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European Commission

CORDIS Results Pack on nano-enhanced industrial materials

A thematic collection of EU-funded research innovation results

January 2019

Building the next European industrial revolution

Research and Innovation

Contents

Editorial

The development and integration of advanced nanomaterials is a key ambition for the European Union as it seeks to make European industry more innovative and more competitive.

This CORDIS Results Pack showcases 14 EU-funded projects that have all addressed the upscaling of laboratory-proven nano-based technologies for reaching industrial-scale production and application, providing exciting new opportunities for European industrial production.

The global market for nanomaterials (materials which often have specific properties due to their small particle size) is estimated at around 11 million tonnes with a market value of EUR 20 billion and growing. The current direct employment in the nanomaterial sector is estimated at between 300 000 and 400 000 in Europe. Whilst most of the nanomaterial sector is still dominated by materials in use for decades, such as carbon black (used for tyres) or synthetic amorphous silica (used in applications including tyres, toothpaste and food powders), researchers have been in the process of developing many new nanomaterial-related applications, many now ready for commercial use.

Overcoming barriers to successfully address societal challenges

Europe has been at the forefront of this research, and funding through the Horizon 2020 programme aims to bridge the gap between nanomaterial research in the lab and getting innovative technologies onto the market. This is crucial, as nanomaterials look set to help overcome several pressing and urgent societal challenges. These include the need to care for an increasingly ageing population, reducing carbon emissions and fighting climate change, the more efficient use of finite resources and the development of more sustainable methods of transport.

But there are still barriers to overcome before European industry can take full advantage of the large-scale commercialisation of innovative, safe and sustainable nanomaterials. The main challenge is to develop seamless integration of materials and processing technologies for using nanomaterials in industrial production. Other challenges include: improving the control and monitoring of the conditions required for the use of nanomaterials in industrial processes; increasing the levels of robustness and repeatability of these processes; and optimising and evaluating the performance and functionality of the production line and the resulting products.

A focus on the projects

In this CORDIS Results Pack, we focus on 14 projects that have made clear and distinguished progress towards overcoming these barriers and demonstrating how nano-enhanced advanced materials can be safely, sustainably and competitively launched into the industrial mainstream.

Hybrid 3D printing produces scaffolds for bone regeneration

A new 3D printing technology, capable of creating medical scaffolding for tissue reengineering, offers multiple benefits to both patients and the healthcare industry.

Over the last decade, the market for Additive Manufacturing (AM) has increased impressively year on year. Factors such as localised production, limitless shapes, full artefact customisation and no waste material are driving growth.

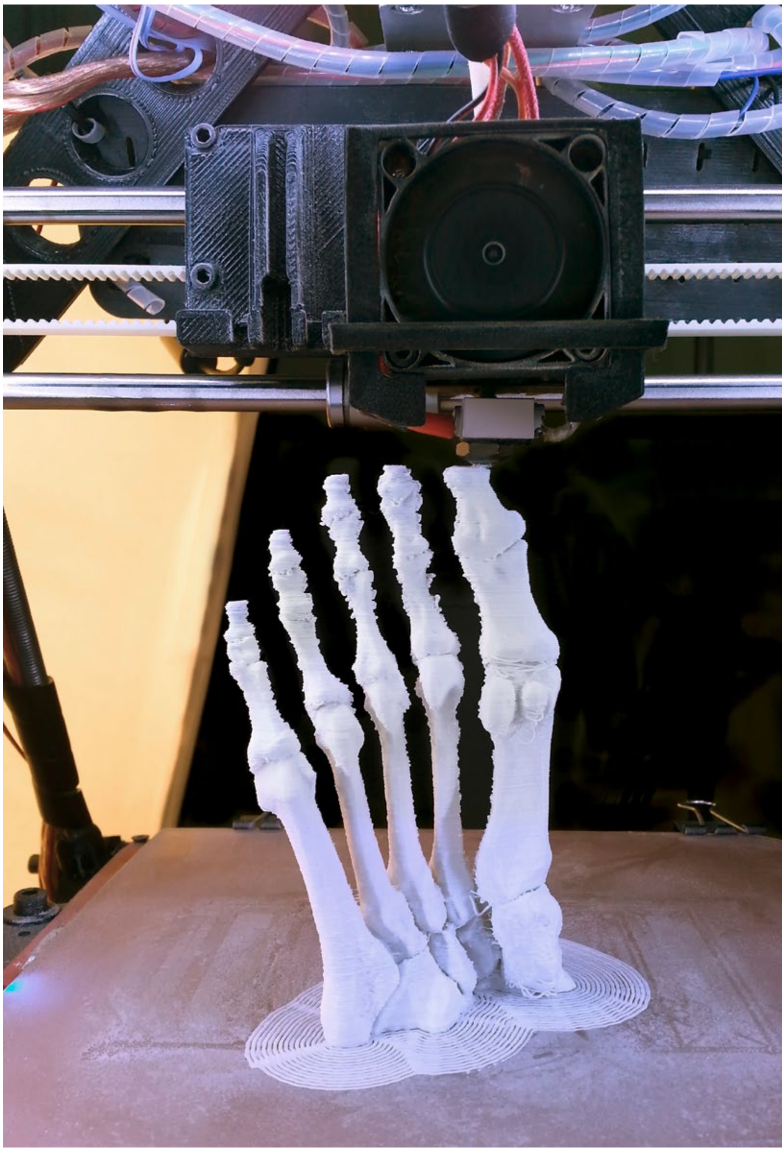
Perhaps chief amongst the advantages is AM's 'Design for Function' feature, whereby artefact production is now not constrained by limitations imposed by the manufacturing processes, but rather prioritises the end use for the piece.

The EU-funded FAST (Functionally graded Additive Manufacturing scaffolds by hybrid manufacturing) project adopted AM techniques to develop and demonstrate a 3D printing machine which combined a hybrid printing process with a physical-plasma based coating to produce scaffolds for bone regeneration. FAST also identified candidates for antibiotic substances suitable for incorporation into the scaffold material, as well as demonstrating cell growth on the surfaces of the printed and coated scaffolds.

Building scaffolds from polymer composites

A range of industries, such as automotive and aerospace, benefit from AM's ability to produce complex and highly customised parts with a number of integrated functions, and in a cost-efficient manner. But AM techniques are also increasingly used to produce medical devices.

Customised implants, for example, offer advantages such as improved preoperative planning, healthcare system cost savings due to shorter surgery times, lengthened implant lifetime, and increased patient comfort with fewer post-surgery complaints.



This is particularly true for the manufacture of scaffolds for tissue engineering (TE) and regenerative medicine, where the technology has now been in use for over a decade. As project co-coordinator Prof. Lorenzo Moroni explains, "These scaffolds are one of the fields where AM's 'Design for Function' characteristic gives it the edge over other production techniques. All the necessary considerations about mechanics, geometry (porosity and shape), biomaterial, bio-active molecules and surface chemical groups can be integrated into one design."

As the technology controls the fibre composition and density, as well as the location of the coating, the operators can design the scaffold's shape, porosity, mechanical stability and biochemical properties.

FAST's new 3D polymer printer can print and subsequently coat the scaffold almost as a single step, and within one machine. Adopting a layer-by-layer method, the technology applies a coat throughout the implant, designed to enhance cell adhesion and so promote bone regeneration.

The technology works by combining the melt compounding of nanocomposites with bio-functionalised fillers directly in the printing head, along with the use of atmospheric plasma technologies during the printing process itself. "As the technology controls the fibre composition and density, as well as the location of the coating, the operators can design the scaffold's shape, porosity, mechanical stability and biochemical properties," says Prof. Alessandro Patelli, consortium co-coordinator.

As well as being biodegradable, these scaffolds contain graded mechanical and biochemical properties customised for individual patients. This proved to be the most challenging aspect of the project as Moroni recalls, "Developing a printer head that is able to create continuous gradients resulted in trials with a few functional prototypes."

Helping build a revitalised healthcare system

FAST's technology promises to contribute to the improved efficiency of Europe's healthcare system, with good prospects especially for applications in bone repairs for orthopaedic, cranial, craniofacial and maxillofacial surgeries.

But first the technology will have to undergo phase I clinical trials, if the animal tests show promising results compared to current treatments. After that, the technology will have to meet the requirements for regulatory approval, anticipated to be within three to six years from the end of the project.

"FAST is expected to strengthen the market competitiveness globally of our small and medium-sized partner companies securing existing jobs, with an expanded product line creating new ones," Patelli says.

Currently, the team are testing FAST scaffolds further, through *in vitro* and *in vivo* studies, while looking for suitable industrial partners for clinical studies.

PROJECT
FAST – Functionally graded Additive Manufacturing scaffolds by hybrid manufacturing

COORDINATED BY
Maastricht University in the Netherlands

FUNDED UNDER
H2020-LEIT-NANO

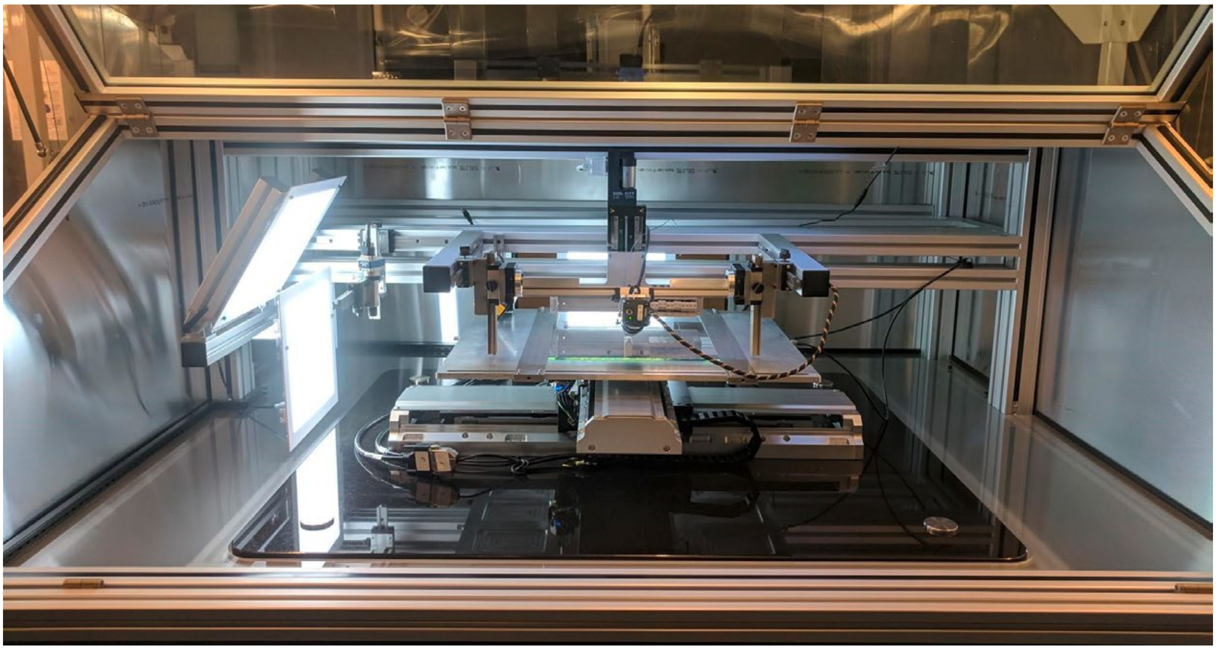
CORDIS FACTSHEET
cordis.europa.eu/project/id/685825

PROJECT WEBSITE
project-fast.eu

VIDEO
bit.ly/2He4iCT

Novel ink-jet system could take Printed Electronics to the next level

Innovative Electro-Static Printing Technology (ESJET) overcomes one of the barriers to industry fully embracing printed additive manufacturing. Namely, the lack of suitable functional inks.



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Printed Electronics (PE) has great potential to bring about a step-change in the electronics industry. But one of the barriers to this comes from the ink technology, which has not achieved the resolution or viscosity necessary. Consequently, the range of functional inks that can be printed, as well as the resolution and final properties of the printed/sintered structures and components, remain limited.

The EU-funded Hi-Response (Innovative High Resolution Electro-Static printing of Multifunctional Materials) project is based on patented ESJET which incorporates a single and multi-head adaptation system that can achieve resolution, speeds and low-costs far surpassing current ink-jet systems.

The ESJET system

Explaining ESJET's functioning, the team describes a reservoir feed system which holds the ink to be deposited, a capillary outlet tube and a charge rod connected to a high voltage supply, with its tip at the outlet tube's entrance. The charge rod maintains an electric field potential between the fluid in the reservoir and any droplets that exit the emitter, landing on the substrate. To release ink drops, the electric field potential is altered by a set amount of controlled voltage.

ESJET can print at a resolution of 1 micrometre, while achieving inks with a viscosity of up to 40 000 centipoise, meaning that it can print highly filled nano-inks and functional organic materials. The resultant printed/sintered structures can achieve high resolution with high-quality component properties.

The system has been demonstrated for a wide range of materials, including: nano-copper, nano-silver and other nano-ceramic filled inks and pastes. These can be used for electrode structures (as small as 0.5-10 micrometres wide), semi-conductors, dielectrics organic polymers and reactive organo-metallic inks.

It's funny but I can't describe the elation that comes from printing conductive lines that you can't see with the human eye. It is at this point that I realise, yes we really have something.

"It's funny but I can't describe the elation that comes from printing conductive lines that you can't see with the human eye. It is at this point that I realise, yes we really have something," project coordinator Dr Pufinji Maclean Obene says.

Meeting its goal, Hi-Response has printed these materials to create components such as: flexible automotive aerials and sensors, touch screens, flexible heating elements for radomes (the radar protecting domes) in electric vehicles and metal mesh for the organic light-emitting diodes (OLEDs) used in digital displays.

However, Obene adds, "We are excited to announce that we will also be using ESJET to deposit quantum dot displays (QLED) for mobile phones and to print very small transistors, and aim to manufacture fully printed microprocessors for microelectromechanical systems (MEMs) used especially in medical devices."

Tapping a gap in the market

Hi-Response supports the EU's overall industrial strategy by optimising manufacturing efficiency and costs, while also generating jobs. Additionally, it contributes to environmental stewardship by reducing energy usage and greenhouse gas emissions during the manufacturing process.

Based on the exploitation to date of Hi-Response's technology for various applications, the consortium estimates their market to be worth around EUR 566 million per year.

Taking commercialisation to the next level, the team are concentrating on a few specific components. These are principally the development of 3-micrometre QLED pixels, applications for Organic and Large Area Electronics (OLAE), as well as sensors and MEM devices – all key areas for the so-called 'fourth industrial revolution'.

"This field is currently limited by time, people and Research and Development funds," says Obene. "But the Intellectual Property opportunities are incredible, so it's full steam ahead for us!"

PROJECT
Hi-Response – Innovative High Resolution Electro-Static printing of Multifunctional Materials

COORDINATED BY
Precision Varionic International Limited in the United Kingdom

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/646296

PROJECT WEBSITE
hi-responseh2020.eu

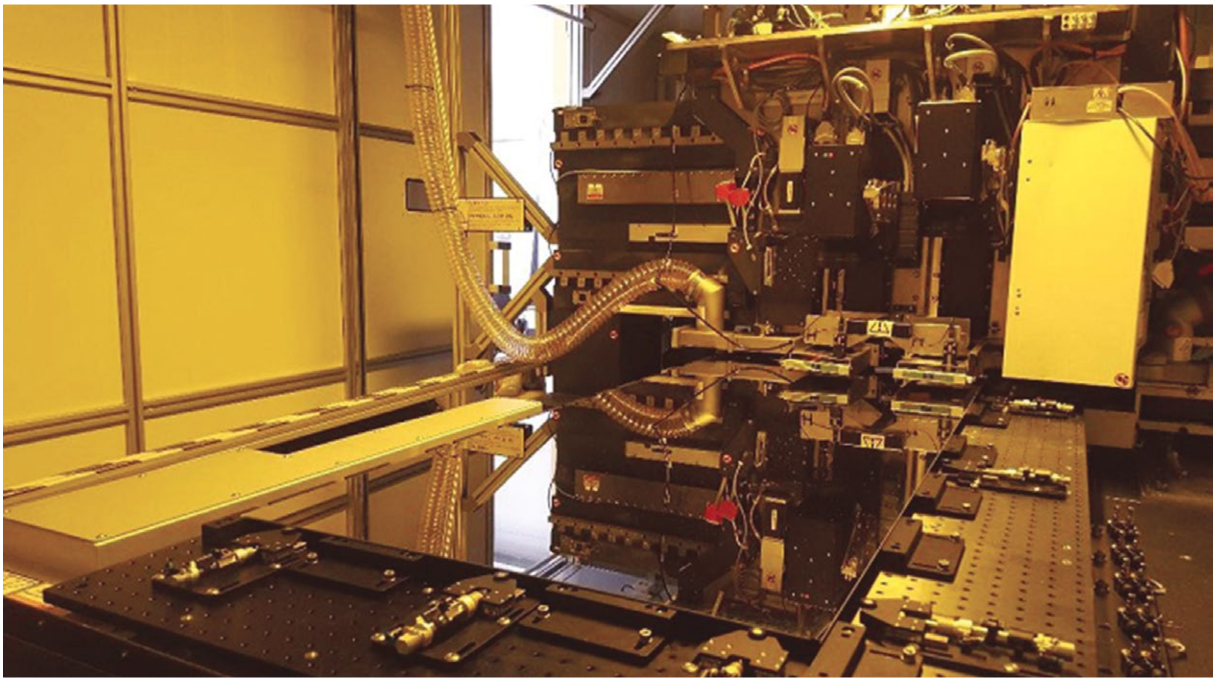
VIDEO
bit.ly/2CoBZx4

Enabling the rapid production of printed electronics with nanomaterial inks

When it comes to the electronics industry, for items such as LCD displays, touch panels or solar cells, printing with nanomaterials is the future, bringing a wealth of new opportunities.

Printed electronics (PE) holds out the promise of revolutionising the electronics industry, due to its ability to print nanomaterials directly onto surfaces. These nanomaterials can have conductive, resistive, capacitive and semi-conducting properties. Compared to traditional circuit board and semiconductor manufacturing techniques, PE offers cost, performance and environmental advantages.

The EU-funded INSPIRED (INdustrial Scale Production of Innovative nanomateRials for printEd Devices) project was set up to further develop the nanomaterial printing technology to meet growing demand. The EU-funded project conducted pilots for silver nanowires and graphene production, and has brought new products based on formulations of these materials to market.



The quest to develop suitable nanomaterials

Compared to current circuit board and semiconductor manufacturing techniques, PE is more cost-effective, is capable of operating at higher volume and is more environmentally friendly.

However, if there is going to be significant migration towards liquid-based, high-throughput PE systems, suitable ink-based nanomaterials will need to be developed and available in industrial quantities. These will also have to meet the relevant industrial standards and be compatible for end user applications.

Project coordinator Mr Andreas Rudorfer adds the caveat that, "PE is often considered as a full replacement of the semiconductor industry but that is not the case. It is a supplement for certain applications and markets where the benefits of PE show their full potential, such as the display market."

INSPIRED will have a positive impact across the entire value chain of the printed electronics sector, benefiting nanomaterial suppliers, ink manufacturers, printing companies, equipment suppliers and the high value manufacturing sectors in general.

INSPIRED set out to develop and demonstrate high-volume printing of nanomaterials for printed electronics such as: solar cells (copper indium gallium selenide photovoltaics (CIGS PV)), capacitive touch screens (CTS) and liquid crystal displays (LCD).

INSPIRED developed two pilot lines to determine nanomaterial characterisation, both of which progressed at a very fast pace. Silver nanowires were synthesised using wet chemical reduction processes, while graphene nanoplatelets were optimised using large-scale exfoliation production.

In terms of formulation, silver nanowires were created and were suitable for use in high-volume spray deposition processes. Graphene nanoplatelets were developed and were capable of providing enhanced properties when combined with the silver nanowires.

"Nanosafety aspects of materials and processes have been considered throughout, ensuring safe handling with substances of concern. To achieve a project-tailored approach, a nano-related safety strategy, in accordance with REACH, has been developed," says Rudorfer.

Towards achieving a volume processing, high-speed, ink-jet printing system, the consortium's equipment manufacturer built a 'Large Area Print and Laser Sinter Tool' capable of handling substrates up to 1.11 x 1.3 m for industrial applications.

Of strategic importance to the EU economy

The INSPIRED project is an industry-driven Research and Innovation Action that supports the objectives and vision of the Horizon 2020 Industrial Technologies Programme, by increasing the nanotechnology base of EU manufacturers.

As Rudorfer says, "INSPIRED will have a positive impact across the entire value chain of the PE sector, benefiting nanomaterial suppliers, ink manufacturers, printing companies, equipment suppliers and the high-value manufacturing sectors in general."

The materials and processes developed by the project are already leading to new and enhanced products. For example, project partner Thomas Swan has developed a pilot line for graphene nanoplatelets and products (under the brand name Elicarb®) which are already being sold to industry manufacturers and component users alike.

To take the work forward, the INSPIRED team is assessing the pilot lines for upscaling potential, and will upgrade or replace production processes as required to meet manufacturing requirements and market expectations.

PROJECT
INSPIRED – INdustrial Scale Production of Innovative nanomateRials for printEd Devices

COORDINATED BY
Joanneum Research in Austria

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/646155

PROJECT WEBSITE
nano-inspired.eu

Nano-improved materials and processes open up the market for enhanced components

As demonstrated by the IZADI-NANO2INDUSTRY project, nanotechnology can improve conventional materials as well as the manufacturing processes of injection moulding, casting and coating to produce components for the automotive, construction and agricultural machinery sectors.

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Nanotechnologies offer significant performance advantages for manufacturing materials and processes. To improve thermoplastics and metallic parts using nanomaterials, three base material provisions hold out much promise: injection moulding using master-batches of thermoplastics, master-pellets for metal casting and nano-structured powders for metallic coatings.

The IZADI-NANO2INDUSTRY (Injection moulding, casting and coating PILOTS for the production of improved components with nanomaterials for automotive, construction and agricultural machinery) project introduced three pilots, all manufacturing real components (thermoplastics B-pillar in cars, and hydraulic motor metallic swashplates and valve plates), to explore these strategies at existing production facilities. The project succeeded in upscaling the manufacture of the new materials as well as the processes, reducing the number of production phases (bringing down costs), as well as greening the process, whilst keeping it safe.

Nanomaterials trials for thermoplastics and metallic parts

Explaining the inception of the project, coordinator Dr Cristina Elizetxea Ezeiza says, "IZADI-NANO2INDUSTRY builds on the results of previous EU-funded projects, including Plast4Future, EFEVE, OFIENGINE and EXTREMAT. A number of us involved over the years became confident that some results could be transferred from the lab to the market and so we set up the pilots."

IZADI-NANO2INDUSTRY builds on the results of previous EU-funded projects, including Plast4Future, EFEVE, OFIENGINE and EXTREMAT. A number of us involved over the years became confident that some results could be transferred from the lab to the market and so we set up the pilots.

With the ESTCRATCH pilot (Basque Region, Spain), thermoplastics reinforced with nanomaterials (based on master-batches) and nano-textured surfaces were inserted into injection moulds for B-pillars (for cars) offering enhanced anti-scratch properties and aesthetics.

The HARDCAST pilot (Lombardia Region, Italy) added nano-reinforcements via master-pellets in a new, low cost, safe gravity casting process, increasing the hardness, wear and tensile properties of hydraulic motor swashplates.

Finally, the TRIBONANO pilot (Emilia-Romagna Region, Italy and Basque Region, Spain) used nano-structured powders for metallic cermet coatings and thermal spray technology for solid state deposition to increase the sealing function, efficiency and durability of hydraulic motor valve plates.

IZADI-NANO2INDUSTRY found that thermoplastic scratch resistance was 140 % higher than with currently available grades, with low variation of gloss and colour. Compared to current commercial materials the hardness and wear of the metallic parts were doubled, with tensile strength increased by up to 30 % and elongation coefficients maintained or even improved. Mechanical efficiency and durability of the final components for hydraulic motors were also increased, with both fuel consumption and maintenance costs reduced.

One of the project's main findings, relevant to commercialisation, was the importance of the 'safe-by-design' approach throughout the life cycle of materials and processes. As Elizetxea says, "Firstly, we need to identify less hazardous nanoforms. But we also need to give industries the tools for risk assessments along the production chain, as well as continually evaluate consumer and environmental exposure, to calibrate safe use."

From lab to market

IZADI-NANO2INDUSTRY opens up opportunities for the automotive industry to respond to market demands for enhanced performance and aesthetics. For construction and agricultural machinery, it offers thinner components, increased mechanical efficiency of machine transmission, less maintenance costs and reduced reliance on diesel consumption, lowering CO_2 emissions.

Ultimately, the range of possible applications is endless – from light lenses for vehicles, to turbines for the hydroelectric industry and even extending to household assets (such as bathtubs) and medical devices (such as bulbs for blood tests).

The team, alongside their early adopters, is now working to produce industrial quantities of nanomaterials and to achieve the full production of the nano-enhanced components studied in the project. They are also continuing to develop safe use tools and guidelines.

PROJECT
IZADI-NANO2INDUSTRY – Injection moulding, casting and coating PILOTS for the production of improved components with nanomaterials for automotive, construction and agricultural machinery

COORDINATED BY
Tecnalia Research & Innovation in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/686165

PROJECT WEBSITE
izadinano2industry.eu

VIDEO
bit.ly/2svqRbR

Connecting Europe’s nanomedicine supply chain

An EU-funded project is pioneering new manufacturing processes and better supply chain coordination in the field of nanomedicine. The goal is to bring more targeted and effective treatments to market and to strengthen European expertise in this sector.

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The NANOFACTURING (The Development of Medium- and Large-Scale Sustainable Manufacturing Process Platforms for Clinically Compliant Solid Core Nanopharmaceuticals) project has made significant progress in the processing of glycan-coated gold nanoparticles, to which therapeutic drugs can be attached. The small size of the particles means that they can pass through blood vessels to deliver medicine directly to diseased sites, and are then quickly excreted by the body.

“This technology enables you to treat cancer by focusing directly on the cells affected rather than the whole body,” explains project coordinator Areitio Junquera from Midatech Pharma in Spain. “It allows highly toxic drugs to be specifically targeted to and delivered at the tumour cells while sparing normal tissue, therefore reducing side effects and enhancing efficacy. This is more effective and much kinder to patients.”

Strengthening the supply chain

There is huge potential here. The global nanomedicines market, which includes cardiovascular, anti-inflammatory and oncology applications, is predicted to grow 12.3 % from 2013 to 2019. Nanocarriers like glycan-coated gold nanoparticles are forecast to account for 40 % of the USD 136 billion nanotechnology-enabled drug delivery market by 2021.

Nonetheless, scaling up production of nanomedicines has sometimes proved to be a challenge, due in part to a lack of manufacturing capacity and supply chain coordination. Development costs can also inhibit innovative SMEs, which often do not have the necessary in-house resources to take their bright ideas all the way to market.

The NANOFACTURING project has addressed these constraints through developing clinically compliant, sustainable manufacturing processes capable of taking products – like glycan-coated gold nanoparticles – from the lab right through to commercial manufacture. "This is a new field, so the first thing we need is agreement with regulators on how nanomedicines should be taken forward," explains project partner Jerry Cooper from CPI in the UK. "A lot of our work in this project has involved better understanding of how the gold nanoparticles function, in order to help address the safety and regulatory challenges."

A key element of the project involved bringing different elements of the nanomedicines supply chain together, from analytical research and companies expert in chemical synthesis through to innovators in process development and pharmaceutical firms. "These are partners who might not have worked together before," says Sarah Scarr, another project partner from CPI. "What we found though is that all partners play a vital role in getting nanomedicines to market. It is very difficult for one company, especially an SME, to have all the expertise they need."

Indeed, the NANOFACTURING project, says Scarr, has been critical in demonstrating how SME cooperation can result in commercial progress. "This sort of support is vital," she says. "Without it, there is a risk that only the major pharma companies will be able to develop these kinds of drugs."

New therapeutic opportunities

The NANOFACTURING project has not only strengthened the European nanomedicines supply chain and boosted SMEs; speeding up the delivery of new therapies will also ultimately benefit those most in need. In addition to gold nanoparticles to treat cancer, the project team has been looking into coating nanoparticles with small molecules that act as antiviral drugs to treat viral infections.

This technology enables you to treat cancer by focusing directly on the cells affected.

Overcoming the difficulty of delivering therapeutic agents to specific regions of the brain has also been examined. Most small-molecule drugs fail to cross the Blood Brain Barrier (BBB), which makes it difficult to develop effective drugs for central nervous system disorders such as Alzheimer's, Parkinson's and strokes. Nanoparticles capable of delivering drugs across the BBB could bring significant therapeutic benefits, a consideration that is all the more pressing given Europe's ageing population.

PROJECT
NANOFACTURING – The Development of Medium- and Large-Scale Sustainable Manufacturing Process Platforms for Clinically Compliant Solid Core Nanopharmaceuticals

COORDINATED BY
Midatech Pharma in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/646364

PROJECT WEBSITE
nanofacturing.eu

Next generation aerogels offer industrial solutions

An EU-funded project has developed organic and hybrid aerogel particles with different physical properties and pore sizes for a range of industrial applications. The aim is to help European businesses take full advantage of increasing demand for this functional and adaptable nanomaterial.

A key result has been the development of new scalable production processes for aerogel particles. The construction of a pilot plant at Hamburg University of Technology has enabled the NanoHybrids (New generation of nanoporous organic and hybrid aerogels for industrial applications: from the lab to pilot scale production) project team to produce prototype aerogel particles in new sizes and in sufficient quantities for industrial partners to trial new applications. New insights into their characteristics have been gained and production processes will continue to be optimised until project completion in April 2019.

"Aerogels are made from polymers with tiny nanosized pores and are among the world's lightest solids," explains NanoHybrids project coordinator Prof. Irina Smirnova from Hamburg University of Technology in Germany. "This makes them ideal, for example, for thermal insulation. Thin aerogel panels are well suited for insulating buildings, and can be used with superlight concrete."

Porous, lightweight aerogels also have potential applications in areas such as gas adsorption, humidity control and the protection of consumer goods, including food. The global aerogel market is expected to grow by around 33 % between 2014 and 2020, which means there will be new opportunities for European businesses.

Production challenges

Aerogel production on an industrial scale however remains limited, and most commercially available aerogels are based on silica. The main disadvantage of silica aerogels is their fragility, which limits their applications. Furthermore, organic aerogels – based on biopolymers such as cellulose – and hybrid aerogels that combine two or more different components, such as alginate and pectin, have not achieved significant market penetration.

"The goal of the NanoHybrids project has been to close this gap," says Smirnova. "To tap into the range of potential industrial applications, we really needed to bring the manufacturing of organic aerogels to the next level, from the lab to large-scale production. Without this, the development of organic aerogels and their transfer to market will remain limited."

Pioneering pilot projects

The project's key breakthrough has been the development of the first pilot-scale production system for next-generation aerogels. Multifunctional nanoporous organic and hybrid aerogels have been produced with industrial partners BASF, Dräger, Arcelik, RISE Bioeconomy and Nestlé, all of whom have recognised the huge application potential as well as the need for upscaling production. The pilot production plant at Hamburg University of Technology has made it possible – for the first time – to produce prototype aerogels of the desired size for large-scale industrial tests, and in food-grade quality.

"We knew that we needed to increase production capacity in order to provide industrial partners with amounts of aerogels large enough to test future applications," says Smirnova. New methods for producing organic and hybrid aerogel particles have also been developed, and new insights into the drying of aerogels – a crucial process step – have been gained through collaboration.

We really needed to bring the manufacturing of organic aerogels to the next level and achieve industrial relevance.

Following project completion, industrial partners plan to build on these successes and continue development towards marketable products. A start-up has been set up based on NanoHybrids' results, and plans to increase aerogel production for industrial prototype purposes. Academic project partners have also been able to share their knowledge via open access reviews and research papers, which will hopefully inspire new research into the potential of aerogels.

"NanoHybrids has shown that production methods for organic and hybrid aerogels can be scaled up to the industrial scale," says Smirnova. "This will ultimately enable the large-scale commercialisation of organic aerogels, especially of bio-based ones."

PROJECT
NanoHybrids – New generation of nanoporous organic and hybrid aerogels for industrial applications: from the lab to pilot scale production

COORDINATED BY
Hamburg University of Technology in Germany

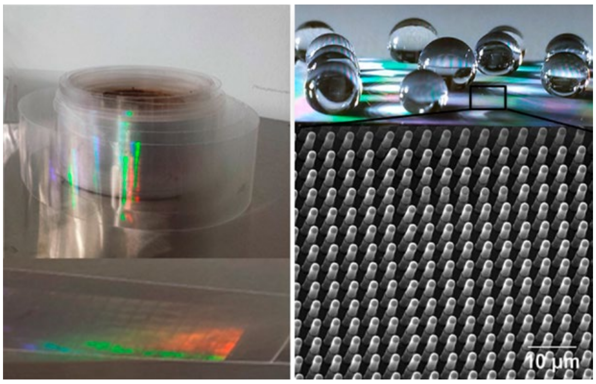
FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/685648

PROJECT WEBSITE
nanohybrids.eu

Scaling up Europe's nanocomposite manufacturing potential

An EU-funded project has enabled manufacturing SMEs to scale up their nanocomposite production processes, address processing bottlenecks and seek expert advice. This experience has helped to bring nano-based construction products closer to market.



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Nanocomposite materials are used in the construction sector to make weather-resistant surfaces, anti-corrosive coatings and easy-to-clean façade panels. Their porous nature also makes them ideal for lightweight insulation. But despite growing industry and consumer demand for such flexible green solutions, commercialising nanocomposite building materials has proven to be a challenge.

"Most of the manufacturing companies we are talking about here are SMEs, which means that producing nanocomposites in volumes that would be useful to the construction industry is a real issue," explains project coordinator Prof. Jose-Luis Valverde from the University of Castilla-La Mancha in Spain. "The challenge isn't getting the science right or even finding the market; it is scaling up from the lab to the pre-commercial production line, or pilot line. This is where the real bottleneck lies, and there are few scale-up specialists out there who can help."

Unblocking bottlenecks

Addressing this bottleneck was the catalyst for the NANOLEAP (Nanocomposite for building constructions and civil infrastructures: European network pilot production line to promote industrial application cases) project. A coordinated network of nanocomposite-based product pilot lines was first established among project partners with experience in scaling up to help SMEs bring their products closer to commercialisation. Next, an open call for tenders was launched to attract SMEs interested in developing or testing their technologies through the network.

"The idea behind the project was simple," says Valverde. "SMEs would normally need a great deal of financial support to bring their ideas to market, so instead we've offered scaling-up services for free. These services also included the development of business plans and market analyses." Focusing on near-industrial scale innovations enabled the project team to help SMEs implement their research results and further develop their products and processes.

Innovations being pioneered by European SMEs include anti-weathering nanocomposite coatings to protect structures exposed to aggressive environments, such as wind turbines and offshore and marine infrastructure. Composite façade systems based on polymeric nanocomposites are another area of potential. These materials are significantly lighter than concrete or glass and can incorporate functionalities such as self-cleaning, UV protection and high thermal insulation.

Simple solutions, major results

Valverde believes that the project has been a highly positive experience for everyone involved. "For example, one of the nanocomposite manufacturing SMEs we helped was an Irish firm that aimed at developing nanocomposite solar thermal panels that could be mass manufactured and installed at a 50% lower cost than existing metallic solar thermal collectors with lightweight and aesthetic benefits that will allow significantly enhanced solar collection capability. Other SMEs were supported for developing both biosensors for the detection of biomarkers in biological fluids, and coatings to be applied on magnetic steel laminations and on other metallic parts of machineries," he says. "They had issues before bringing these to market. We were able to tap into our experience and help them improve and optimise their production processes."

Reducing maintenance costs for civil infrastructure could lead to significant savings.

For Valverde, this encapsulates the value of the NANOLEAP project: delivering simple solutions to SMEs that help them address major processing hurdles. A slight tweak to the firm's production process means that they will now be able to bring more product to market, quicker.

Other processing bottlenecks – for specific kinds of high-performance nanocomposite coatings that help protect against corrosion for example – were also addressed. "Metallic corrosion costs Europe EUR 200 billion every year," says Valverde. "Reducing maintenance costs for civil infrastructure could lead to significant savings."

The success of the NANOLEAP project, which was officially completed in mid-2018, has led to the organisation of a new open call for nanocomposite manufacturers interested in benefiting from scaling-up expertise. "We are calling this the Flat Rate Open Call, with special low rates to attract SMEs," says Valverde. "Our idea is to launch this call before the end of the year. Most project partners are involved, and from our side it's about ensuring sustainable results."

PROJECT
NANOLEAP – Nanocomposite for building constructions and civil infrastructures: European network pilot production line to promote industrial application cases

COORDINATED BY
University of Castilla-La Mancha in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/646397

PROJECT WEBSITE
nanoleap.eu

Production scale-up drives nanomedicines to market

An EU-funded project has set up a pilot plant to produce small batches of polymer-based nanopharmaceuticals. There are expectations that this new technology will improve drug delivery, create new commercial opportunities and lead to more effective treatments.

© NanoPilot

After nearly four years of work, the NanoPilot (A Pilot Plant for the Production of Polymer based Nanopharmaceuticals in Compliance with GMP) project pilot plant in Spain is up and running, and the team is now working on the process to certify the plant. Three nanopharmaceuticals were developed and are now closer to the point where they can be tested on patients.

"One of the barriers to innovative European nanomedicines reaching the market has been the lack of specialised plants such as this," explains NanoPilot project coordinator Iraida Loinaz from CIDETEC in San Sebastián, Spain. "Our aim in this project has been to address this need and establish good practice. We have also advanced in the development of quality control protocols that have been validated for the characterisation of nanopharmaceuticals."

Maximising opportunities

The four-year project was launched in January 2015 to establish a nanopharmaceuticals plant operating under good manufacturing practices (GMP), the quality system required in the manufacturing of drugs. GMP is compulsory in the manufacturing of pharmaceuticals for use in patients, even if the drugs are under development and intended to undergo clinical testing.

Nanopharmaceuticals provide drug developers with a range of potential advantages. Due to their incredibly small size, nanoparticles can be absorbed more easily and targeted at specific organs or tissue areas. Active agents such as proteins and nucleic acids can be reformulated – or 'nanoformulated' – for accurate delivery to these specific targets. The toxicity of some existing therapies can therefore be reduced, their efficacy improved, and the overall patient experience transformed.

While there is little doubt that nanopharmaceuticals present the pharma and medical sectors with huge potential, getting the technology to market is a key challenge. Producing innovative nanopharmaceuticals in the quantity and quality required for clinical trials is incredibly expensive and often beyond the means of Europe's innovative SMEs.

One of the barriers to innovative European nanomedicines reaching the market has been the lack of specialised plants such as this.

"The inability to upscale the nanopharmaceutical manufacturing limits the capacity of SMEs to advance their research and slows the development of innovative drugs," says Loinaz. "This is why we urgently need to provide these organisations with the tools to help them validate their technologies."

Open innovation

The three nanopharmaceuticals trialled at the plant were a short interfering RNA for the treatment of dry eye syndrome, a possible HIV vaccine, and nanoparticles for the treatment of interstitial cystitis / painful bladder syndrome. The aim now is to open the plant up to other types of projects, not only to nanomedicines ready to enter initial clinical trial phases, but also to drugs ready for late clinical phases and even commercialisation. The plant facilities can also be used to produce other innovative therapies and products that require intravenous administration, as well as smaller batch sizes.

"We are working hard to ensure that this plant is fully sustainable and are currently working on a business plan that exploits the potential of the plant as much as possible," says Loinaz. "We really think that we have the capabilities here to go much further. We have already been in contact with several technology developers, and we are excited that new projects will begin here in the near future."

Loinaz adds that successful collaboration between the consortium partners was essential, and made possible thanks to the NanoPilot project. "This allowed us to explore highly innovative nanoformulations and innovative production processes, something that would have been very difficult to do otherwise."

PROJECT
NanoPilot – A Pilot Plant for the Production of Polymer based Nanopharmaceuticals in Compliance with GMP

COORDINATED BY
CIDETEC in Spain

FUNDED UNDER
H2020-LEIT-NANO

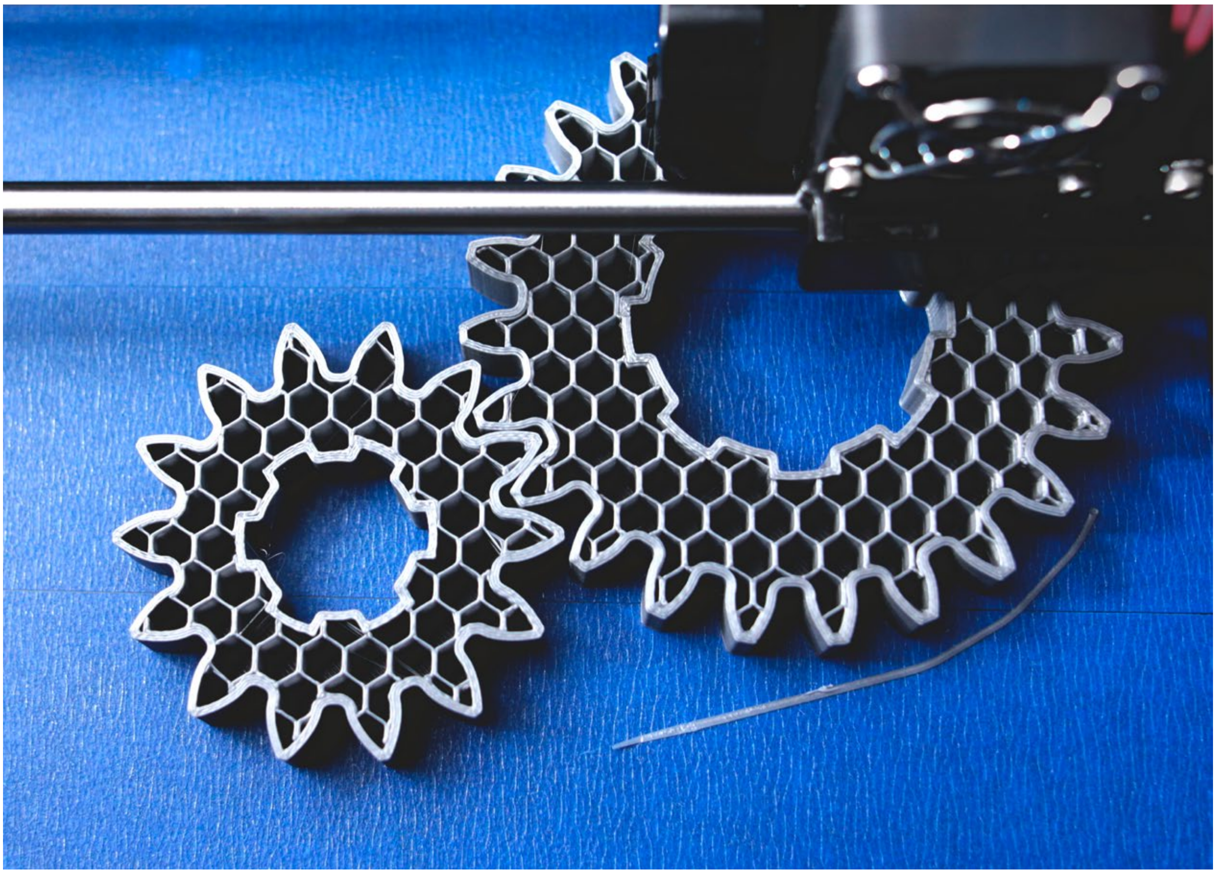
CORDIS FACTSHEET
cordis.europa.eu/project/id/646142

PROJECT WEBSITE
nanopilot.eu

Nanotech 3D printing drives lightweight manufacturing

EU-funded researchers are developing a new nanoparticle metal powder for 3D printing that will enable sectors such as automotive, space and tooling to manufacture strong, lightweight parts with improved performance.

The NANOTUN3D (Development of the complete workflow for producing and using a novel nanomodified Ti-based alloy for additive manufacturing in special applications) project addresses the entire processing chain, from nanoparticle production though to mixing and inclusion of the particles in a base titanium (Ti) alloy. This Ti alloy powder is then used in 3D printing – or Additive Manufacturing (AM) – to create products and parts across a range of industries.



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"3D Printing, or AM, is a technology that enables free-form production," explains project coordinator Luis Portolés Griñán from AIDIMME in Spain. "This allows manufacturers to customise shapes and parts, opening up new opportunities in sectors that require precision such as medical devices, personal safety equipment and aeronautics."

Portolés expects that by project completion in Spring 2019, the NANOTUN3D consortium will have demonstrated the feasibility of manufacturing advanced metal parts with the new material and established best practices in industrial processing. Following the project, nine pilot plants will be available in Europe to provide material and support for AM processing at the industrial scale.

The project delivers lightweight, 3D printed parts by combining advanced manufacturing methods with advanced materials.

Lightweight manufacturing

A key advantage of the AM technology being pioneered by NANOTUN3D is that parts can be made with less material – sometimes much less material – which makes them cost-effective and lighter. This offers important fuel-cost benefits for the automotive and space sectors.

"The project is ultimately focused on providing solutions to the 'lightweighting' needs of industry, which means lowering mass and energy consumption," says Portolés. "Using our process, material savings are expected to reach between 40 and 50 % for some critical applications."

This could have a major impact on manufacturing costs. "Each kilogramme of weight reduced in an aircraft for example saves between 0.02 and 0.04 kg of fuel per hour," says Portolés. "This adds up to savings of around four tonnes of fuel throughout an aircraft's service life."

Collaborative opportunities

The focus of the NANOTUN3D project has been on developing a nano-based material specifically suited to metal AM. "While the inclusion of nanoparticles into some materials can improve their mechanical properties, the range of materials that can be processed by AM is still limited," explains Portolés. "Metal AM is based on metal powders, and producing them involves a complex process that gets even more complicated when you need to keep an even nanoparticle distribution throughout the powder batch."

The project team began by devising a Health and Safety Management System to ensure that all production processes are far from hazard thresholds. Nanoparticles were then developed and integrated within the Ti alloy base, and the final nanoparticle metal powder prepared for AM processing.

In addition to opening up new opportunities for manufacturing lightweight metal parts across a range of industries, the project will also help to strengthen Europe's position in AM. "Europe has been a traditional leader in this field, with SMEs the main actors," says Portolés. "This project helps to foster innovation among powder manufacturers, AM technology manufacturers and finishing workshops. The project has achieved its objectives through cooperation and combining advanced manufacturing methods with advanced materials."

Portolés also believes that the legacy of EU-funded projects such as this has been to create a 'common language' among European industry partners. This not only makes getting in touch with technological partners much easier; it also allows for the fluid development of workplans and roadmaps. "In the case of NANOTUN3D for example, developing the new material required the development of a supply chain, with every consortium partner acting as provider-customer in relation to the other partners," he says. "This experience will help us to turn the project results into marketable opportunities within a short timeframe and we invite powder manufacturers, AM technology manufacturers and finishing workshops to get in contact."

PROJECT
NANOTUN3D – Development of the complete workflow for producing and using a novel nanomodified Ti-based alloy for additive manufacturing in special applications

COORDINATED BY
AIDIMME in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/685952

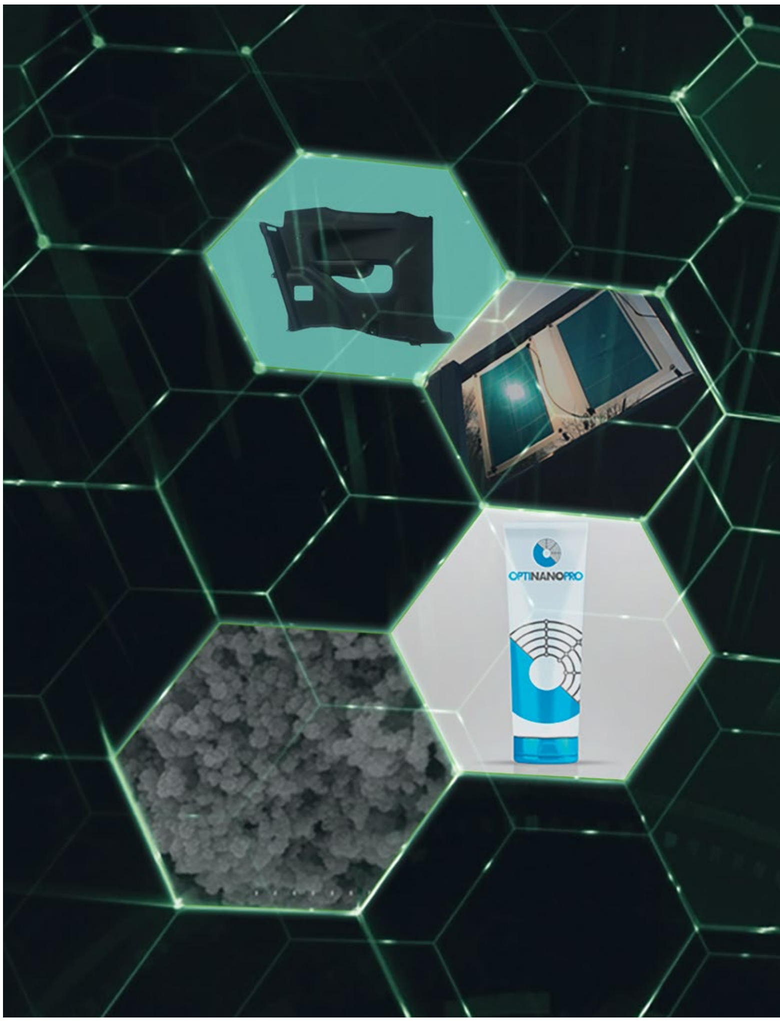
PROJECT WEBSITE
nanotun3d.eu

Integrating nanomaterials into existing production lines

It is well known that nanotechnology and related industries have the potential to become a powerful engine for economic growth – that is if they can be successfully scaled for industrial use. To help make this transfer from lab to industrial production lines, the EU-funded OptiNanoPro project developed optimised materials and processes for a range of applications.

With a focus on the packaging, automotive and solar sectors, the OptiNanoPro (Processing and control of novel nanomaterials in packaging, automotive and solar panel processing lines) project brought together 15 partners from across the supply and value chains. Together, they successfully demonstrated the integration of nanomaterials into existing production lines, considering performance improvements, along with such issues as nano-safety, sustainability, productivity and cost-effectiveness.

Researchers started by developing innovative polymer nanocomposite formulations combining the appropriate polymer and nanoparticle types and contents for each applicative requirement. In nanotechnology, polymer nanocomposites are defined as solids consisting of a mixture of two or more phase-separated materials. Next, they adjusted different polymer converting processes for the nanocomposites' bulk and/or surface applications in semi-industrial production lines. These processes, typically used within the targeted packaging, automotive and OPV industries, included: high-energy ball milling (HEBM), compounding, injection moulding, electrospray deposition, coating and lamination.



25 exploitable processes and products

The result of this work was the creation of 25 key exploitable processes and products, including barrier-laminated and injected packages (tubes, pouches and jars). These packages use both bio and standard plastics to cut oxygen permeation in half, thus offering significantly improved protection to food products and cosmetics.

The project also produced a self-cleaning OPV laminate with the potential for increasing a solar panel's ability to harvest energy. In the automotive field, OptiNanoPro researchers developed parts that weigh up to 20 % less than current parts – a weight reduction that will substantially reduce fuel consumption and CO_2 emissions.

Designing new products with versatile and valuable life cycles can help keep them from ending up in landfills or littering our oceans.

A life cycle assessment (LCA) was conducted to measure each product's environmental impact, starting from resource extraction and on through to production, use and end-of-life. "Designing new products with versatile and valuable life cycles can help keep them from ending up in landfills or littering our oceans," explains OptiNanoPro project coordinator Elodie Bugnicourt. "We also created a number of easy-emptying tubes and pouches that help achieve a 50 % decrease in residual product when discarding the package after use."

An eye towards marketisation

According to Bugnicourt, marketisation and business plans are now available for the most advanced results. "These products will be further explored, leading to the selected innovations being marketed either via a sub-group of partners acting together along a supply or value chain, or via partners acting on their own in terms of single results used in new applications outside of the consortium," she explains. "It is also very likely that we will spin off further research ideas along the lines opened in the project, for example in the transfer of the project processes and material innovations towards new sectors."

PROJECT
OptiNanoPro – Processing and control of novel nanomaterials in packaging, automotive and solar panel processing lines

COORDINATED BY
IRIS Technology Solutions in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/686116

PROJECT WEBSITE
optinanopro.eu

VIDEO
bit.ly/2CgCoBu

Nano-capsules: a smarter solution to skin care

Researchers with the EU-funded PEPTICAPS project are using nano-capsules to treat such common conditions as allergic and irritant dermatitis, sun-damaged skin and skin pigmentation.

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Nanotechnologies have the potential to revolutionise healthcare. Take nano-capsules for example. These nanoscale shells exist in miniscule sizes, from 10 nm to 1 000 nm, and represent a new frontier for delivering drugs. The drug is placed into the nano-capsule's cavity, which is surrounded by a biocompatible polymer membrane that releases the active ingredients on demand.

In skin care, nano-capsules could be used to treat such common conditions as allergic and irritant dermatitis, sun-damaged skin and skin pigmentation. But before using products containing nano-encapsulated actives can become a reality, they first need to be developed, tested and validated – which is where the EU-funded PEPTICAPS (Design of polyPEPTIdes diblock copolymers as emulsifiers to produce safe, controlled and reliable novel stimuli-responsive nanoCAPSules for skin care applications) project comes in.

Our objective was to facilitate the use of nano-capsules in cosmetic products by demonstrating that well-designed nanomaterials are safe and showing the added value that nanotechnology can bring to current products.

"Our objective was to facilitate the use of nano-capsules in cosmetic products by demonstrating that well-designed nanomaterials are safe and showing the added value that nanotechnology can bring to current products," says PEPTICAPS project coordinator Dr Damien Dupin. "As a result of our work, PEPTICAPS are now positioned as a new, safe and smart cosmetic ingredient."

Nano-capsules that feel your skin

During the project, researchers developed and validated a new family of safe, stimuli-responsive nano-capsules designed to carry such fragile and natural active ingredients as vitamins and extracts. These nano-capsules are incorporated into, for example, cosmetic creams. When the user applies the cream to their skin, the PEPTICAPS technology takes advantage of the changes induced by damaged skin (such as a change in pH and the presence of enzymes) to release the nano-capsule's active ingredients where the skin needs it most.

"Unlike traditional liposome technology that lacks any release control, thanks to its smart polymer membrane, PEPTICAPS adapts the active delivery of the drug in a personalised way," says Dupin.

In addition to the nano-capsules themselves, project researchers also developed a new software tool for predicting the toxicity of polymer-based nanomaterials. "Although similar tools are already available, they tend to be more appropriate for inorganic particles," explains Dupin. "For the first time, the tool has been adapted to polymer-based nanomaterials – an adaptation that will surely have a great impact in further developing nanomaterials."

From PEPTICAPS to EMISSARY

Not only has the project produced a solution capable of better treating common skin conditions, it also demonstrated how this solution can be produced at an industrially-relevant scale and in accordance with cosmetic and safety regulations. "In just three years, we have successfully gone from a proof-of-concept to a fully-patented product that is market-ready," says Dupin.

The consortium partners have established EMISSARY Cosmetics, a new company that will commercialise the products developed during the PEPTICAPS project. The company has the exclusive rights to commercialise the nano-capsules with actives developed during the project and a full encapsulation service. "Through EMISSARY, PEPTICAPS are expected to replace liposome technology, thus becoming the gold standard for encapsulation in the cosmetic world and offering a better product to customers," adds Dupin.

PROJECT
PEPTICAPS – Design of polyPEPTIdes diblock copolymers as emulsifiers to produce safe, controlled and reliable novel stimuli-responsive nanoCAPSules for skin care applications

COORDINATED BY
CIDETEC Foundation in Spain

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/686141

PROJECT WEBSITE
pepticaps.eu

A sustainable way of protecting materials against corrosion

The EU-funded PROCETS project is using nano-particles to produce environmentally-friendly composite coatings that will better protect our infrastructure from the costly effects of wear, tear and corrosion.

Wear, tear and corrosion of building materials currently cost developed countries a 3-4 % loss in GDP every year. Billions of euros are spent annually on replacing corroded infrastructure. Thus, it should come as no surprise that the surface engineering of protective coatings is big business – and one that is critical to the competitiveness of EU industry.

Currently, the two main techniques for protecting surfaces are hard chromium (HC) electro-plating and the application of tungsten monocarbide (WC) by thermal spray (TS). HC is a common, simple and cheap method of coating surfaces, providing high hardness levels, good wear and corrosion resistance. TS, on the other hand, sprays the melted coating materials directly onto the surface.

Although both succeed at lengthening the lifespan of the material being protected, these approaches create environmental and health risks. As a result, there is high demand for less-hazardous methods and materials that offer the same – or a greater – amount of protection.

The EU-funded PROCETS (PROtective composite Coatings via Electrodeposition and Thermal Spraying) project believes they have the answer: the use of nano-particles for producing superior composite coatings. "We intend to deliver protective coatings covering a wide range of applications and industries – including automotive, aerospace, metal-working, oil and gas and cutting tools – by utilising more environmentally-friendly materials than those currently being used," explains project coordinator Dr Dionysis Bochtis. "This will allow industry to permanently replace the hazardous use of hard chromium and WC thermal spray."

Goodbye HC plating, hello nano-particles

Although the project will only conclude in June 2019, several important results have already been achieved. For example, researchers produced nano-composite coatings with enhanced mechanical properties compared to HC and WC. Researchers also made significant progress in improving the structure and morphology of composite coatings – a major step towards increasing their resistance to wear, corrosion, impact damage and fretting.

We intend to deliver protective coatings covering a wide range of applications and industries… by utilising more environmentally-friendly materials than those currently being used.

"These improvements open the door to the successful integration of nano-particles," says Dr Bochtis. "This in turn will free a number of industries from their dependence on hard chromium plating, which will soon be greatly restricted by EU regulations."

Progress is also being made on the TS side of the equation. Here, researchers have developed a 'green cermet' that offers similar mechanical properties to WC, but with a drastic decrease in weight.

A new generation of coatings

This work isn't just theory, as Dr Bochtis says researchers have already performed an initial pre-screening of the tribological behaviour of several electro-deposited and sprayed coatings under conditions that can be extended to real industrial scenarios. "Based on this pre-screening, the most promising candidate systems will be selected," he says. "Moreover, different methodologies for materials testing and evaluation were developed and/or updated to better simulate the needs of the end-users and perform testing under realistic conditions."

PROCETS is well on its way to delivering a new generation of environmentally-friendly and health-conscious coatings based on reinforced nano-particles. "Upon completion of the project, I fully expect to see an accelerated market uptake of nanomaterials and products by the surface finishing sector," adds Dr Bochtis.

PROJECT
PROCETS – PROtective composite Coatings via Electrodeposition and Thermal Spraying

COORDINATED BY
The Centre for Research and Technology Hellas (CERTH) in Greece

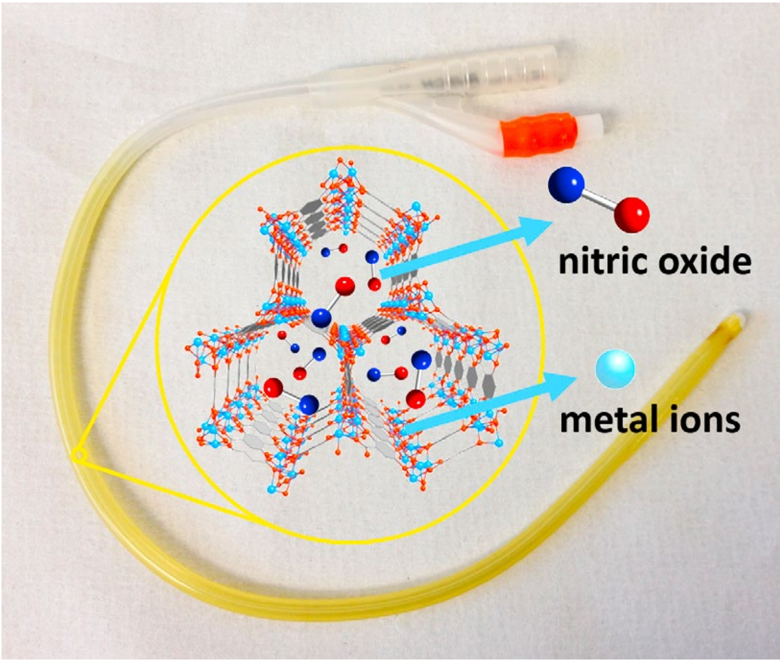
FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/686135

PROJECT WEBSITE
procets.eu

Demonstrating the industrial relevance of hybrid nanoporous materials

Researchers with the EU-funded ProDIA project have successfully demonstrated the feasibility of large-volume industrial production processes for hybrid nanoporous materials as finished products.



Over the past two decades, researchers have discovered several new classes of nanoporous materials (NPM), including aluminosilicates and metal-organic frameworks (MOF). Nanoporous materials can generally be defined as high surface area powders having pores in the nano-range. MOFs are a family of porous compounds consisting of metal ions or clusters coordinated with organic ligands to form one, two- or three-dimensional porous structures.

Despite the significant potential this new class of materials offers, they have not yet found their way into industrial processes and applications. This is because the materials required to create them are currently seen as too expensive and not in a shape that justifies their industrial use.

Thanks in part to the EU-funded ProDIA (Production, control and Demonstration of structured hybrid nanoporous materials for Industrial adsorption Applications) project, this is about to change.

The project demonstrated the feasibility of large-volume industrial production processes for hybrid nanoporous materials as finished products. “In ProDIA, we developed processes for the production of nanoporous powders, including MOFs and aluminosilicates, using sustainable solvents like water or close-to-solvent-free processes,” says ProDIA project coordinator Richard Blom. “We also demonstrated the shaping of such materials at the same scale.”

Demonstrating the sustainable production of NPMs

The project's consortium partners conducted four pilot-scale demonstrations: onboard adsorbed natural gas (ANG), removal of toxic industry chemicals (TIC), adsorption driven heat-pump applications (AHP) and antimicrobial agents to be used within healthcare. These pilots showed that by switching from state-of-the-art adsorption materials (typically silica and active carbon based) to new NPMs, industry can achieve significant improvements in energy and system size compared to existing technologies.

I really hope the developers of adsorption-based technologies and material manufacturers will soon dare to take the leap into the world of MOF – optimising their instrumentation for this new family of adsorbents.

From this work, ProDIA researchers succeeded in demonstrating that sustainable production of NPMs is possible at the >10 kg scale. They also produced shaped bodies of the chosen NPMs with negligible reduction in performance compared to precursor powders.

According to Blom, the project has shown that it is possible to shape MOFs for specific applications, and that the shaped MOFs – at least for selected adsorption-based applications – have significant improvements in performance compared to the adsorbents commercially used today.

"One of the main messages coming out of this project is that MOF-based adsorbents do not necessarily need to be expensive," he says. "Another key takeaway is that shaping MOFs is possible, but one needs to take into consideration the fragile nature of these materials, which limits the use of high pressure and temperatures during the shaping process."

Dare to take the leap

The project's results have already received attention from a number of industries. Several of the SMEs and larger enterprises involved in the project are set to adopt the ProDIA processes to further develop their business. Furthermore, the project's research-oriented partners continue to develop these processes in new research projects and potential spin-off companies.

"I really hope the developers of adsorption-based technologies and material manufacturers will soon dare to take the leap into the world of MOF – optimising their instrumentation for this new family of adsorbents," adds Blom. "Considering the possibilities that the huge chemical diversity of MOFs offers, I am sure making this switch will pay off in the long-run."

PROJECT
ProDIA – Production, control and Demonstration of structured hybrid nanoporous materials for Industrial adsorption Applications

COORDINATED BY
SINTEF AS in Norway

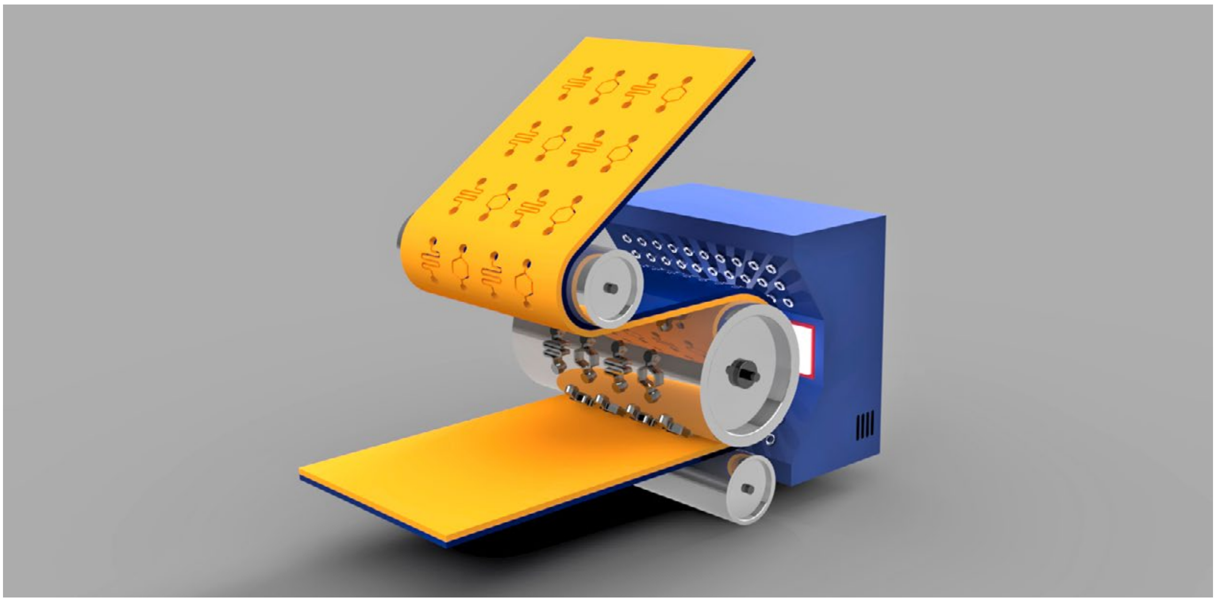
FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/685727

PROJECT WEBSITE
prodia-mof.eu

Using roll-to-roll processing to manufacture microfluidics for lab-on-a-chip devices

By reducing the costs of roll-to-roll technologies, researchers with the EU-funded R2R Biofluidics project have opened the door to using R2R to develop novel diagnostics for rapid and reliable pathogen detection.



Roll-to-Roll (R2R) processing is the method of applying coatings, printing or performing other techniques, starting with a roll of flexible material and then re-reeling after the process, to create an output roll. Once coated, laminated or printed, the rolls of material can be slit to their finished size.

Unlike batch processing, R2R is a continuous process that can lead to agile manufacturing and increased automation – not to mention a 10x reduction in cost. Therefore, the process has long been used by the graphic printing industry and is today attracting the attention of a number of other sectors. For example, the electronics sector uses R2R to create devices such as organic light emitting diodes on a roll of flexible plastic or metal foil.

Now, the EU-funded R2R Biofluidics (Large scale micro-and nanofabrication technologies for bioanalytical devices based on R2R imprinting) project is working to adapt the R2R process for the diagnostic and bioanalysis industries, predominantly for manufacturing microfluidics for lab-on-a-chip devices. "We need high quantities of these products, which will be used for diagnostics, drug discovery and food control," says project coordinator Martin Smolka. "R2R technologies allow for the significant reduction in production costs required to achieve mass production."

Microfluidics deals with the behaviour, precise control and manipulation of fluids that are geometrically constrained to a small, typically sub-millimetre scale. Lab-on-a-chip (LOC) devices are miniaturised devices used to carry out laboratory experiments on a very small scale. LOCs can integrate several laboratory functions on a chip ranging in size from a few millimetres to a few square centimetres – thus allowing for high-throughput screening and automation.

A quantum leap

R2R Biofluidics has demonstrated a completely new process chain for the large-scale production of LOC devices for such point-of-care applications as detecting antibiotic-resistant pathogens. Using an *in vitro* diagnostic chip with imprinted microfluidic channels based on detecting chemiluminescence and containing imprinted optical nanostructures for light coupling, researchers were able to improve the device's performance. Chemiluminescence is the emission of light during a chemical reaction that produces significant quantities of light.

Introducing R2R technologies for high-throughput manufacturing for diagnostic tests represents a quantum leap.

"These novel chips designed for chemiluminescence detection provide improved sensitivity, thanks to their imprinted optical structures," explains Smolka. "R2R fabrication will allow for the high throughput, low-cost manufacturing of these innovative devices, facilitating their market entrance."

Researchers also demonstrated how to develop cell chips containing imprinted cavities and micro- to nano-scale channels for controlled neuron culturing, which can be applied in high-throughput drug screening. Using this demonstrator as a foundation, SCIENION, one of the project's partners, developed a customised roll-to-roll microarray spotter for biomolecule printing.

"Introducing R2R technologies for high-throughput manufacturing for diagnostic tests represents a quantum leap," says SCIENION AG CEO Holger Eickhoff. "By offering such low cost flexible devices, this technology will soon be heading towards an unrivalled level of diagnostic device production."

Award winning idea

In September 2018, R2R Biofluidics received the Austrian Fast Forward Award in recognition of its pioneering work to develop novel diagnostics for rapid and reliable pathogen detection. "This award recognises our position as pioneers in such R2R-based process steps as implementing new imprinting concepts and achieving the very first spotting of biomolecules using R2R technology," adds Smolka.

PROJECT
R2R Biofluidics – Large scale micro-and nanofabrication technologies for bioanalytical devices based on R2R imprinting

COORDINATED BY
Joanneum Research in Austria

FUNDED UNDER
H2020-LEIT-NANO

CORDIS FACTSHEET
cordis.europa.eu/project/id/646260

PROJECT WEBSITE
r2r-biofluidics.eu

VIDEO
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Take a look at our latest Results Pack on Graphene, spotlighting 12 articles on six ambitious cutting-edge EU research projects relevant to graphene and 2D materials. Of these, seven articles cover different aspects of the Graphene Flagship, the EU's biggest research initiative.

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