games that automatically generate conflict situations to fit different scenarios, enabling the system to be used by school teachers all over Europe. It also aimed to prove that educational games with a 'serious' purpose need not be boring.

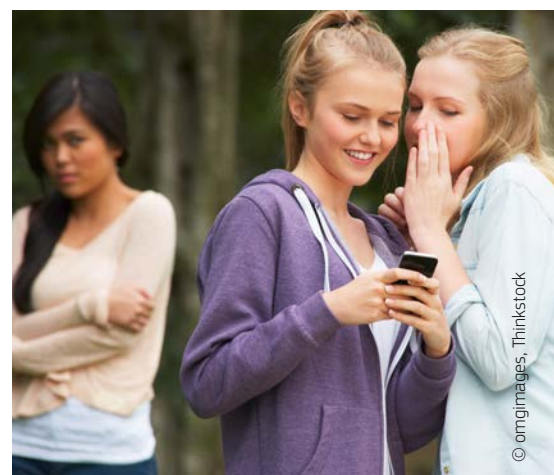
The project led to three years of hard work by researchers from Greece, Denmark, Portugal, the UK and the US. A game — Village Voices — has since been developed with the help of designers from the Institute of Digital Games at the University of Malta, promising to

take classroom-oriented game-based learning to the next level. Indeed, Village Voices was voted the best learning game in Europe at the 2013 Serious Game Awards.

The basic premise of Village Voices is that pupils are one of four characters in a medieval village. All the game characters are interdependent, and this becomes more apparent as the game progresses. From the outset, a key objective of the game was to explore the different kinds of everyday conflicts that take place in schoolyards, from friendship disputes and differences in opinion to arguments over possessions.

By combining interactive narrative and emotional modelling technologies, the games are fun and have an implicit educational objective. Computational intelligence automatically detects how high the level of conflict is through player actions and predicts how the player is feeling. In addition, there are no laws or law enforcement measures in the game; you have to work through conflicts in order to succeed. Players are free to steal things and even damage other people's property. Flashpoint situations are created that enable players to choose whether to collaborate or retaliate.

Finally, the project sought to accurately evaluate the impact of learning games like Village Voices on young students. The team found that a vital learning component actually came after the playing experience, when players were able to sit down together and discuss



the choices they had made while playing. In this way the game underlines the importance of strengthening social networks — in the original sense of this phrase — the networks of friends, colleagues and fellow pupils we interact with on a daily basis. The key point here, perhaps, is that what one learns in the online world has to be applicable in a face-to-face environment in order to make a difference.

While the SIREN project has now ended, the success of Village Voices should ensure that other learning-focused games will be in the pipeline shortly.

#### SIREN

- ★ Coordinated by the National Technical University of Athens in Greece.
- ★ Funded under FP7-ICT.
- ★ [http://cordis.europa.eu/news/rcn/121659\\_en.html](http://cordis.europa.eu/news/rcn/121659_en.html)
- ★ Project website: <http://sirenproject.eu/>



## NEW IDEAS ABOUT OCCIDENTALISM

Orientalism, the study of the East, is well established but Occidentalism, the study of the West, is not. An EU study examined the latter as an identity system, using Japanese-Italian relations to trace the concept's origins and its effect on the world.

The term Orientalism refers to the collective association and study of East Asian societies and people, illustrated by the Asian Studies departments of many universities. However, the reverse study of collective western peoples, Occidentalism, is not a unified discipline, and hence is an academic 'blind spot'.

Aiming to break down both concepts in favour of a more globalised approach was the EU-funded BETWATE (Beyond 'the West' and 'the East': Occidentalism, Orientalism, and Self-Orientalism in Italy-Japan Relations) project, which ran for two years from August 2011. The Italian study addressed three questions: 'How did the shaping ideas of West and East become universal?', 'How does the concept of Occidentalism affect the world?', and 'How can criticism promote dialogue and interaction?'

The project began by studying the history of Japanese-Italian relations. Since the 1990s, both nations have been the most popular representatives from the other region in those countries and the study aimed to find out why. It focused on 19th and 20th century history, and included a study of more recent fashion/culture exchange and media stereotypes. The researchers elaborated a three-point theoretical framework for the discussion, essentially examining Occidentalism as an identity construct and how it may be open to change.

BETWATE's legacy will be the establishment of a new discipline: Critical Occidentalism Studies. The field will help



create international dialogue, break down stereotypes and inform policy.

### BETWATE

- ★ Coordinated by the Ca' Foscari University of Venice in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/100334\\_en.html](http://cordis.europa.eu/project/rcn/100334_en.html)
- ★ Project website: <http://virgo.unive.it/miyake/betwate/>

## INDIVIDUAL EMPLOYEE PROFITABILITY

Your daily wages are not an indication of your true value to your company. Researchers have developed a new method of calculating your true worth on the job.

Researchers have studied and analysed job productivity and worker ability. Theory indicates that if these are optimised then better workers are employed at the best firms in their field. To illustrate this notion, a top lawyer would work for a top law firm.

*"It seems a worker can be offered a higher salary at a lower ranked company and be enticed to take the job."*

According to the outcome of the EU-funded project COMPLEMENTS (Identifying the sign and strength of complements in production), this does not happen. Explored first was

the notion that wage is an important determinant of whether the job and employee are an optimal match. The key insight was that the wage offered to a worker is not the most important factor. It seems a worker can be offered a higher salary at a lower ranked company and be enticed to take the job. Thus, wage is only one factor and not an ultimate measure of the optimal relationship.

The results from this research show a better measurement to be when a worker changes jobs. Researchers found other factors, such as time and energy involved in a new search and a change in wage, to be better measurements.

Profitability by employee was the second choice answer to the

question: 'Are better workers employed by more productive firms?' The researchers looked for answers here but concluded that individual jobs are team efforts and not measurable at an individual profit level.

COMPLEMENTS formulated a new theory of production that allows for attribution of the profits to jobs from firm-level profit and wages.

### COMPLEMENTS

- ★ Coordinated by the Pompeu Fabra University in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/93382\\_en.html](http://cordis.europa.eu/project/rcn/93382_en.html)

ENERGY AND TRANSPORT

# HI-TECH COOPERATION: THE ANSWER TO EFFECTIVE TRANSPORT SECURITY

The SECUR-ED project aims to establish new tools to achieve truly integrated security monitoring, thus ensuring the highest levels of passenger safety.

Transport hubs such as train stations can be difficult places for security services to monitor. People are constantly on the move, departures and arrivals are happening all the time and spotting potential dangers or hazards can be like looking for a needle in a haystack.

What is more, the security systems in train stations tend to be self-contained; that is, they are not in communication with other transport hubs, or even sometimes with the security services. This can make coordinated action in an emergency all but impossible. A major EU-funded project entitled SECUR-ED (Secured Urban Transportation — European Demonstration) — completed at the end of September 2014 — aimed to change all this by establishing new tools to achieve truly integrated monitoring, thus ensuring the highest levels of passenger safety.

With 39 partners and a budget of EUR 40.2 million — the EU is providing EUR 25.5 million in funding — SECUR-ED was one of the largest and most ambitious demonstration projects in European security research. The project started off by identifying possible ways for security personnel across a city to share information during crisis situations. The data gathered in this initial phase then enabled the development of new innovative tools to make closer cooperation a reality. One such tool is a new multi-touch table that enables participants to select data and send it to partners in order to jointly assess any given situation.

The SECUR-ED project has also worked on improving inter-city collaboration, and run a series of demonstrations to assess feasibility and effectiveness in connecting railroad networks in Berlin, Madrid, Milan and Paris. One such test run involved, for example, an 'unauthorised party' slipping into a railroad storage depot in Milan, which staff at the control centre were able to detect with the aid of a heat-sensitive camera and a zoom-lens camera.

In a demonstration of potential cross-city cooperation, researchers in Madrid transmitted an image of a suspicious individual to the city's buses. Cameras in the buses were then able to compare the faces of boarding passengers with that of the target individual. If the face was a match, the system dispatched an automatic message to the bus driver and the control centre. In Paris, a demonstration was organised to evaluate the effectiveness of new technology in the prevention of different attacks — explosive, toxic/chemical and radioactive — while the network and IT systems were assessed for their vulnerability against cyberattacks.

All in all, this project has the potential to significantly improve mass transportation security through upgraded targeted surveillance technology and facilitating much greater cooperation between partners across Europe. Indeed, the success of the demonstrations has shown that cross-border collaboration can be an effective means of achieving results. Furthermore, this is only the beginning; a group of medium-size cities will now take up the research in order to assess their own risks, and design their own solutions through adapted demonstrations.

The closing conference of SECUR-ED took place on 17 September in Brussels. The project was also presented at Future Security 2014, the security research conference in Berlin, from 16 to 18 September.

## SECUR-ED

- ★ Coordinated by Thales Communication and Security in France.
- ★ Funded under FP7-SECURITY.
- ★ [http://cordis.europa.eu/news/rcn/121732\\_en.html](http://cordis.europa.eu/news/rcn/121732_en.html)
- ★ Project website:  
<http://www.secur-ed.eu>
- ★  <http://bit.ly/1mUDcjL>



## TOWARDS SAFE HYDROGEN STORAGE IN VEHICLES

The world is keen to transition from fossil fuel-powered vehicles to greener transport, and hydrogen-powered fuel cell vehicles are highly promising in this respect. However, their extensive uptake is hampered by issues with cost, safety and performance.

To improve cost and safety, use of high-pressure and cryogenic tanks, reversible adsorbents and metal hydride for on-board vehicle hydrogen storage has been attempted. These measures have been unsuccessful.

The EU-funded project COMHMAT (Computational study of hydrogen storage in metal-doped materials) worked on developing alternative techniques for cost-effective hydrogen storage utilising 'hydrogen spillover'. Hydrogen spillover involves the use of a transition-metal-doped sorbent to bind hydrogen in atomic form using a catalytic pathway with metal nanoparticles.

Project members worked closely with experimental groups to develop novel materials for hydrogen storage. For this purpose, existing and model-designed materials were used. This

included metal-doped graphene and functionalised graphitic materials, graphite oxides, metal-organic frameworks, oxidised carbon foam, graphdiyne, and defected graphitic materials with substitutional single-metal adatoms. Graphdiyne are 2D carbon allotropes of graphene with honeycomb structures. Adatoms are adsorbed atoms that lie on a crystal surface.

Consortium members' expertise in quantum chemical simulations stood them in good stead when it came to performing in silico experiments. Functional hydrogen spillover materials with improved hydrogen storage capacities were successfully identified thereafter.

Project activities led to eight publications in top-quality scientific journals. Promising outcomes have laid the foundation for further experimental and theoretical research worldwide. Success



would increase the market uptake of hydrogen-based transport systems that are safe and emission free.

### COMHMAT

- ★ Coordinated by the University of Crete in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/93130\\_en.html](http://cordis.europa.eu/project/rcn/93130_en.html)

## SAFER CARBON CAPTURE AND STORAGE

A recent EU-funded project analysed the risks associated with gas leaks from carbon dioxide (CO<sub>2</sub>) pipelines used for 'Carbon capture and storage' (CCS).



An emerging technology, CCS could reduce carbon emissions from coal-fired power stations to near-zero. To implement this technology on a large scale, it is important that pipeline failure will not have any major impact on environmental or human health.

The CO2PIPEHAZ (Quantitative failure consequence hazard assessment for next generation CO<sub>2</sub> pipelines) project

began addressing this problem. Its approach was to develop and test accurate models of pipeline leaks and explosions.

Researchers built models of multi-phase (gas and liquid) discharge and dispersion from a pressurised CO<sub>2</sub> pipeline. The models were validated using data from a specially built pipeline rupture test facility in China.

Project members used combined models and experimental data to build risk assessment tools for the CSS industry. CO2PIPEHAZ also produced best practice guidelines for risk analysis and a case study of a CO<sub>2</sub> pipeline failure.

The outcomes of this project allow for the safe commercial application of CSS technology in the future. In time, this will result in massive decreases in CO<sub>2</sub> emissions and an improvement in overall environmental health.

### CO2PIPEHAZ

- ★ Coordinated by University College London in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/92935\\_en.html](http://cordis.europa.eu/project/rcn/92935_en.html)
- ★ Project website: <http://www.co2pipehaz.eu>

## A PLATFORM TO HELP CONSUMERS ACHIEVE SUSTAINABLE ENERGY CONSUMPTION

While promoting sustainable electricity supplies requires coordination at the EU level, the actual implementation has to happen locally. However, if local actors — such as consumers — are to make a difference, they need to be equipped with the knowledge and the means.

This has been a key goal of the EU-funded CASSANDRA (A multi-variate platform for assessing the impact of strategic decisions in electrical power systems) project, which has developed a way to help consumers decrease their energy consumption and electricity bills. Completed in April 2014, the project's long-term legacy is an open source platform that enables both consumers and stakeholders to compare energy consumption scenarios. What makes this so innovative is that the platform can be used to visualise both an individual's energy consumption and an entire city's energy needs.

The CASSANDRA project evaluated the effectiveness of the platform by running test cases in Italy and Sweden, using real-life data. The first pilot took place at a large commercial centre near Milan, Italy, while the second took place at a multi-residential building in Luleå, Sweden.

These two scenarios demonstrated how the tool can be used to fulfil the needs of a variety of end users. Participants were able to attain an accurate picture of their electricity

*“Participants were able to attain an accurate picture of their electricity consumption and their energy needs.”*

consumption and their energy needs, which led to significantly more energy-efficient behaviour. Indeed, one important lesson from both pilots was how participants were able to decrease their electricity consumption during peak times and thus achieve an overall reduction in their electricity bills.

Another interesting lesson from both scenarios was that people who were less committed to energy efficiency in the beginning finally managed to increase their interest and engagement. This underlines the importance of providing consumers with accurate



and useful information that can lead to environmentally-friendly and cost-efficient behaviour. Indeed, the success of the two pilots encouraged the CASSANDRA team to develop software that could be made available to the general public.

The project also directly addressed the needs of the energy market, which has undergone significant change over the past few years. Sustainability is no longer an option, as such; it is a central objective of EU energy policy, and European industry has had to adapt accordingly. Furthermore, power production has become increasingly fragmented, with a growing number of decentralised, small-scale production sites based on renewable energy sources. It is important that the energy sector views these changes as a key opportunity to achieve energy savings and to provide new levels of customer service.

In order to ensure the long term sustainability of the project and to promote interest in the platform, the CASSANDRA Network of Interest has been set up. This network is made up of engaged people, companies and organisations from a range of industries who share a mutual interest in the project and its applications. The goal is to exchange information, ideas and thoughts about the platform, and to give members the opportunity to test the CASSANDRA platform and provide feedback.

### CASSANDRA

- ★ Coordinated by Eketa in Greece.
- ★ Funded under FP7-ICT.
- ★ [http://cordis.europa.eu/news/rcn/121612\\_en.html](http://cordis.europa.eu/news/rcn/121612_en.html)
- ★ Project website: <http://www.cassandra-fp7.eu/>



## NEW SOLAR CELLS MADE MORE EFFICIENT

EU-funded scientists have developed a laser-based technique to automatically repair defective 'photovoltaic' (PV) cells and wafers. These should be reused to produce custom, low-cost solar modules.

Currently, there is growing demand for small-format, semi-transparent or custom-shape PV cells. Repairing and reusing defective solar cells should provide the European PV industry with a competitive advantage.

Funded by the EU, the project REPTILE (Repairing of photovoltaic wafers and solar cells by laser enabled silicon processing) provided the technology and methodology to transform cheap mate-

*"Modules produced from repaired cells proved to have equivalent or even better performance compared to standard A-class cells."*

rials (scrapped cells and wafers) into small, custom and efficient PV cells and modules. The methodology employed promises higher efficiencies compared to that of the modules that are manufactured with standard solar cells.

The concept is based on automatically recognising and classifying defects in C or D class cells. Then, automated laser processing is performed to obtain a smaller A-class cell. Furthermore, a computer algorithm selects the optimal geometry to achieve maximum cell efficiency and minimum material waste.

REPTILE's prototype system consists of a contactless laser system that cuts and isolates non-defective parts. A vision system and software were developed for detecting the defects and providing the laser repairing system with the required automation and flexibility degree.

Another key prototype component is the automated characterisation system that is integrated with the laser system. A powerful luminescence and thermography combination was tested for detecting and characterising all significant defects with enough spatial resolution to feed the repair system.

Furthermore, a novel gripper design was developed to automatically separate cells during the sorting phase and to feed the repaired and modified cells back into the manufacturing line.

By using the project prototype, project members built proof-of-concept modules from the repaired solar cells and evaluated their repairing process effectiveness. Modules produced from repaired cells proved to have equivalent or even better performance compared to standard A-class cells.

The project successfully bridges the gap between the European PV market and the small- and medium-sized enterprises (SMEs). Rejected cells and wafers



end up being reprocessed, thus opening the door to new markets for SMEs.

### REPTILE

- ★ Coordinated by AIMEN in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/100305\\_en.html](http://cordis.europa.eu/project/rcn/100305_en.html)
- ★ Project website: <http://www.reptile-project.eu/>

## STUDYING HYDROGEN STORAGE POTENTIAL

Not only is hydrogen an environmentally-friendly energy source, it is also suitable as a storage medium. EU-funded scientists assessed its potential for storing renewable electricity in both the short and long term.

Through water electrolysis using energy generated from wind or the sun, hydrogen can be produced. If this energy is needed, the hydrogen can be combusted into electricity or reconverted into electricity with the aid of fuel cells. Although large-scale underground gas storage is a relatively mature solution, hydrogen underground storage still needs to be thoroughly evaluated from a technical as well as an economic standpoint.

The EU-funded project HYUNDER (Assessment of the potential, the actors and relevant business cases for large scale and seasonal storage of renewable electricity by hydrogen underground storage in Europe) provided the first Europe-wide assessment regarding hydrogen storage in underground salt caverns over the long term. The ultimate goal was to develop a concrete action plan on how to move hydrogen storage from the current development phase to the deployment phase. This should also include policy

recommendations on how to overcome technical, commercial or regulatory deployment hurdles.

HYUNDER was based on case studies for six representative European regions. Each case study considered the hydrogen competitiveness against other large-scale energy storage concepts, how to introduce it in the energy market and the region's geological potential.

Project members developed a common methodology for all individual case studies. Firstly, they documented the current benchmark state of large-scale seasonal hydrogen underground storage against other competing technologies.

Another task was to compile and present all known physical options of underground high-pressure gas storage, as well as establish a set of criteria for each type. Salt caverns, depleted gas fields and aquifers were assessed for their applicability and potential in these six countries.



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*"The ultimate goal was to develop a concrete action plan on how to move hydrogen storage from the current development phase to the deployment phase."*

The project team also delivered an overview and detailed information about the process technologies. This was required for safe operation of the hydrogen underground storage plant.

Results showed that hydrogen storage cannot possibly contribute to solving short-term challenges in the energy markets — e.g. help mitigate local electricity grid congestions. Other technologies may be cheaper for this. However, such a chemical energy carrier can come into play for all energy sectors that need large-scale energy storage, such as the transport sector.

#### HYUNDER

- ★ Coordinated by the Foundation for the Development of New Hydrogen Technologies in Aragon in Spain.
- ★ Funded under FP7-JTI.
- ★ [http://cordis.europa.eu/project/rcn/104756\\_en.html](http://cordis.europa.eu/project/rcn/104756_en.html)
- ★ Project website: <http://www.hyunder.eu/>
- ★  <http://bit.ly/1x2KD9m>

## A NEW BREAKTHROUGH IN PORTABLE POWER

Engineers have long been struggling to develop a new breakthrough idea that will push battery technology to the next level. Now, EU-funded researchers have developed not one, but two technologies for micro fuel cells running on hydrogen while enabling their use with fuels that are more easy to store.

Miniature fuel cells promise a huge power boost to portable electronics ranging from mobile phones to power-hungry web-enabled handheld devices. Unlike today's most efficient lithium-ion mobile-phone batteries, with an average of only four hours of talk time, micro fuel cells with a proper fuel storage could provide longer talk time in off-grid situations. Moreover, this technology could be designed to be recyclable or disposable with user-friendly portable fuelling systems.

The ISH2SUP (*in situ* H<sub>2</sub> supply technology for micro fuel cells powering mobile electronics appliances) project proposed two different solutions for fuelling micro fuel cells. The primary fuel — either methanol (CH<sub>3</sub>OH) or sodium borohydride (NaBH<sub>4</sub>) — is stored in a rechargeable cartridge. Electrical power is generated in the fuel cell using gaseous hydrogen released on demand from the cartridge.

NaBH<sub>4</sub>-based technology was already known before the ISH2SUP project, but needed further development to make it

suitable for long-term use in miniature fuel cells. Electrolysis of methanol, on the other hand, was a completely new method, which needed extensive research. During the ISH2SUP project, different catalysts were examined and, finally, platinum and an enzyme were chosen.

Commercially available small fuel cells that produce one tenth of a watt to 50 watts were used to prove the feasibility of the new fuelling technologies. The prototypes developed included a battery and control electronics for hydrogen release. They were tested on a smart mobile phone and a laptop computer. For both these devices, a hydrogen-driven charger was built.

*In situ* production of hydrogen is not limited to the small power range examined in the ISH2SUP project. Research to extend its applicability from 100 watts to 1 kilowatt is scheduled for the final phase of the project. Thanks to the high-energy fuels used, fuel cells can produce more energy for their weight than

batteries ever will, supporting greater portability.

*"The prototypes developed included a battery and control electronics for hydrogen release."*

Furthermore, electrolysis with the help of an enzyme opens up interesting possibilities to cheaply produce hydrogen from different kinds of bio-decomposable wastes — including alcohols or sugars. This new class of power packs that is expected to enter into the market in the coming years might render the ubiquitous battery obsolete.

#### ISH2SUP

- ★ Coordinated by Aalto University in Finland.
- ★ Funded under FP7-JTI.
- ★ [http://cordis.europa.eu/project/rcn/94281\\_en.html](http://cordis.europa.eu/project/rcn/94281_en.html)



ENVIRONMENT AND SOCIETY

# USING ROBOTS FOR A BETTER UNDERSTANDING OF THE UNDERWATER WORLD

It is where we all came from and it is vital to our future, but the earth's oceans, seas and waterways remain a mystery to us — a final frontier. The SUNRISE project is at the forefront of a revolution in communications, creating an underwater 'internet of things', which will mobilise robots to work in groups, interacting together and passing back information to us on life underwater.

The internet is omnipresent and has become a part of how we live, but now this connectivity is being extended from where we all take it for granted to where it has never been before — underwater.

Thanks to the SUNRISE project (Sensing, monitoring and actuating on the UNderwater world through a federated Research InfraStructure Extending the Future Internet), supported by the European Commission under the 7th Framework Programme, underwater robots will be able to work autonomously, having received instructions. For the first time, they will be able to

communicate with each other and send data back to computers through the internet, regardless of swiftly changing circumstances and challenges to data transmission.

'The gaps in our knowledge of the underwater world are extensive. We know so little despite the fact that marine ecosystems are central to the health of our planet and vital to our economies,' project leader Dr Chiara Petrioli says. Identifying threats to oil and gas pipelines, monitoring the environment, protecting archaeological sites and finding out more

about the geology of our planet — the ways teams of aquatic robots could help us learn more is endless. 'This list is as extensive as your imagination,' says Dr Petrioli.

## Designing robots which can communicate in rapidly changing environments

Those changing environments are one of the key challenges the project faces. The robots communicate with each other using acoustic signalling, as do marine mammals. But whereas a dolphin will adapt the way it signals according to what is around it, robots need to be programmed to do so, presenting researchers with the task of developing machines capable of responding to a rapidly shifting set of variables. 'Salinity, temperature, interference in the form of waves or passing shipping, all these will change the range of effective communication,' explains Dr Petrioli. This unpredictable environment is one of the key ways the internet of things underwater differs from our land-based use of WiFi and the internet.

The need to respond reliably to the shifting environment means multiple robots are needed, so if one can't communicate temporarily, another will take over the signalling. Schools of robots will carry a greater number of sensors and cover a larger area, cooperating and communicating together. Those operating them will send messages through modems transmitting acoustic waves. The waves are modulated to send information — but bandwidth is limited, meaning



transmission rates are slow. Additionally, sound waves only travel 1 500 metres a second, five orders of magnitude slower than radio communication in the air. Only a relatively limited range of tone will travel well — high tones don't go so far.

'These challenges can only be met by bringing together a cutting-edge team with partners from Italy, Germany, Portugal, the Netherlands, Turkey and the United States. This is the biggest-scale endeavour in this field, globally. We are putting Europe at the frontier of this type of work,' says Dr Petrioli. The international dimension means that the project's labs also include underwater

zones as diverse as the Baltic and the Mediterranean. 'We get to try our prototypes in environments that present completely different challenges, making for stringent testing,' Dr Petrioli adds.

### Results are starting to come in...

Work completed in summer 2014, in Porto, showed the team that their ambitions were feasible: the components communicated, the robots responded to their instructions, and the scientists were thrilled. On the practical side, they've already helped to find a lost container in Porto's waters. 'The scientists are more enthusiastic than ever

now we can see that we are on the right track,' says Dr Petrioli.

Now that the project has working prototypes, the next stage is to bring in new partners from different areas of interest and set up centres off the coast of the USA, in Dutch lakes and in the Black Sea in Turkey.

#### SUNRISE

- ★ Coordinated by the Sapienza University of Rome in Italy.
- ★ Funded under FP7-ICT.
- ★ [http://cordis.europa.eu/result/rcn/148257\\_en.html](http://cordis.europa.eu/result/rcn/148257_en.html)
- ★ Project website: <http://fp7-sunrise.eu/>
- ★  <http://bit.ly/1oGSLqZ>

## ENHANCING EUROPEAN BIODIVERSITY BY CONNECTING CONSERVATION AREAS

Connecting up conservation areas will help animals to migrate and further protect Europe's wonderful biodiversity, an EU-funded project has found.

While conservation areas have helped European biodiversity to flourish, there needs to be more connection between protected areas, along with greater attention to the needs of individual species. These are some of the key findings of the EU-funded SCALES (Securing the Conservation of biodiversity across Administrative Levels and spatial, temporal, and Ecological Scales) project, a major five-year study that assessed the management of Europe's natural habitats. Completed in the summer of 2014, the project has since published a final report and made an online interactive tool available for policy-makers.

The SCALES project focused on the European nature protection network Natura 2000. With over 26 000 onshore areas and covering around 17.5% of the area of the EU, Natura 2000 is now the largest network of nature reserves in the world. What this network lacks, however, are functioning connections between these individual protected areas. These would allow rare species to migrate between them, securing long-term genetic stability for the populations.

Taking this into consideration, the final report details how more action is needed to support species that find it harder to disperse. While birds typically have no problem migrating between nature reserves, roads can prove to be virtually insurmountable obstacles for many types of amphibians, such as frogs. The SCALES project found that an effective solution to this sort of issue was to connect smaller protected areas to large ones.

Scientists believe that this would benefit the economy as well as nature protection: natural structures — such as hedges and field margins — are important to endangered species of plants and animals, as they allow them to migrate through the agricultural landscape. At the same time, these structures help to counter soil erosion and provide habitats for pollinating insects, which increase the agricultural yield of these areas.

In the long term, says the project's report, connections that allow species to migrate over large distances, following habitats that have shifted as a result of climate change, will be of particular importance. Furthermore, species moving over large areas — such as the white stork or the wolf — should be managed in cooperation with neighbouring countries.

Ultimately, the scientists behind the SCALES project would like to see minimum standards for nature conservation to be observed in areas between protected areas as well. These minimum standards, they say, would have no negative impact on agricultural or forestry production.

Project results have also been presented in an easy-to-use interactive tool, designed specifically for the needs of policy and decision-makers. The tool also provides access to a range of biodiversity data and maps compiled or created over the course of the project. This tool is the first of its kind, and will hopefully lead to new innovative ideas for how complex conservation issues are addressed.

With a total budget just under EUR 10 million, the SCALES project has been one of Europe's largest biodiversity research projects, with regional case studies covering the United Kingdom, Finland, Poland, France and Greece.

#### SCALES

- ★ Coordinated by the Helmholtz Centre for Environmental Research in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/news/rcn/121753\\_en.html](http://cordis.europa.eu/news/rcn/121753_en.html)
- ★ Project website: <http://www.scales-project.net>



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# MINERAL VARIABILITY IN SUB-MARINE GEYSERS

Hydrothermal vents in the ocean's floor transfer chemicals from the Earth's crust up to the atmosphere. Novel insight into the sources of chemical variability in these vents could yield both economic and environmental benefits.

© David Pillinger/Corbis

*"The team successfully described the main contributors to isotope variability in vent fluids and ruled out factors that do not contribute."*

**G**rowing interest in mining sea-floor deposits of metals highlights the need for greater understanding of the chemical exchanges between the lithosphere (the Earth's outermost rocky shell) and the oceans covering much of it.

The global geochemical balance also has important implications for climate change.

EU-funded scientists working on the project ISOBAB (Isotope constraints on the contribution of metal-rich magmatic fluids to back-arc sea-floor hydrothermal systems) studied unique hydrothermal systems associated with mineralisation to gain fundamental insight into sub-seafloor processes involved in metallogenesis. First discovered in 1977, hydrothermal vents are like geysers of super-heated mineral-rich water spewing from fissures along the ocean floor.

Hydrothermal processes in 'Back-arc basins' (BABs), a special type of submarine basin, generate a rich variety of vent chemistry and mineral deposits, therefore chemical exchanges are important here.

Two sources likely contribute to BAB ore deposits: metal-rich magmatic

fluids and sub-seafloor metal precipitation/remobilisation.

However, the contribution of each is not clear. ISOBAB chose non-traditional isotopes of cadmium, zinc and antimony coupled with sulphur isotopes in seafloor hydrothermal vent systems (fluids, deposits and substrate rocks) to gain insight.

They added iron and copper isotopes to the planned analyses early in the project for a comprehensive picture of mineralisation.

Through a combination of experiments and modelling, the team successfully described the main contributors to isotope variability in vent fluids and ruled out factors that

do not contribute. Results are important to the EU's future in ocean exploration and ocean mining as well as to its excellence in non-traditional stable isotope chemistry.

A broader perspective includes a role for fundamental understanding of hydrothermal systems and their contribution to geochemical exchange in fostering better insight into implications for global climate change.

## ISOBAB

- ★ Coordinated by Ifremer in France.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/97499\\_en.html](http://cordis.europa.eu/project/rcn/97499_en.html)





## HIGH-VALUE BIOPRODUCTS FROM WASTE

Hotels, restaurants, vegetable oil industries and biodiesel producers are sources of cheaper oils and oil wastes. Use of such waste streams to produce bioproducts such as biosurfactants and ester oils could sustainably reduce production costs.

The EU-funded BIO-SURFEST (Development of novel environmentally added-value surfactants and esters by biotechnological processes from fats and oils waste streams) project worked on the semi-industrial scale production of biosurfactants and ester oils using such waste streams. The fermentation process was developed to produce biosurfactants, and enzymatic catalysis was used to manufacture ester oils.

Comprehensive characterisation of waste streams revealed that oil wastes, such as waste cooking oil and restaurant grease, are the most suitable substrates for producing biosurfactants and ester oils. Other waste streams, including olive oil mill wastewater and cheese whey, were also investigated for use as raw material.

*“Bioproducts were produced with good yield and consistent quality.”*

Requirements and specifications for the two biotechnological processes were determined for lab-scale production. The biosurfactants should be non-toxic, ethylene oxide-free, sulphate-free, biodegradable, and capable of withstanding extreme conditions of temperature, pH and salinity. Ester oils need to be biodegradable, non-toxic and compatible with materials like plastics, resins, rubbers and elastomers. Based on market needs, researchers focused on producing biosurfactants, such as rhamnolipid and sophorolipid, and ester oils, such as ethyl esters and monoacylglycerides.

After successful validation of fermentative and enzymatic catalysis at lab scale, pilot plants were designed to upscale production. Process optimisation and validation followed,

and bioproducts were produced with good yield and consistent quality.

In parallel, the team carried out environmental impact assessment, techno-economic analysis and a life cycle assessment to ensure optimal exploitation of these bioprocesses and bioproducts. Bio-based products were found to be more expensive to produce than their non-bio-based counterparts due to issues with economy of scale and technology maturity.

Two main business models were proposed by project partners and involved the commercial development of such plants and production of bioproducts. Safety, non-toxicity and eco-friendliness of these methods and products feature highly in the exploitation strategy.

The EU bio-based market is estimated to be worth billions of euro and this market is expected to grow. Besides increasing employment opportunities, product and process commercialisation will enhance EU competitiveness in several industrial sectors.

### BIO-SURFEST

- ★ Coordinated by Industrias Suescun in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/100420\\_en.html](http://cordis.europa.eu/project/rcn/100420_en.html)
- ★ Project website: <http://www.biosurfest.com>



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## HOW TO COMBAT UNDESIRABLE ODOURS



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Odours from industry, chemical plants or livestock breeding can be a nuisance for people living in the surrounding areas. Those affected have in the past been asked to help tackle the cause of the problem, but in the majority of cases their input has seldom been used. Until now that is. The EU-funded project OMNISCIENTIS brings together state-of-the-art information and communication technologies as well as Earth observation applications to help reduce odour annoyance.

The project team has taken the unprecedented approach of involving citizens, industry and public authorities to come up with effective solutions to combat undesirable odours. Giving all stakeholders the chance to express and share their

opinions and concerns is the backbone of the project.

The first stage has seen the OMNISCIENTIS (Odour MoNitoring and Information System based on ClitizEN and Technology Innovative Sensors)



team's web-oriented service platform technology being put into place. This platform is integrating citizens' feedback and observations regarding potential sources of odours in their area.

*"Public authorities could use the web application developed by the project team to access various statistics."*

'People are free to sign up to participate on the website and can download the application to provide their own personal feedback on a certain odour-related nuisance in their area,' says project coordinator Philippe Ledent from the Belgian software engineering company SPACEBEL. 'Potential

participants are however required to take a half-hour test in advance to ensure their sense of smell is up to scratch,' he adds.

Meanwhile, public authorities could use the web application developed by the project team to access various statistics, impact levels and emission rates. Due to the subjective nature of odour perception, odour monitoring and modelling will be used to assist and adjust the information provided.

'The communication with citizens is vital in addressing the issue of odour annoyance and is expected to lead to better cooperation between potentially conflicting parties,' comments Ledent.

The OMNISCIENTIS project's technology is currently being tested at a pig fattening farm in Austria and at an industrial paper mill site in Belgium. Once tests are finalised, the project

team expects the solution to be rolled out across Europe. This will help generate better information to improve the national and European legislative framework as well as to support local authorities in their environmental decision-making. Last but not least, citizens' well-being will improve as undesirable odours are dealt with appropriately.

#### OMNISCIENTIS

- ★ Coordinated by Spacebel in Belgium.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://ec.europa.eu/research/infocentre/article\\_en.cfm?artid=32758](http://ec.europa.eu/research/infocentre/article_en.cfm?artid=32758)
- ★ Project website: <http://www.omniscientis.eu>
- ★  <http://bit.ly/1BITNg>

## RICE RESISTANCE TO BACTERIAL DISEASES

'Bacterial blight' (BB) is one of the most severe diseases affecting rice crops in rice growing countries in Asia and Africa. Achieving resistance against BB will improve yield and increase profitability of rice farming.

Pathogenic '*Xanthomonas oryzae* pv. *oryzae*' (Xoo) causes BB disease in rice crops. Xoo represents a significant threat to agriculture and global food security. The EU-funded RXOMICS (Identification of novel genes conditioning bacterial blight resistance in rice using genomic resources and functional analysis tools) project worked on accelerating gene discovery for BB resistance to reveal novel resistance loci in rice varieties.

Asian and African Xoo genomes contain multiple members of a gene family encoding 'Transcription activator-like' (TAL) effectors. TAL effectors enter host cells via the bacterial secretion system and turn on specific host genes by binding to effector sites in the host genome. Some TAL effectors activate host genes that enhance susceptibility, but some function as avirulence factors by activating resistance genes.



Some weakly virulent Xoo strains contain no TAL effector genes. Researchers used one such strain (X11-5A) as a 'TAL recipient' and confirmed its ability to express and deliver TAL effectors. They demonstrated that Xoo TAL effectors enhanced X11-5A virulence on most host varieties. Using the X11-5A delivery system, they identified previously unknown TAL-mediated resistant interactions in the diverse germplasm. This demonstrated that the X11-5A delivery system is an excellent tool for screening new sources of resistance to Xoo TAL effectors.

New draft genomic sequences of African Xoo strains were used to develop specific diagnostic primers. Primers were designed based on predicted sequences specific to several African Xoo strains. The same strategy was applied to design primers specific to Asian strains of Xoo.

Results from the RXOMICS project were presented at international meetings and workshops and several papers were published in high-impact journals. The research team

organised collaboration between labs in the USA, Europe and Africa.

Understanding the roles of TAL effectors in diverse genetic backgrounds of rice will help define key disease susceptibility factors in plants as well as novel sources of resistance. X11-5A will be useful as a tool for characterisation of multiple TAL effectors to rapidly identify potential resistance genes in rice crops.

*"New draft genomic sequences of African Xoo strains were used to develop specific diagnostic primers."*

#### RXOMICS

- ★ Coordinated by the Institute of Research for Development (IRD) in France.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/93152\\_en.html](http://cordis.europa.eu/project/rcn/93152_en.html)

## NEW STANDARDS FOR EUROPEAN BEE PRODUCTS

A recent project has supported the beekeeping industry in Europe by proposing new health and quality standards for pollen and royal jelly products.

The European beekeeping industry is facing a myriad of threats to its competitiveness. These include declining bee health, cheap and inferior international products, and a lack of standards for bee products like pollen and royal jelly.

To address some of these problems, the EU-funded APIFRESH (Developing European standards for bee pollen and royal jelly: Quality, safety and

authenticity) project undertook reformation of the industry by developing Europe-wide standards for these products.

The project focused on three aspects: authenticity of bee products; chemical, microbiological and sensory standard criteria; and health-enhancing compounds. This research was collated into a number of tools, reports and guides for bee industry stakeholders.

A quality-standard proposal was also completed for both pollen and royal jelly. These proposals covered the required physico-chemical properties, as well as the methods used to analyse these properties.

*"The project developed a molecular method to identify the plant source and geographical origin of pollen and royal jelly."*



APIFRESH produced best practice guides for harvesting and analysing pollen and royal jelly. Furthermore, a manual of health-enhancing compounds present in the products was compiled.

Lastly, the project developed a computer vision method to identify the plant species and geographical origin of pollen and royal jelly. This was incorporated into a decision support tool to help farmers and distributors verify the source of their products.

#### APIFRESH

- ★ Coordinated by Inspiralia in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/94698\\_en.html](http://cordis.europa.eu/project/rcn/94698_en.html)
- ★ Project website: <http://www.apifresh.eu>





*“ARCAS is pioneering in that the flying robots are being equipped with arms to perform increasingly complicated manipulation tasks autonomously.”*

IT AND TELECOMMUNICATIONS

## FLYING ROBOTS WILL GO WHERE HUMANS CAN'T

There are many situations where it's impossible, complicated or too time-consuming for humans to enter and carry out operations. Think of contaminated areas following a nuclear accident, or the need to erect structures such as antennae on mountain tops. These are examples of where flying robots could be used.

The EU's ARCAS (Aerial Robotics Cooperative Assembly System) project has designed a range of different flying robots with multi-joint manipulator arms to work together to grasp, transport and deposit parts safely and efficiently. The autonomy and skills of the robots are being developed to build or dismantle structures for a host of future applications, from rescue missions to inspection and maintenance in the energy and space sectors.

‘The idea is that the robots should be able to fly in anywhere where it is impossible or impractical for piloted aircraft or ground robots to operate,’ explained ARCAS project manager

Professor Aníbal Ollero, from the University of Seville. ‘We have helicopters, and multi-rotor systems with eight rotors to give more hovering control, increase the payload and carry arms with greater degrees of freedom.’

Up to 10 mini-prototypes have been demonstrated working together on an indoor test bed at CATEC, the Advanced Aerospace Technologies Centre in Seville, Spain. Larger outdoor demonstrations using adapted helicopters and bigger multi-rotors have been performed at the facilities of DLR, the German national aerospace research centre, near Munich, and the University of Seville, to show how they grasp bars

and transport them over distances before depositing them.

The idea of flying robots is not new, of course. A large range of unmanned aerial vehicles is already in use, notably to take photographs and collect other sensor data. But ARCAS is pioneering in that the flying robots are being equipped with arms to perform increasingly complicated manipulation tasks autonomously. They are programmed with briefing information and 3D maps to orient them, equipped with sensors to adapt if a mistake is made (such as dropping a part) or circumstances change (like weather conditions), and even taught how to land safely in an emergency or fly home



automatically when they lose contact with base.


‘The robots work very well,’ said Professor Ollero. ‘We still need to improve accuracy and repetitiveness in different conditions, but the results are very promising. We have demonstrated aerial manipulation with six- and seven-joint arms, and perception and planning functionalities, and this is a first worldwide.’ Now the aim is to improve the robots’ robustness and reactivity, working them together in bigger numbers and increasing the complexity of tasks they perform.

### From pipeline inspection to space junk

ARCAS is paving the way for the flying robots to be used in applications, as soon as national safety laws allow. At first, this is likely to be for inspection and maintenance purposes: oil and gas pipelines and electricity networks stretching over thousands of kilometres, for example. In the medium term, the team believes the robots could cooperate in the rapid building of structures, such as antennae stations in remote areas or platforms between buildings, say, to rescue people from

fires. In the long term, post-2020, they will be able to dismantle satellites, service space stations or even help remove space junk.

#### ARCAS

- ★ Coordinated by FADA in Spain.
- ★ Funded under FP7-ICT.
- ★ [http://cordis.europa.eu/result/rcn/148256\\_en.html](http://cordis.europa.eu/result/rcn/148256_en.html)
- ★ Project website: <http://www.arcas-project.eu>
- ★  <http://bit.ly/1s1xln0>

## HIGH-SPEED OPTICAL INTERNET

Barely anyone in Europe has premium-speed Internet, and providing it via underground cabling is impractical. A new EU solution promises an affordable alternative: super-fast optical connection between buildings.



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For many Europeans, the internet has become vital for work and study. However, to meet these needs, the growing bandwidth demand often exceeds the capacity. Only 2 % of Europeans have 100 MB/s connections; providing this to the rest of the population would be cost prohibitive, mainly because of the trench-digging involved.

Europe requires a solution that does not involve such trenches or the laying of cable. Working on this is the EU-funded CONNECTOO (Development of a wireless

high capacity broadband product, based on Free Space Optics, providing a new opportunity for low cost connection of houses to the fibre-based digital highway) project. The aim was to develop a low-cost ‘Free space optical’ (FSO) device capable of high-rate data transmission, suitable for any short-range wireless application. To this end, work first required matching user needs with available technologies, leading to a functional product. The seven-member partnership ran from October 2010 to September 2014.

Project members identified and published the technical requirements, leading to product design specifications. Separate design documents were produced for each of three key components: optics, electronics and mechanics. Much of the work involved finding an existing product capable of being adapted to CONNECTTOO specifications. The optical sub-assembly from a 'Small form-factor plug-gable' (SFP) module was chosen. Testing showed that the component exceeded requirements.

The result of the CONNECTTOO consortium is an FSO device, providing four 1 GB/s channels simultaneously between buildings up to 100 metres apart. The system

will open up affordable high-speed internet capability for much of Europe.

#### CONNECTTOO

- ★ Coordinated by Polewall in Norway.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/104813\\_en.html](http://cordis.europa.eu/project/rcn/104813_en.html)
- ★ Project website: <http://www.connecttoo.no>

## DEFENCE AGAINST COMPUTER ATTACKS

There are more computer threats than viruses alone. An EU project helped to protect against one kind, neutralising disguised attacks and compromised documents other systems could miss.

Computer viruses and other malicious software are well known. Attacks that exploit memory corruption vulnerabilities are less familiar to most people, but arguably more dangerous as they can give unrestricted system access.

Looking to offer protection was the EU-funded MALCODE (Malicious code detection using emulation) project. Organised under the Marie Curie programme for researcher development, the single-member study ran for three years to the end of June 2013. The aim was to design, develop and evaluate new algorithms for detecting malicious code, based on code emulation.

*"Defences can be applied to third-party software, but without slowing processor time."*

Malware can hide or disguise itself, therefore an advantage of the project's technique is that it detects malicious code by its actions at the machine-instruction level. By examining those actions, the project aimed to establish new principles for detection.

The project successfully achieved its aims. Outcomes included two new methods for detection of network-level attacks and malicious PDF documents. The first method involved a shellcode detection technique, and a means of identifying machine-level operations performed by different types of shellcode. In effect, the technique enables detection that other systems could miss. The second detection technique, called MDScan, is a document scanner, similarly able to detect hidden threats embedded in PDF files.

The second half of the study resulted in two techniques for attack prevention based on Return Oriented Programming. The method detects hidden threats in data sources such as network traffic or process memory, and provides protection using in-place code randomisation. As a result, defences can be applied to third-party software, but without slowing processor time.

Work also contributed to other fields, including network-level traffic monitoring and analysis, and the use of graphics processors for accelerating the processing of network traffic. Additionally, the research advanced online privacy issues and investigated the Android operating system environment.

MALCODE achieved significant advances in detection of and protection against malicious code threats. As a result, computer and data systems will be more secure.

#### MALCODE

- ★ Coordinated by the Foundation for Research and Technology Hellas in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/95542\\_en.html](http://cordis.europa.eu/project/rcn/95542_en.html)



# FROM EU PROJECT FOR MUSIC INDUSTRY ROADMAP TO GLOBAL MUSIC TECH FESTIVAL

An EU-funded initiative for creating a European music industry roadmap has led to a series of music technology events around the world. Five Music Tech Fest events have already been held and 13 more are scheduled for the coming year, covering eight countries and drawing hundreds of participants.

Music touches everyone, and MIREs (Roadmap for Music Information ReSearch) project organisers say the Music Tech Fest is galvanising the world of music technology, drawing global recording labels and high-tech companies, start-ups and innovative small and medium-sized enterprises (SMEs), new and established performers, young innovators and hackers, designers and academics.

'The field of "Music information retrieval" (MIR) has tended to centre on the analysis of sound signal, for the purpose of more efficient searches and faster access to digital collections of recorded music,' explains Michela Magas, coordinator of the MIREs project and founder of Music Tech Fest.

Magas says the advent of web-based social networks has created a dynamic global market for digital music, collateral services and new user behaviour,

with significant challenges and opportunities for commercial exploitation.

'Our aim was to create an EU Roadmap for Music Information

Research,' she says, 'to address major challenges, formulate research evaluation standards for the discipline, and open the field to cross-disciplinary collaboration.'

Workshops were to be a part of the project, allowing a meeting of minds between artists and scientists, industry and academia. The end result was a 'festival of music

ideas', a creative platform for the free exchange of ideas, without jargon from individual fields of activity.

As soon as Music Tech Fest had a website, interest exploded. 'The numbers of participants grew daily, and we soon realised that our budget was too low,' Magas says. 'So we got matching funding from the European Regional Development Fund (ERDF), and my company, Stromatolite, invested substantially in the event.' The MIREs project, which was completed in March 2013, had also received EUR 573 000 of funding under the EU's 7th Framework Programme (FP7).

## Unprecedented success for an EU project

The Music Tech Fest was launched in London in 2012, uniting major players like Soundcloud, Spotify, Shazam, EMI Music and the BBC, innovative labels like Ninja Tune and Warp, tech media like WIRED, great performers and a large number of innovative start-ups.

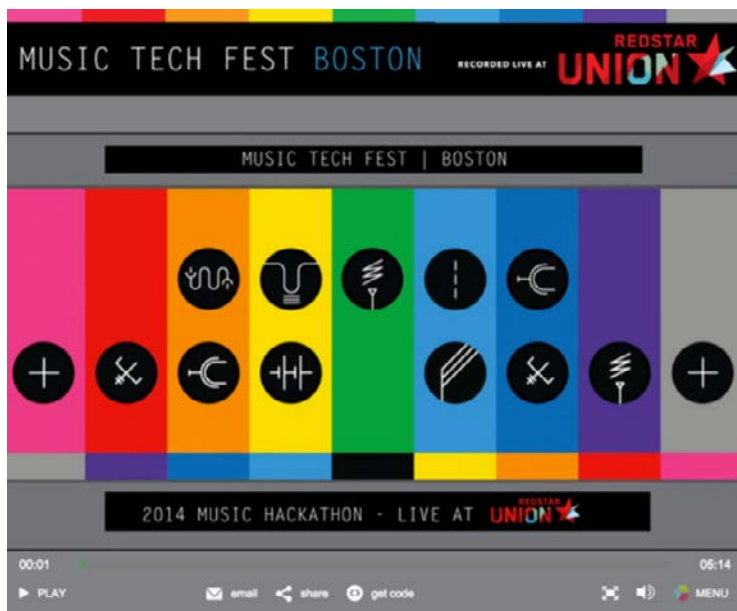
'In 2014 we are going global,' says Magas, 'from Wellington to Boston, Berlin, Paris and New York.' The flagship event in London is now part of the official autumn season of the Barbican LSO St Luke's, in partnership with the London Symphony Orchestra, and in 2015 the festival will come to the brilliant Umeå campus in Scandinavia, and to São Paulo, Los Angeles and Amsterdam.

While the astounding triumph of Music Tech Fest has been an unexpected result of the MIREs initiative, the original goal of creating a European Roadmap has also been successfully achieved. 'The final roadmap document has had a notable impact on the global MIR research community,' she says, 'contributing to the establishment of music production and digital library management standards.' It has also laid out a framework for an MIR excellence network, involving drivers and stakeholders in the field.

Some of the activities being promoted by MIREs might sound rather abstract and academic, but there is really much more at stake. The Music Tech Fest academic community has launched the 'Manifesto for Music Technology Research', highlighting the importance of these activities for all citizens and fields of study, and intellectual property policy debates.

'The intersection of music and technology profoundly impacts upon the well-being, culture and creative experience of all citizens,' Magas says, 'while Music Tech Fest's wide reach enables us to encourage new economic directions, new business models and new venture ideas.'

*"The Music Tech Fest was launched in London in 2012, uniting major players like Soundcloud, Spotify, Shazam, EMI Music and the BBC."*



## MIREs

- ★ Coordinated by Pompeu Fabra University in Spain.
- ★ Funded under FP7-ICT.
- ★ [http://cordis.europa.eu/result/rcn/147678\\_en.html](http://cordis.europa.eu/result/rcn/147678_en.html)
- ★ Project website: <http://www.mires.cc>



## DIGITAL GRAFFITI AS A MARKETING TOOL

Graffiti, a new-age art form, is taking on a different meaning for the EU. The digital graffiti platform is the latest way to create visibility and generate sales for small businesses.

The smartphone has become the main medium for global communication. With it, social networking websites have emerged and provided a platform for user interaction. Users of social network sites



create and participate in communities based on common interests. The rise of social networking sites shows how users have an urge to share their life and ideas with others.

The purpose of the DIG (Digital interactive graffiti) project is to allow every user and business to write on the (digital) walls of a street. Everyone would be able to write on these walls and leave messages for each other. Users who wish to read the messages left on these walls will have the option to use filters. This ensures that only the graffiti that users are interested in is shown to them. Location tags such as QR codes or GPS markers are utilised to write or read on a wall.

Enterprises worldwide are trying to understand and utilise social networking to drive more profit. Social networking can be used to draw information about the consumer. This could be their opinion on the product or which demographic is

more likely to have interest. It can also be used for advertising purposes. DIG's tools would allow businesses to leverage social networking for profit.

This consumer information could represent valuable insight for increasing sales by finding more like-minded customers. Another way the platform could be used is to measure interest by time spent on a page with the graffiti; before the time runs out, a better offer could be made, for example, proposing an alternative vacation location or hotel.

### DIG

- ★ Coordinated by the Chamber of Commerce of Barcelona in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/101519\\_en.html](http://cordis.europa.eu/project/rcn/101519_en.html)
- ★ Project website: <http://graffiti.mobi>

## FASTER AND BETTER ENCRYPTION

An EU project has fostered collaboration in the field of cryptography. The resulting new applications of cryptographic algorithms mean faster and better encryption, and help to secure certain wireless devices.

Certain kinds of computer networking systems, for example those connecting wireless sensors or tags, are vulnerable to hacking. While the systems are well protected against direct attacks, they can be accessed via indirect means that extract the cryptographic key and other secondary data.

Addressing the problem was the EU-funded ND-ETCRYPTOUC (New directions in efficient and tamper-resilient public-key cryptography for ubiquitous computing) project. The main goal was to secure the relevant devices, by making effective public-key cryptography available for use in this context. The availability was to be achieved via three complex technical objectives based on cryptographic algorithms.

A further purpose was developing the career of one Turkish researcher, through a series of collaborative exchanges, hence also fostering knowledge transfer with Europe. The project ran for four years, concluding in June 2014.

In the first reporting period, the first objective was fully achieved. The next two objectives were partially accomplished, and will be completed in later periods.

The researcher met and worked with numerous other researchers at universities and commercial organisations in Europe and Turkey. In a series of proposals, his applications of various algorithms helped improve cryptographic speed and performance. The results of the collaborations were published as conference and journal papers. He also presented various guest lectures and seminars, plus designed and taught several well-received comprehensive postgraduate courses. Additionally, he supervised a group of research students.

*"The main goal was to secure the relevant devices, by making effective public-key cryptography available for use in this context."*

Thanks to the ND-ETCRYPTOUC project, vulnerable devices will be better protected. The exchanges have also led to positive collaboration with European researchers and institutions.

### ND-ETCRYPTOUC

- ★ Coordinated by Bahçeşehir University in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/95038\\_en.html](http://cordis.europa.eu/project/rcn/95038_en.html)

INDUSTRIAL TECHNOLOGIES

# MASS-PRODUCING SUPER-THIN FILMS THAT CAN 'SQUEEZE' ELECTRICITY

Today, we might take it for granted that mobile-phone cameras, desktop printers, medical equipment, automobile parts and other everyday items will continue to get smaller, lighter and more reliable. These enhancements seem so natural and gradual that we might not even realise it on a day-to-day basis.

However, many technological advances are needed to improve and miniaturise such devices. One such advance is the growing use of a type of thin material known as 'piezoelectric' film. The EU-funded project PIEZOVOLUME (High volume piezoelectric thin film production process for microsystems) focused on speeding up the production of this material. The research team worked to develop high-volume production tools and methods that are expected to help make the high-tech devices and systems of the future faster, lighter and more efficient.

Up to 100 times thinner than a piece of office paper, these ceramic 'piezoelectric' films have the remarkable ability to either generate electricity when squeezed, or move when subjected to electricity. Translated from the original Greek, in fact, piezoelectric means 'pressure electricity'.

The thin films, as delicate as they may be, are an essential component in a growing number of medical, communications, aerospace and consumer products — from ultrasound machines and computer disc drives, to automobile airbags and miniature pumps, disposable blood-pressure

sensors and even machines that could scavenge energy from vibrations.

Despite the critical importance of piezoelectric thin film, Europe has lacked the ability to mass-produce it on an industrial scale. This has held back the competitiveness of industries that rely on the material. 'By mass-producing piezoelectric films, we can ensure that a whole range of electronic devices become smarter than they are now,' says PIEZOVOLUME coordinator Frode Tyholdt from the Norwegian research organisation SINTEF. 'Europe has a chance to lead in this field.'

Tyholdt notes that an endless range of devices will need to become smaller, use less power, perform better and be easier to manufacture. Piezoelectric microsystems can help achieve this goal. 'There is a limit to how small traditionally manufactured parts can be,' explains Tyholdt. 'Piezoelectric microsystems can solve this problem, and they can also let us do things we could not do before.'



As futuristic as they sound, piezoelectric materials are not a recent innovation. They were first used in sonar devices in World War II to detect enemy submarines and underwater mines. They are still used by boats, including in fishing crafts to find schools of fish. Piezoelectric microsystems now have countless uses — to make auto-focus camera lenses smaller and faster, and to miniaturise the ink dots produced by computer printers. 'Industries are constantly working to make their products smaller and smaller,' says Tyholdt. 'This is where piezoelectric film can come in.'

Because piezoelectric materials can generate electricity when shaken, systems in the future could generate their own electricity by harvesting it from nearby vibrations. This would be ideal for equipment or machinery for which changing batteries is difficult, such as in remote locations.

Commercial success resulting from the PIEZOVOLUME project has already been recorded — and this has been particularly beneficial for small and medium-sized enterprises (SMEs). Several companies are using the new types of tools developed by Tyholdt's team, and others have already begun to incorporate these films into their products, including a manufacturer of auto-focus camera lenses for mobile phones.

*"Commercial success resulting from the PIEZOVOLUME project has already been recorded."*

Additionally, the first competence centre with the capability to prototype piezoelectric microsystems in Europe has been established. 'We are making a lot of progress,' says Tyholdt. 'These advances are expected to speed up the time needed for new products to reach the market, open new horizons for SMEs and ease the introduction of piezoelectric materials into new industries,' concludes Tyholdt.

#### PIEZOVOLUME

- ★ Coordinated by SINTEF in Norway.
- ★ Funded under FP7-NMP.
- ★ <http://ec.europa.eu/programmes/horizon2020/en/news/mass-producing-super-thin-films-can-squeeze-electricity>
- ★ Project website: <http://www.sintef.no/Projectweb/piezoVolume/>

## A NEW INSULATING FOAM FOR BUILDINGS

A recent research project is advancing an insulating foam for construction and shipping that is cheap, asbestos-free and manufactured without using fossil fuels.

Building regulations in the EU are increasingly demanding in terms of physical properties. This has created a need for an effective insulating material that is not manufactured from asbestos or fossil fuel derivatives.

*"The method has yielded a 30% increase in volume, even distribution of bubbles, and a foam that sets in three minutes."*

The EU-funded AT-INSULATE (Development of a new cost-efficient and not-fuel fossil dependent insulating foam material which meets the strict EU requirements regarding thermal and noise efficiency in building and ship construction) project aims to develop a novel material to fulfil these requirements. The envisioned material will be light and non-flammable, offer good acoustic insulation and be produced at low cost.



Researchers have already managed to create a gypsum and sodium bicarbonate solution that rapidly produces a gypsum foam. Their method has yielded a 30% increase in volume, even distribution of bubbles, and a foam that sets in three minutes.

To prevent contraction of the foam while setting, fillers and surfactant additives have also been tested. Certain types of perlite (an inert inorganic filler material) have improved the stability of the foam, and a surfactant has yielded more uniform bubble size.

AT-INSULATE has conducted various tests to characterise the new material. The findings show it has excellent strength and heat conductivity for its density, and it is completely non-combustible.

#### AT-INSULATE

- ★ Coordinated by Nutec in Spain.
- ★ Funded under FP7-SME.
- ★ [http://cordis.europa.eu/project/rcn/105722\\_en.html](http://cordis.europa.eu/project/rcn/105722_en.html)
- ★ Project website: <http://www.atinsulate.eu>

## PERSONALISED RADIATION DOSIMETERS

EU-funded scientists have advanced the current state-of-the-art of a small semiconductor-based radiation reader. With greatly increased sensitivity, the first such device for personal dosimetry is on its way to market.

Personal thermoluminescent dosimeter (TLD)

© Zaphodbeebroxx, Thinkstock



Radiation sensing is important for the protection of human health, instrumentation and the environment in many fields. A very small radiation dosimeter, called the radiation-sensing field effect transistor, was invented in 1970. It has been an important tool for the last 20 years in space, high-energy physics laboratories and radiotherapy clinics.

Until now, such devices for personal dosimetry have not been possible due to the lack of sensitivity. A world leader in radiation-sensing field effect transistor technology recently demonstrated two to three times greater sensitivity using a stacked architecture. The EU-funded project NEWRADSENS (Development of radiation sensors based on stacked RADFET technology) was launched to develop and commercially exploit this potential.

Recruitment of and collaboration with an experienced researcher in stacked radiation-sensing field effect transistor technology proved quite fruitful. The team advanced the semiconductor dosimeter in terms of both fabrication yield and performance. The first stacked radiation-sensing field effect transistor reader has now been produced. During the one-year project, the research team also began investigations into another type of silicon radiation detector technology with great promise.

NEWRADSENS provided an excellent opportunity to the recruited academic researcher for training in technical and administrative aspects of EU-funded projects as well as in obtaining venture capital funds, research commercialisation and patenting.

The industry project coordinator provided invaluable input during the establishment of a centre for nuclear radiation research by the fellow at his university. The extensive experience of the project coordinator is also paving the way to rapid commercialisation and marketing of this personal radiation dosimeter.

Enhanced technical output of all involved in the project supported by the strong partnership has created ties that bind beyond project termination. The team has already collaborated on two joint project proposals with more certain to follow.

### NEWRADSENS

- ★ Coordinated by the National University of Ireland.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/103978\\_en.html](http://cordis.europa.eu/project/rcn/103978_en.html)

## NEW MARKETS FOR VOLCANIC ROCK

Perlite is a naturally occurring volcanic rock that expands with heat to between four and 20 times its original volume. Novel processing has enabled improved products for the construction, chemical and manufacturing industries.

The lightweight, porous, chemical- and fire-resistant expanded perlite is an excellent candidate for components in the chemical, construction and manufacturing industries. However, applications have been limited by undesirable attributes created during the conventional expansion process such as pores that are open to the exterior (open porosity).

The innovative EU-funded project EXPERL (Efficient exploitation of EU perlite resources for the development of a new generation of innovative and high added value micro-perlite based materials for the chemical, construction and manufacturing industry) developed new processing technologies leading to innovative, closed-structure perlite-based micro-particles and high added-value commercial end-products exploiting them. Scientists improved the expansion process with indirect heating in a vertical electrical furnace and microwave heating. A wet silicon spray treatment was developed to minimise water absorption, and multifunctional



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nanoparticles were used for surface coating of the perlite particles.

*“Lightweight insulating panels, bricks, plasters and mortars were developed for the construction industry.”*

Five different perlite-based materials were successfully developed within the scope of the four-year project, including closed-structure perlite, perlite micro-spheres and expanded perlite flakes. These were used as functional fillers in a variety of

industrial applications. Lightweight insulating panels, bricks, plasters and mortars were developed for the construction industry. Researchers created vacuum insulating panels and envelope films for the manufacturing sector. Finally, perlite-based materials were incorporated into novel paints and thermal insulation coatings for the chemical industry.

In all cases, life cycle assessments of the production technologies and the new products demonstrated lower environmental impacts than those of conventional techniques and products. EXPERL's 29 exploitable results led to numerous patents and trademarks. Many products are

at pilot-scale and others are ready to hit the market. Technology and materials will boost the competitive position of the EU's industrial minerals sector while creating new markets benefitting the construction, chemicals and manufacturing sectors.

#### EXPERL

- ★ Coordinated by S&B in Greece.
- ★ Funded under FP7-NMP.
- ★ [http://cordis.europa.eu/project/rcn/92582\\_en.html](http://cordis.europa.eu/project/rcn/92582_en.html)
- ★ Project website: <http://www.experl.eu>

## ENHANCED POLYMER PROCESSABILITY

Polymers form the basis of numerous products made from melted polymer mixtures. New research supports the potential of a processing treatment to decrease viscosity, opening the door to novel formulations with high-tech fillers.

Polymers, often called plastics, have become ubiquitous. They are in products ranging from food and beverage containers to automotive components and consumer electronics and are a major pillar of the EU economy. Viscosity plays a critical role in processability, as a polymer melt is typically employed to fill a mould. High viscosity (internal friction and resistance to flow) affects processing temperature, cycle time, productivity and product quality.

Low-frequency pulsed shear and extensional mechanical treatment helps reduce shear stress. This could help in orienting the melt during extrusion (sustained orientation or

disentanglement of the normally tangled polymer chains). However, the topic is one surrounded by controversy given its contradiction of established theories. EU-funded scientists investigated the physical mechanisms of sustained orientation with EU-funding of the project SISAPEM (A contribution to the fundamental understanding of Shear-Refinement of polymer melts by entanglement manipulation).

*“Researchers made an inestimable contribution to the field of polymer science by verifying the existence and mechanisms of sustained orientation.”*

Researcher made an inestimable contribution to the field of polymer science by verifying the existence and mechanisms of sustained orientation. Decreasing the viscosity of high-tech polymer mixtures with high concentrations of fillers including carbon nanotubes opens important new markets for the polymer industry. These include the production of flame retardants and components with high electrical conductivity.

Researcher made an inestimable contribution to the field of polymer science by verifying the existence and mechanisms of sustained orientation. Decreasing the viscosity of high-tech polymer mixtures with high concentrations of fillers including carbon nanotubes opens important new markets for the polymer industry. These include the production of flame retardants and components with high electrical conductivity.



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Future research will focus on controlling the viscosity of polymer melts using low-frequency pulsed shear and extensional mechanical treatment during processing. SISAPEM outcomes are expected to spawn a flurry of research and discovery, and superior components for high-tech devices could be just around the corner.

#### SISAPEM

- ★ Coordinated by the University of the Basque Country in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/89803\\_en.html](http://cordis.europa.eu/project/rcn/89803_en.html)

SPACE

# AFRICA–EUROPE EARTH OBSERVATION PROJECT

African and European scientists have worked together to improve marine 'Earth observation' (EO) provision to African nations. This will support the sustainable use of the marine environment.

The EAMNET (Europe–Africa Marine Network) project built a network for coastal and marine observations to support sustainable development. The network linked EO information providers, user networks and centres of excellence in Africa and Europe.

EAMNET conducted capacity building and maintenance, and built upon existing infrastructure and expertise, enhancing bilateral research and job opportunities for African scientists. The initiative's overall aim was to improve exploitation of EO data for coastal and oceanic monitoring and develop an Africa-wide observation system.

Access to near-real-time data had a number of scientific and environmental monitoring applications. These included the monitoring of harmful algal blooms, the coastal movement of sediments, and the location of eddies and upwelling, which are often preferential sites for fisheries. The data was also used in the development and updating of computer models.

EAMNET also installed five operational GEONETCAST satellite-receiving stations in Benin, Côte d'Ivoire, Egypt, Mozambique and Uganda. In addition, access to satellite data was provided to research institutes, thereby enabling them to better manage marine areas (plus Lake Victoria in Uganda).

The project also provided an interface between European 'Global monitoring for environment and security' (GMES)-related initiatives and African initiatives such as AMESD and MESA. Best practice was ensured through the exchange of personnel in Africa and Europe.

A Masters-level module in EO was established at the Universities of Cape Town, Dar-es-Salaam and Ghana as well as other universities. Open access lesson materials were also developed for self-learning. In addition, a regular marine science presence was established at the 'African association for remote sensing of the environment' (AARSE) conference.

EAMNET's success will enable African scientists to easily access EO data at low cost. The resulting gain in expertise will support sustainable development in Africa by enabling marine EO data to be fully exploited.

## EAMNET

- ★ Coordinated by Plymouth Marine Laboratory in the United Kingdom.
- ★ Funded under FP7-SPACE.
- ★ [http://cordis.europa.eu/project/rcn/94037\\_en.html](http://cordis.europa.eu/project/rcn/94037_en.html)
- ★ Project website: <http://www.eamnet.eu>



# UTILITY OF EARTH OBSERVATION DATA

Since the first satellites were launched, several applications on Earth observations have been made available to benefit society. To maximise their full potential, an EU-funded initiative has identified gaps and created bridges between providers and users.

The aim of the GEONETCAB (Geo Network for Capacity Building) project was to create opportunities for the development of the market for satellite imaging. The motivation was the still limited awareness of the possibilities offered by environmental monitoring and warning systems for health hazards.

This is partly due to issues with access to and reliability of data. However, the lack of familiarity with solutions offered or of knowledge of available products also plays a role. The capacity-building strategy formulated was a marketing effort to promote the use of Earth observation products and services. The target group was a triangle formed by decision-makers, professionals and end-users.

The GEONETCAB project established links with a critical mass of research institutions, organisations and policy-makers in new EU Member States, neighbouring countries and developing countries. Specifically, promotion activities were carried out in Southern Africa, the French-speaking African region, the Czech Republic and Poland.

These four regions were selected to provide practical examples that demonstrate how public and private organisations can benefit from Earth observation data. These include success stories of applications of Earth observation data that work and can be replicated in other parts of the world without too much investment. Most importantly, they are put together in terms that are understandable by non-experts.

GEONETCAB partners also compiled an online database with technical guidelines and training material. In addition, a catalogue was developed, referencing various kinds of useful resources for accessing Earth observation data and open source software for their manipulation. The plan

is for this inventory of Earth observation resources to be continued even after the project ends.

The GEONETCAB project has made a small, but significant contribution to the 'Global Earth observation system of systems' (GEOSS) — the capacity-building resource facility is further developed and now an integral part under the name GEOCAB. Through cooperation between users and resource providers, it facilitated the capacity building that is needed to use Earth observation data for environmental and societal purposes.

*“GEONETCAB partners compiled an online database with technical guidelines and training material.”*

## GEONETCAB

- ★ Coordinated by the University of Twente in the Netherlands.
- ★ Funded under FP7-ENVIRONMENT.
- ★ [http://cordis.europa.eu/project/rcn/92873\\_en.html](http://cordis.europa.eu/project/rcn/92873_en.html)
- ★ Project website: <http://www.geonetcab.eu/>



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# COMPUTING THE DARK SECTOR OF OUR UNIVERSE

Progress in the field of cosmology has always been closely tied to the availability of easy-to-use software tools and sufficient computational resources. An EU-funded project developed such a computational base for the study of elusive properties of dark energy and dark matter.

Numerical simulations are effective tools that provide robust predictions to solve cosmological problems, including the birth and growth of astrophysical objects. These estimations of how various physical processes evolve, once compared to present and future observations, can help assess the main cosmological parameters.

The available computational resources permit the study of a multitude of astrophysical processes in the observable universe. However, 95% of the energy in our universe is provided by two components of an as-of-yet unknown nature. Dark energy and dark matter was the focus of the COSMOTOOLKIT (Computing in the dark sector: a Cactus toolkit for modified-gravity cosmologies) project.

The COSMOTOOLKIT project was devoted to extending the freely accessible Einstein toolkit for use in numerical cosmology. This toolkit, developed by researchers around the world, combines a set of tools needed to simulate black holes, collapsing stars and other compact objects. COSMOTOOLKIT researchers developed a set of new software tools and libraries that can enable new science.

Specifically, numerical techniques were incorporated for the evolution of fluids such as cosmic dust and scalar gravitational fields. Besides simulations of regions larger than a few gigaparsecs, the computational basis was adapted to

allow the first 3D models of our universe. The groundwork was also laid to support theoretical efforts to define gravitational wave signatures.

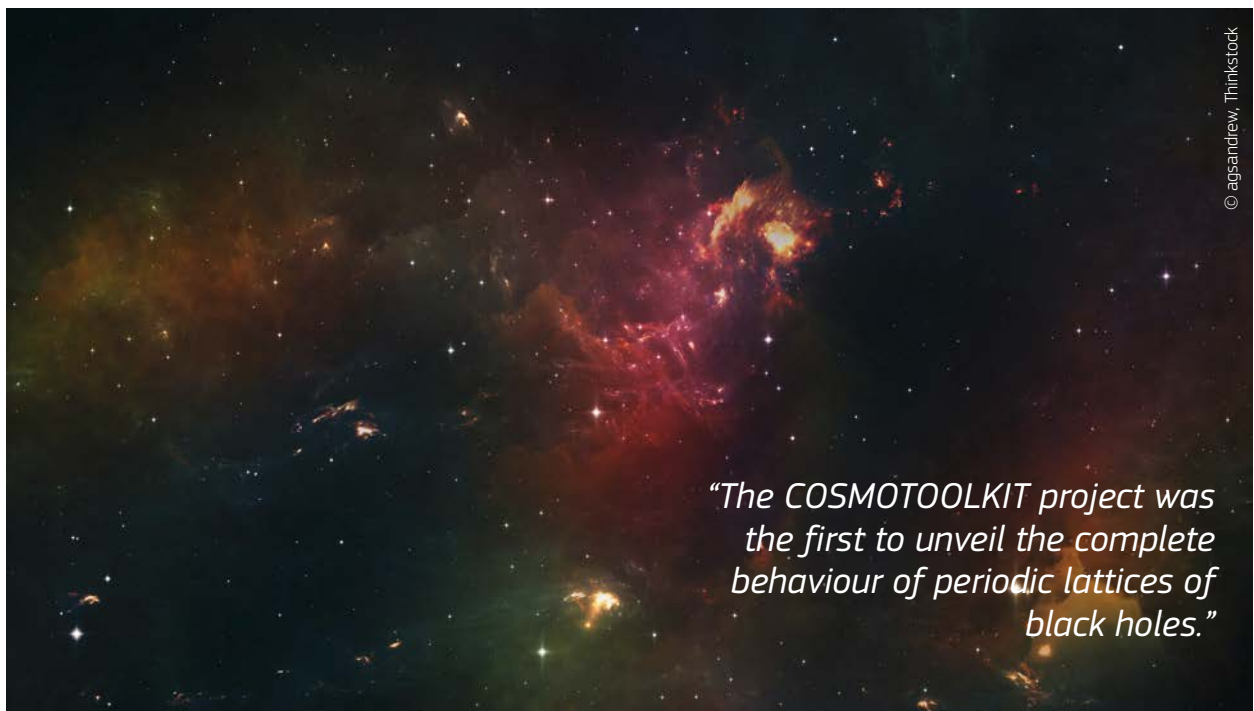
In parallel, the existence and uniqueness of solutions for Einstein's field equations on space-times that are periodic were investigated. While solutions had been sought for half a century, the COSMOTOOLKIT project was the first to unveil the complete behaviour of periodic lattices of black holes. The rich phenomenology was described through numerical simulations for expanding lattices.

The online portal 'The black-hole-lattice lab' (<http://black-holelattices.wikidot.com/>) was established to share the new codes and realistically model cosmological phenomena. This will also serve as a repository of information on black holes and a place for scientists to meet and discuss. Close collaboration had been fruitful within the COSMOTOOLKIT project and will be necessary for optimisation of the numerical methods.

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## COSMOTOOLKIT

- ★ Coordinated by the Max Planck Society in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ [http://cordis.europa.eu/project/rcn/93979\\_en.html](http://cordis.europa.eu/project/rcn/93979_en.html)



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*"The COSMOTOOLKIT project was the first to unveil the complete behaviour of periodic lattices of black holes."*



# EVENTS

DECEMBER

9

## Brussels, BELGIUM

### CONFERENCE

#### INTERNATIONAL INNOVATION LIVE: SPACE

A conference entitled 'International Innovation Live: Space' will take place on 9 December in Brussels, Belgium.

The event will bring together over 100 of the world's leading space researchers, funders, policy-makers, NGOs and key Horizon 2020 programme leaders to discuss the most important issues facing space research today.

Participants will have the opportunity to disseminate their research and commentary via International Innovation — a free-to-access global publication that has featured over 5 000 researchers and scientific leaders.

For further information, please visit:  
<http://internationalinnovation.com/live/>

JANUARY

15 ▶ 16

## Portsmouth, UK

### CONFERENCE

#### FOURTH INTERNATIONAL CONFERENCE ON NETWORK AND COMPUTER SCIENCE

The Fourth International Conference on Network and Computer Science (ICNCS 2015) will be held from 15 to 16 January 2015 in Portsmouth, UK.

The conference is one of the leading international conferences for presenting advances in the fields of network and computer science. It aims to foster communication among researchers and practitioners working in a wide variety of scientific areas with a common interest in improving network and computer science related techniques.

For further information, please visit:  
<http://www.icnscs.org>

JANUARY

21 ▶ 23

## Copenhagen, DENMARK

### CONFERENCE

#### 11TH SUSTAINABILITY CONFERENCE

The 11th Sustainability Conference will be held from 21 to 23 January 2015 in Copenhagen, Denmark.

This year's edition will focus on sustainability dividends. Participants will analyse how to prevent development 'fault lines', and how research can help to address the nexus between the four pillars of social, economic, cultural and environmental sustainability.

The conference is built upon the key features of internationalism, interdisciplinarity, inclusiveness and interaction. Participants will include leaders in the field as well as artists and scholars representing a broad range of disciplines and perspectives.

For further information, please visit:  
<http://onsustainability.com/the-conference/>

DEC.

18 ▶ 20

## Barcelona, SPAIN

### CONFERENCE

#### FIFTH INTERNATIONAL CONFERENCE ON NANOTECHNOLOGY AND BIOSENSORS

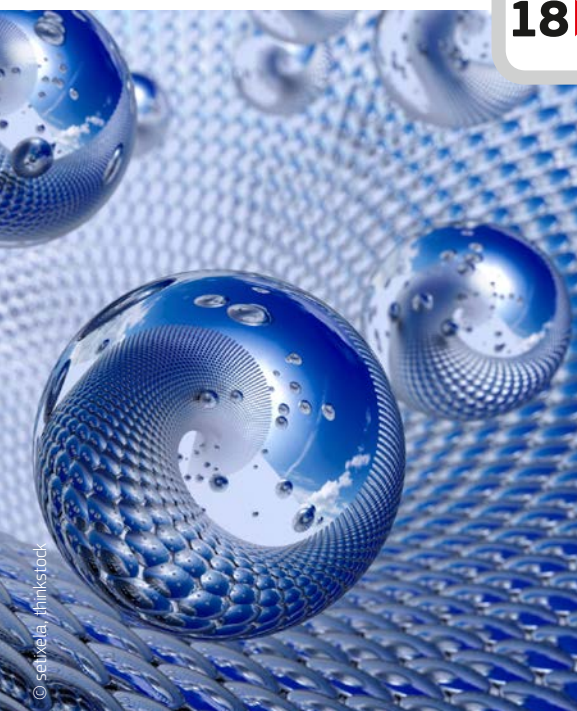
The Fifth International Conference on Nanotechnology and Biosensors (ICNB 2014) will be held from 18 to 20 December 2014 in Barcelona, Spain.

The conference aims to bridge the gap between materials sciences and life science by demonstrating the increasingly important role of nanotechnology in the development of biosensors. ICNB 2014 will bring together participants from different backgrounds to foster cross-pollination between various research fields and to expose and discuss innovative theories, frameworks, methodologies, tools and applications.

For further information, please visit:  
<http://www.icnb.org/>

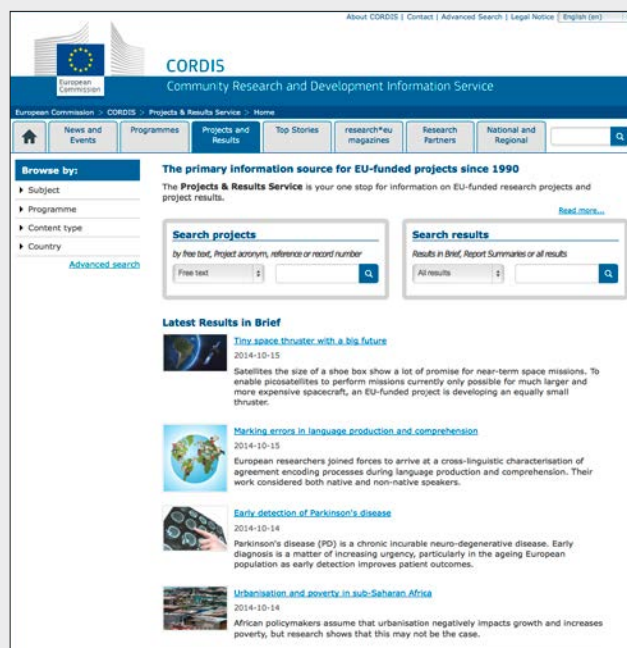
## EVENTS

For more forthcoming events:  
<http://cordis.europa.eu/events>



# CORDIS upgrades its web applications

The new search and repository architecture recently launched by CORDIS leads to a simplified and harmonised user experience.



A host of new web applications and services are now available to users eager to stay up-to-date with CORDIS News. A single search engine now drives the [Projects & Results](#), [News & Events](#) and [Top Stories](#) services, as well as the [simple](#) and [advanced](#) searches.

You can refine your search results, download into PDF, CSV and XML formats and keep up with the latest content with [RSS feeds](#) and a new email [Notifier](#).

[CORDIS Wire](#) has also been simplified and your news and events are now listed directly in the main News service. You can register directly as a Wire contributor through the central [MyAccount](#) service.

Web services are being adapted to share the same look and feel, and other information is being moved to complementary websites like the [Participant Portal](#), [Research on Europa](#), [Digital Agenda](#) and the [European Research Council](#) or joining the extensive CORDIS archives.

CORDIS continues to deepen its focus on the dissemination of research results, with a commitment to making it easier to find and reuse its data. With a new data model behind the scenes, richer datasets are being added to the [Open Data Portal](#) and information on the first [Horizon 2020](#) projects is planned.

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