FFG
Austrian
Research Promotion Agency

Production of the Future

Research and Technology for Innovative Manufacturing

Information provided by the Austrian Federal Ministry for Transport, Innovation and Technology

bmvit

Austrian Federal Ministry for Transport, Innovation and Technology

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IMPRINT

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September 2015

Foreword

Alois Stöger,
Federal Minister for Transport, Innovation and Technology

To ensure that the Austrian manufacturing industry remains competitive and growth-oriented in the long term, answers must be found to challenges such as globalization, cost pressure, resources and environmental issues as well as the demographic developments in the population and the job market. At the same time, the industry must seek new ways to bring its products and services to market even more flexibly and uniquely.

These dynamics in the global demand-driven markets, coupled with changing framework conditions, offer those companies and industries able to adapt quickly to change a great opportunity. This flexibility requires extremely versatile technologies, processes and resources. The future of Austrian manufacturing is therefore largely dependent on the targeted modernization of production processes for new, competitive and sustainable products. For this reason, research and development that aims to improve production and process technologies for the entire manufacturing sector is essential for Austria as a business location. Following the mechanical, electrical and digital phases of the Industrial Revolution, the next evolutionary step industry must take is already upon us: networked, decentralized, real-time capable and self-optimizing production and logistics systems. This "4th Industrial Revolution" – also called Industry 4.0 – will result in profound industrial transformation and will give businesses a chance to gain competitive advantages in the global marketplace.

In 2011, the BMVIT (Austrian Federal Ministry for Transport, Innovation and Technology) launched the research program "Production of the Future". The goals are to boost the domestic manufacturing industry's innovative performance, to improve the industry's access to relevant research competence at research facilities and companies, to establish research competencies in research institutions and to strengthen European and international cooperation and networks. In total, the BMVIT invests approx. €100 million in Austrian industrial research every year. In the long term, the Austrian manufacturing industry should have one of the highest penetration rates in terms of state-of-the art, high-performance manufacturing technologies in the world; and with the help of energy and resource efficient, flexible production and process technologies, produce first-class, customized products with a high degree of added value and sophisticated functionality both for private as well as business customers.

This brochure contains an overview of projects funded by the research program "Production of the Future" selected specifically to demonstrate the technological performance of the Austrian manufacturing industry and its research partners.
I am certain that you will find it interesting and informative reading.

Sincerely,

Alois Stöger

Federal Minister for Transport, Innovation and Technology

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Production of the Future

Challenge and Mission

Klaus Pseiner and Henrietta Egerth

Management board
Austrian Research Promotion Agency FFG

"Quality 'Made in Austria' is known and respected around the globe. And yet, the main challenge facing companies is remaining ahead of the competition. This is why the Austrian Research Promotion Agency FFG funds innovative and efficient methods in process and product development within the framework of "Production of the Future". Superior process competence goes hand in hand with developing intelligent and renewable materials. Excellent research results have come to light that contribute to mastering societal challenges. These findings drive sustainable growth, above all for domestic companies, and in turn secure jobs in Austria far into the future."

The manufacturing industry, with approx. 640,000 employees in 29,000 companies and a gross value added of approx. 50 billion euros per year is the backbone of Austrian economy. Almost every fifth euro in Austria is earned by the domestic manufacturing industry, almost two thirds of the workforce depend directly on it. All the more reason why producing internationally competitive products is an essential factor for prosperity. Therefore the goal is to keep the manufacturing industry in Austria and to make it fit for the future. Many outstanding production companies are located in Austria, not few of these are global and technological leaders. Still, the pressure from international competition is enormous and domestic industry can only survive if it can develop innovative technologies and improve in productivity.

The requirements are exacting: on the one hand, new high-tech materials, lower production costs and shorter development cycles; on the other hand, greater product diversity, resource and environmentally friendly manufacturing processes, logistics and recycling issues and many more aspects. All this and more demand innovative solutions.

Overview of the RTI Initiative "Production of the Future"

www.ffg.at/produktion
www.ffg.at/produktionderzukunft

"Production of the Future" 2011-2015

61 million euros funding allocated
150 funded projects
450 million euros applied for
573 project submissions
1800 stakeholders from the business and science sectors

Photos: FFG/Klaus Morgenstern

The "Production of the Future" Program

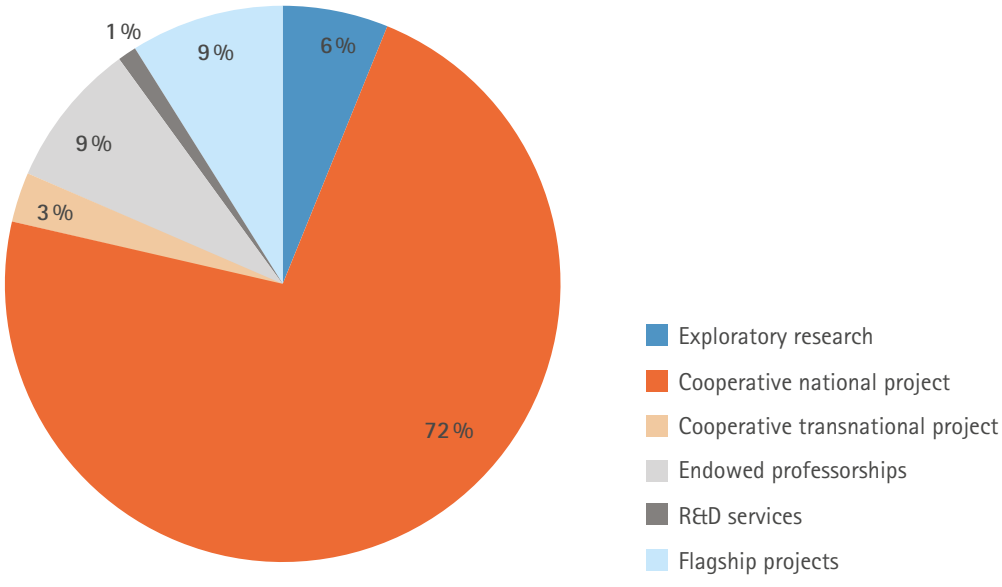
To meet these challenges, the RTI funding initiative "Production of the Future" has set itself the following goals:

- Efficient resources and resource management, efficient production technologies to increase international competitiveness and to strengthen Austria's position as an industrial location
- Flexibilizing production to enhance Austria's production expertise
- Manufacturing high-tech products to underscore Austria's position as an innovation center

Since 2011, the RTI initiative "Production of the Future" has implemented a number of new strategic measures. More than 570 projects, national and transnational as well as human resources-related projects such as endowed professorships have been submitted. The portfolio has now been expanded to include new measures to promote R&D infrastructures. By now, total project costs worth 450 million euros have been applied for in "Production of the Future" and since 2011 more than 150 projects with a funding volume of 61 million euros have been approved. Since the start of the initiative, over 1,800 stakeholders from business and science have been recorded in applications for the funding program "Production of the Future".

This brochure gives for the first time an overview of some of the projects that have been funded by the "Production of the Future" initiative. The following 30 projects represent

Funding awarded according to instrument in the 2013/2014 "Production of the Future" open calls



Source: FFG funding statistics 2014; "Production of the Future"

only a few of the more than 150 highly innovative R&D projects that have been awarded funding in the following categories:

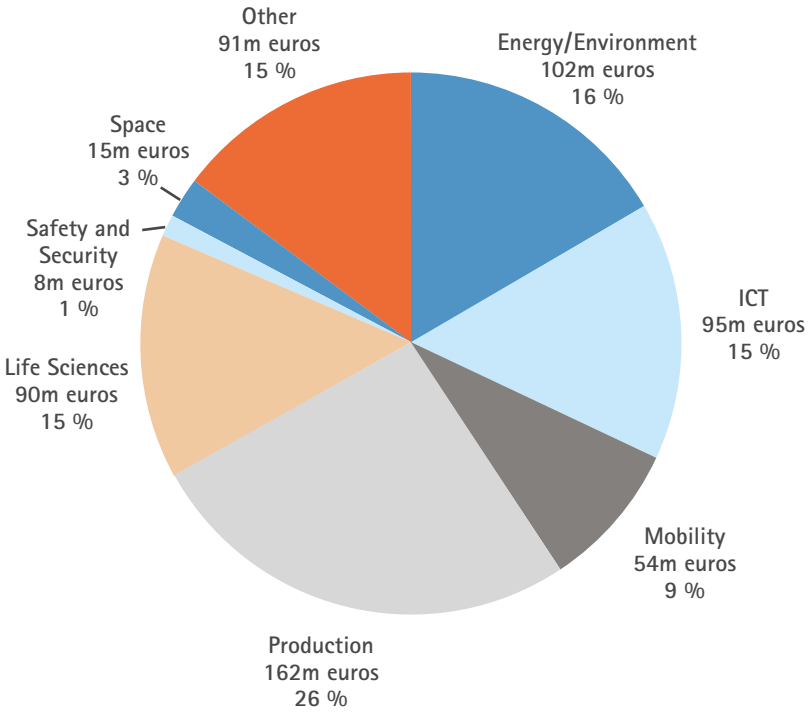
- Efficiency and quality in manufacturing
- Advanced materials, surfaces and coatings and nanotechnology
- Critical raw materials
- Bio-based industry

Every year, "Production of the Future" provides approx. 25 million euros in funding to projects in various instruments. "Cooperative R&D projects", which also include "flagship projects", are the most important instrument. Over 80 % of the funds are awarded to these science / business research collaborations.

Particular emphasis is placed on "Industry 4.0", meaning advanced manufacturing with the support of information technology. For this reason, a number of innovative R&D projects received funding along with, and for the first time, endowed professorships for production research in Industry 4.0.

With its wide range of funding opportunities, "Production of the Future" covers a broad spectrum of the FFG funding portfolio, from small-scale exploratory studies through to large, strategically oriented flagship projects, and has become an integral part of production and materials research in the FFG and in Austria today.

FFG Total Funding By Topic in 2014



This chart shows all funding sources as well as loans and guarantees.

Source: FFG funding statistics 2014;
Total FFG funding without assignments

Material and production research in the FFG

From the very beginning, "Production of the Future" has stood for managing the thematic and open funding portfolio within the FFG's production and materials research category.

Every year, approximately one quarter of projects newly approved by the FFG are dedicated to or involved in materials and production research. This makes it the "number one topic" awarded funding by the FFG. In 2014, the FFG provided approximately 162 million euros to projects in these fields.

Strengths

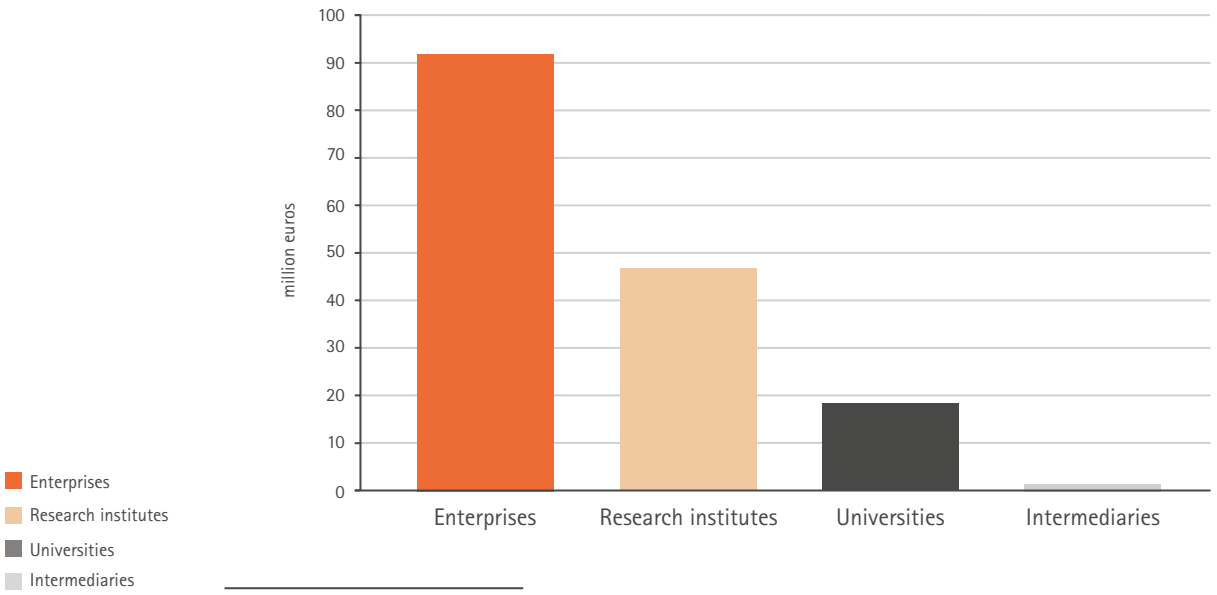
More than half of all Austrian companies engaged in research are involved in this interdisciplinary area.

Austria holds a strong record in production technologies, materials science, photonics and micro- and nanoelectronics. This strength is reflected in the successful, research-intensive manufacturing industries such as metal production and processing and their materials focus, the data processing industry, electronic and optical products, mechanical engineering and rubber and plastic goods production.

FFG Funding Opportunities

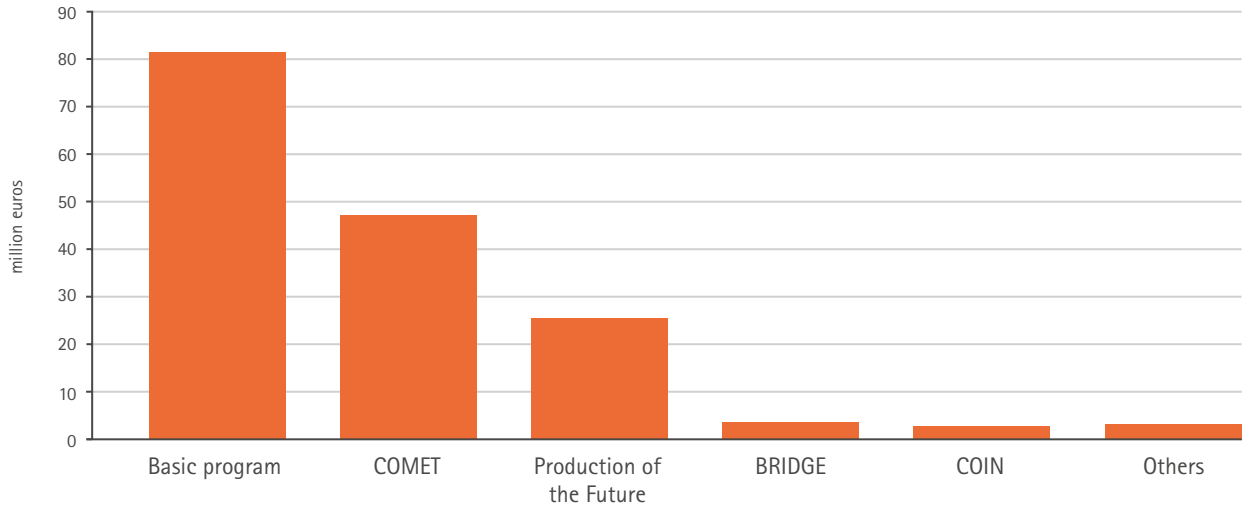
Projects in materials science and production technologies and processes are eligible for funding in many FFG programs. The range of thematic programs such as Production of the Future, ICT of the Future, TAKE OFF, Energy research or Mobility of the Future

Funding by type of organization, production research, FFG-wide 2014



Source: FFG funding statistics 2014; total FFG distribution by type of organization

Funding by programs, production research FFG-wide 2014



Source: FFG funding statistics 2014; Total funding production topic

This graph includes BMVIT subsidies, loans and guarantees, BMWFW subsidies and appropriations from the Climate and Energy Fund.

addresses the great challenges faced by business and society. "Production of the Future" additionally supports the European network M-ERA.NET. This network is the largest, transnational funding initiative in the materials and production sectors and is coordinated by the FFG. More than 35 funding organizations in over 25 countries are involved.

The range of open programs and individual projects in the basic program, the basic research-based program BRIDGE – knowledge transfer or structural funding programs – are utilized intensively for projects relating to materials and production. The competence center COMET, the program group Cooperation and Innovation (COIN for short) and not least the FFG's career program are open for project ideas.

Moreover, the Competence Headquarter Program encourages globally active companies in Austria to focus more strongly on establishing research centers in Austria.

In addition to providing national funding opportunities, the FFG supports the participation of Austrian research institutes and companies in Horizon 2020 – in particular NMPB (Nanotechnologies, Advanced Materials, Advanced Manufacturing and Processing, and Biotechnology) - as well as in the Knowledge Innovation Communities (KICs) of the European Institute of Technology and Innovation (EIT).

FFG funding for the materials and production topics

www.ffg.at/en/materials-and-manufacturing

Statements to the program

Harry Heinzelmann

Dr. Harry Heinzelmann, Vice-President Chief Technology Officer CSEM Centre Suisse d'Electronique et de Microtechnique SA, Schweiz

"The BMVIT program "Production of the Future" is an important addition to the research programs at the European level. It is easier to access for local research partners, and it underlines the importance of manufacturing for the industrial site of Austria."

Margit Kapfer

Dr. Margit Kapfer, Project Manager, Denkstatt GmbH

"Thanks to the BMVIT program, we can develop new, spearheading production processes in our research project "Intelligent production – modular bio refinery for complete utilization of ligneous biomass to value added products". The program makes it possible to move the project forward step by step until an industrial standard is developed to attract the attention of international investors."

Andreas Pichler

Dr. Andreas Pichler, President PROFACTOR GmbH

"Despite the negative connotation of this buzzword, the term Industry 4.0 describes the reality of manufacturers today. A research program like "Production of the Future" can, as best as possible, anticipate the challenges that factories of the future will face. In my opinion, industrial assistance systems and additive manufacturing are two relevant research topics."

Sabine Seidler

Prof. Dr. Sabine Seidler,
Rector TU Wien

"The world of employment will be transformed by Industry 4.0. It will require targeted funding, training and research work - from the basics through to industrial application - to secure the business location. With its 'Learning & Innovation Factory,' the TU Wien has laid the foundation for efficiently supporting the BMVIT and the "Production of the Future" program by developing and implementing the new funding model R&D Infrastructure. Together with leading companies, the goal is to find solutions for the Austrian economy."

Horst Schmidt-Bischoffshausen

Prof. Dr. Horst Schmidt-Bischoffshausen
former Head of the Patents Office EADS Germany, and deputy head of EADS Corporate Research Center Germany

"The BMVIT program "Production of the Future" plays an important role in European applied research as it exactly meets the essential requirements and the competitive innovation needs of Austria's industry, characterized by medium-sized businesses."

Eberhard Abele

Prof. Dr. Eberhard Abele,
Head of the Institute Product Management, Technology And Tooling Machines (PTW), TU Darmstadt

"Austria's economy relies on the strength of its innovations and the competitiveness of its manufacturing industry. The "Production of the Future" promotion program commendably and efficiently furthers the necessary future-oriented production technologies. This program gives important impetus to Austria, securing it as a business location and securing jobs."

Photos: Joëlle Neuenschwander; denkstatt Gmbh; PROFACTOR; Raimund Appel; privat; PTW

Research must play a major role

Networked production is a great challenge for industrialized societies in times of global competition. To meet this challenge, Austria needs more research and private investment, according to an interview with Professor Fritz Prinz.

Europe is hoping that, with the digitalization of industry, it will be able to secure its global competitive position and industrial locations. What is your opinion from an American point of view?

This really is a great challenge for those countries in the West that traditionally have a high standard of living and are now being challenged by Asian countries such as China and Korea. Western industrialized society must take on this challenge. Digitalization did not happen overnight. It is a continuous process that has been taking place over many years and for many years now, the pace has been accelerating. 20 or 30 years ago there was also a lot of automation, just think of robots or computer-operated cutting machines.

It's been around for a while. Now, however, it is much more networked and increasingly being integrated into production planning. This is a step that has taken place continuously, but the speed of integration is constantly increasing. Only flexible automation processes will be implemented more often in the future. Ultimately, successful industrial competitiveness does not only depend on a good idea, it has to be profitable, too.

On the one hand I have to be innovative, offer unique products that society wants and will buy, on the other hand I have to keep it cost-efficient, otherwise only a few will be able to afford it. Our prosperity comes from industry first and foremost, and not tourism. This is why industrial flexibility is so important for us. I also believe that the environment will play an ever more important role in the future, not only with respect to production, but the product. People expect environmentally friendly products and production processes that emit less greenhouse gases.

Government is facing a big task here, to regulate this. We have to take on these challenges and, as a small country like Austria, ensure that we stay with the forerunners and help steer change - internationally, too.

What role can Austrian research play in developing the industry of the future?

It has to play a very significant role. An industrial country with a high standard of living is largely dependent upon research and development.

We cannot maintain a standard of living if we are not at the forefront of product development and production. This requires further investment in research and development.

Prof. Friedrich Prinz

Finmeccanica Professor in the School of Engineering at Stanford University, Professor of Materials Science and Engineering, Professor of Mechanical Engineering, Senior Fellow at the Precourt Institute for Energy, Co-Director of Stanford Energy 3.0 and Director of the Nanoscale Prototyping Laboratory at Stanford University. Prinz is a solid state physicist and member of the RTI-Initiative "Production of the Future" advisory committee, and for the past two years has served as program advisor to the Federal Ministry of Transport, Innovation and Technology. Prof. Prinz was born in Vienna, where he studied Physics at the University of Vienna.

Are there any specific research fields in Austria that could contribute more than others?
You can't separate production development from product development.

Product and production integration have essentially converged during the past 10 to 20 years – they must be considered simultaneously. Not only the idea of the product itself, but the needs and desires of the end customers have sparked off a race towards further product and production integration.

We can only manage this by taking advantage of modern computer technology. This is why Austria must make sure it keeps its research and development in the premier league.

How will the new digital and networked production technologies change the structure of industrial manufacturing? Is this the end of the big factory?
I think this is something you can't generalize, as it depends entirely on the product. I'm assuming that even in the future there will continue to be very large car factories. Some industries will become smaller, and will relocate to low-wage countries. Human resource-intensive production is always a problem in countries with a high standard of living, such as Austria. That's why it's important that we move into capital-intensive, highly automated areas. That's why we have to go into flexible automation. If we buy an expensive production machine today, we have to make sure it's flexible and can be used for a wide range of products. Investments such as these have to pay off over many years, so flexibility is paramount. But currently we have the strategic advantage of much lower capital costs than in many other countries of the world, especially in Asia.

From which institutions and organizations should research and innovation for the production of the future come from?
From large companies to startups, we must stay competitive on all fronts. One problem in Austria continues to be that, while there is no lack of ideas, no lack of engineering capability, no lack of researchers and scientists, it lacks - funding. We profit from the proximity to Germany, true, but it is unlikely that we will establish large new industries as long as the capitalization that, for example, is available to a much larger extent in Germany, is missing. Several companies have asked me if help could come from other countries. The problem is that venture capitalists, like those in the USA, mainly invest locally. They want to sit on the advisory board and keep an eye on what's happening locally. They want to go there every other week and see for themselves what progress the company is making. It takes a lot for them to go to Europe, because it would be more difficult to maintain contacts due to the distance. We also have the problem that we in Europe have an entirely different capital market than here in America, for example. In Europe, most investments are made by banks. When they invest, they want a property, a house or similar collateral, and they are not as prepared to capitalize on ideas or intellectual property. In many cases there aren't enough specialists to make such decisions, because they don't have enough experience dealing with the risk that new products involve.

INTERVIEW: SONJA BETTEL

"Assembly satnav" takes the pressure off workers

A virtual assembly assistant gives line workers real time warning of errors in the assembly process, provides smart instructions for production and long term know-how transfer.

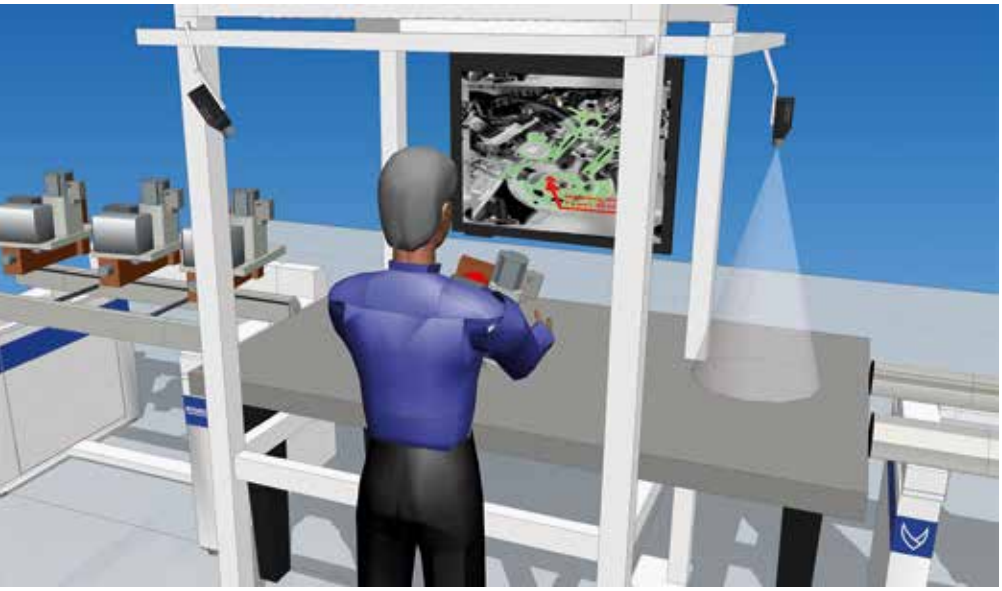
Cue Man-Machine Communication: The project ShowMe designs the assembly line workplace of the future. Production is under pressure to meet requirements, on the one hand due to the diversity of variants, on the other due to ever shorter innovation cycles. Against this backdrop, ShowMe focuses on the modern workplaces of the future. The new concept puts people first and proposes a visual assistance system for manual production tasks. The system passes on intelligent, context-based assembly instructions and signals mistakes even while these are being made. Transferring the knowledge of experienced workers to new workers is, so to speak, already built in.

All this has a positive effect on the quality of the workplace. Mental pressure is taken off the workers, they are supported better ergonomically, and can work more efficiently to fulfill quality requirements.

System detects potential errors in real time

ShowMe acts like a navigation system. It is based on real time enabled 2D and 3D object position recognition – it "sees" the workpiece, the components and the surroundings and "tracks" the movements the assembly worker makes. In combination with familiar assembly sequences the system is able to independently and intelligently provide operational guidance that assures quality at the same time. Based on historical data and experience stemming from quality assurance, the assembly planning component attempts to guide the assembly worker through the system in the best possible way, i.e. so that assembly is optimally balanced with respect to ergonomics, efficiency and quality. If an error is detected, the software adaptively calculates detours - alternative paths and assembly routes - to the destination.

Any hardware component designs can be used for visualization: smart glasses, monitors, tablets or projection systems. The system superimposes the real world on a simulated world by means of computer graphics or augmented reality, depending on the requirements of the situation.



Project Title
Ergonomic management of assembly personnel

Consortium Manager
PROFACTOR GmbH
www.profactor.at

Project Coordinator
Harald Bauer
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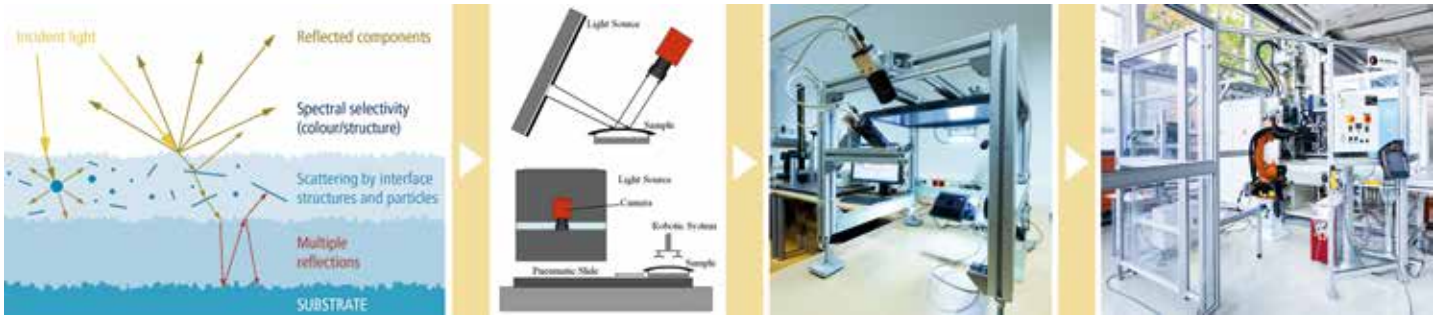
Other Consortium Partners
BMW Motoren GmbH
E+E Elektronik

Period
2012 - 2014

The world's first seeing robot

The human eye perceives tiny irregularities on smooth, glossy surfaces as defects. Now, a "seeing robot" enters the field.



The human eye is very sensitive. The tiniest irregularities on smooth, glossy surfaces are perceived as defects in certain light. The result: the quality impression of the acquired products suffers, whether it is large panels on car exteriors or the surfaces on electronic devices. This poses a major problem, particularly to the automotive industry, because so far it has only been possible to inspect injection molded parts for defects manually. The results were subjective and non- reproducible and particularly unsatisfactory when inspectors from suppliers and equipment manufacturers arrived at different conclusions. Complete, in-line inspection has been considered hardly feasible until now.

The "artificial eye"

An "artificial eye" developed at the Polymer Competence Center Leoben remedies this. The SurfaceVision project has made it possible for the first time to automatically and quickly measure defects on the surfaces of injected molded parts even during production. The central aspect is the deployment of robots that unload parts from an injection molding machine. The opto-mechanical system simulates human visual perception of surfaces, accurately assesses the quality of curved parts, and documents the results reproducibly. For the first time, a verifiable basis for quality inspection has been created that will signify a marked decrease in "false rejects" and potential "defects not found."

Defective injection molded parts can be rejected in time, before they continue to the next, expensive production cycles such as paint coating or metallization. This constitutes a huge cost-saving potential, as coated parts can be up to 15 times more expensive than uncoated parts. In addition, significant savings can be achieved with respect to material and energy consumption. The feedback from prestigious manufacturers of highly sophisticated plastic components and their customers - for example the automotive industry - has been positive.

The project won the Magna ACS Innovation Award 2013. The project manager, Dieter P. Gruber, won a Houska Prize in 2014 in addition to being named Austrian of the Year in the category Research.

Project Title
Integrated measurement system for optical surface inspection of sophisticated plastic parts

Consortium Manager
Polymer Competence Center Leoben GmbH
www.pccl.at

Project Coordinator
P. Gruber
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Other Consortium Partners
Wittmann Battenfeld GmbH

Period
2012 - 2015

In just three minutes to a finished tablet

Injection moulding is well-established in plastics manufacturing. But it can also be impressively used to produce pharmaceuticals.

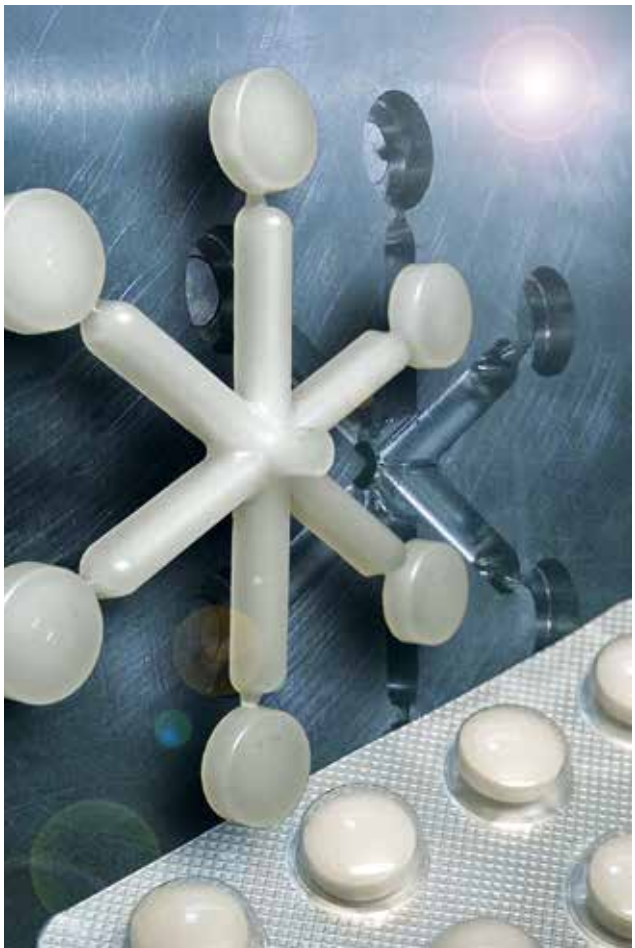
Innovative active ingredients pose a growing challenge to the pharmaceutical industry: 40 percent of the ingredients currently being developed are not readily soluble, and in future this fraction will grow to 90 percent. However, active pharmaceutical ingredients (APIs) are only bioavailable in soluble form to be absorbed via the membranes of the gastrointestinal tract to reach systemic circulation.

Processing bioavailable medicines on the basis of poorly-soluble ingredients is a tedious process. It is not unusual for the production of a single pharmaceutical, from the raw material through to the tablet in a box, to take 200 days or more. One possibility to transform poorly-soluble ingredients into bioavailable medicines is to integrate active ingredients in a polymer matrix by means of hot melt extrusion. After extrusion, however, many more production steps are often required - for example grinding, sifting, and pressing - before the final, desired dosage form is achieved. An alternative processing technique is injection moulding, which combines the advantages of hot melt extrusion with direct shaping. Pharmaceuticals can therefore be processed in one step, and, equally important, in different shapes and sizes, too.

Direct processing in a single step

The Pharma-Mould project investigated injection moulding currently established in the plastics industry with respect to its applicability in processing pharmaceuticals. By optimizing the injection moulding equipment and the tools, the researchers succeeded in establishing a single-step process for producing the final dosage form. In addition to achieving increased solubility, they were also able to modify the release behavior of the ingredients, depending on the materials used. This process allows now for the production of both fast release medication such as painkillers, and retarded-release systems (where the active ingredient is released over several hours).

A big innovation, indeed. The final dosage form can be processed in just three minutes, directly from the primary raw materials. With the assistance of near-infrared spectroscopy, a fully automated, 100 percent, end-to-end quality control procedure was demonstrated on the manufactured tablets.



Project Title
Injection molded pharmaceutical dosage forms

Consortium Manager
Research Center Pharmaceutical Engineering (RCPE) GmbH
www.rcpe.at

Project Coordinator
Gerold Koscher
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Other Consortium Partners
ENGEL AUSTRIA GmbH
Karl-Franzens University Graz, Institute of Pharmaceutical Sciences (IPW)
Johannes Kepler University Linz, Institute of Polymer Injection Molding Technology and Process Automation (IPIM)
FH Joanneum Gesellschaft mbH

Period
2012 - 2015

Leading innovation for the food industry

Until now, samples used during traditional lab testing procedures in the food processing industry were destroyed in the process. A domestic innovation has changed this, while improving food safety and product quality at the same time.

Inline food analyser based on IR spectroscopy

Sensor technology is very useful to the food processing industry, particularly for analyzing a wide range of food parameters. Results and applications that have hitherto not been possible have become reality with new key technologies. For example, product contaminants can be identified with almost 100% accuracy, as can disparities in sugar, water and dry mass content. All this is now possible, faster and cheaper – and without destroying produce.

The researchers built a fully functional new food analyser based on a specialized spectrometer (see Ill.).With this machine, it is possible to quantitatively measure chemical product parameters in food processing flows. Analyzing chemical components replaces time-consuming quality control in the lab.

The project comprises planning, testing and improving individual modules as well as developing, adapting and upgrading the software. In addition, new mathematical methods were developed to investigate and assess the special camera technologies implemented in the food analyser.
These had to prove their performance on the basis of reference-analytical lab data collected by the TU Graz.

Gold Medal for Food Analyser made in Austria

The new machine recently won gold at the largest international food technology fair, where it was one of the main attractions. The reasons are clear: automated work process, better quality, higher yield, accurate measurements that deliver more information and statistically highly accurate analyses for immediate quality classification, process steering or grading. The benefits for domestic innovation and Austria as a business location speak for themselves: the entire value chain -development, design, building the devices – was forged in Austria.

Project Title
Inline Food Analyser based on IR spectroscopy for touch-free, non-destructive application in food processing.

Consortium Manager
Infruits GmbH
www.infruits.at

Project Coordinator
Matthias Jeindl
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Other Consortium Partners
EVK DI KERSCHHAGGL GmbH
i-RED Infrarot Systeme GmbH
Insort GmbH
Technical University Graz

Period
2012 - 2014

Getting the most out of the high-tech raw material

The Montanuniversitaet Leoben is examining ways to improve the security of supply of high value, high-tech graphite by means of a new processing method. A database focused on the achievable functional product properties is also under consideration

Every pencil contains a core made from graphite. But putting words on paper is not the only thing this industrial mineral is capable of. Besides being highly lubricious, graphite is a good thermal and electric conductor, making it essential as an additive or material used in the steelmaking, automotive, glass and electronics industries. In 2011, the EU commission declared the mineral as a critical raw material. While graphite is in great demand across the globe, 90 percent of the world's supply originates in only a few countries outside of Europe.

The "Innovative Graphite" project, a collaboration between the Montanuniversitaet Leoben and the graphite mining company Kaisersberg GmbH, aims to investigate ways to secure Austria's supply of innovative graphite products. Improving security of supply involves among other things: assessing Austria's own deposits, creating a better overview of the achievable functional properties of graphite products and how these may be exploited by industry, and investigating new processing methods.

Drilling at the underground mining operations in Kaisersberg revealed further graphite layers in the depths and an optimized mining plan has been developed to take advantage of this discovery.

Electrostatic separation as a new processing technique

New processing techniques will make it possible to process graphite ores deeply embedded in the waste rock to marketable products, as well as to refine globally available, cheap intermediates to high-tech products in Austria. This will create more value for Austria while reducing domestic industry's dependency on imports. Currently, the preferred processing method for enriching graphite is usually flotation. Now pilot experiments, involving electrostatic separation as a dry and low-cost process, are being conducted at the Montanuniversitaet Leoben to test its possible fields of application and limitations. Furthermore, a product database is being created that matches the achievable functional properties of graphite products produced by these means with potential industrial applications. The idea is that if the functional properties of the producible graphite products can be better matched, the result will be a wider range of potential applications.

Core Box

Project Title
Increasing Austria's security of supply with innovative graphite products

Consortium Manager
Montanuniversitaet Leoben, Chair of Mineral Processing
www.unileoben.ac.at/mineralaufbereitung

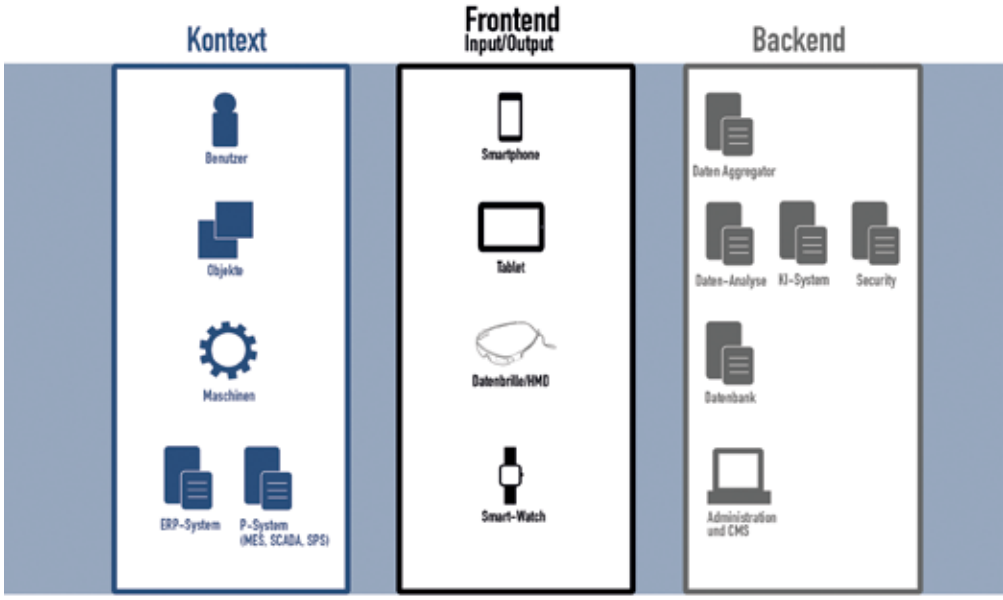
Project Coordinator
Helmut Flachberger
helmut.flachberger@unileoben.ac.at

Other Consortium Partners
Montanuniversitaet Leoben, Chair of Mineral Processing
Montanuniversitaet Leoben, External Institute
Grafitbergbau Kaisersberg GmbH

Period
2013 - 2015

Service Avatar: A new service era begins

Mobile end devices support plant and machine servicing and staff training in Industry 4.0. Thanks to digital technologies, even across continents.



An average day in automated manufacturing: the robot ballet dances, the components are transported along the assembly line to the next stage of production, special tools perform their tasks without complaint. The manufacturing industry in Europe is increasingly turning to automation and efficient human resource management to remain competitive. Servicing complex machines remains the domain of qualified personnel. ASSIST 4.0 helps production and service technicians, in direct interaction with the machines, to make effective decisions based on visualized data, information and events. The assistance systems must be designed in such a way that they help people, providing them with the information they need for specific contexts, so they are able to perform their work efficiently.

Smart Glasses and Augmented Reality as Key Technologies

The ASSIST 4.0 project aims to develop and test assistance systems for Industry 4.0. The research team designs six use cases, realizes and evaluates them. The new technologies are tested on logistics equipment at KNAPP, semiconductor production in the cleanroom at Infineon, and by example of the automotive industry in connection with AVL. The goal: In the smart factory, it should not be necessary anymore to stop production until the service technicians arrive.

With mobile assistance systems, travel time is already service time. In future, experts will be able to provide instructions and assistance using the latest key technologies – regardless of where they are. A central software system combined with tablets, smartphones or smart glasses will support service staff by delivering information and visualized data during man-machine interaction; for decisions, handling, fault prognosis, maintenance, training and data gathering. With the head up display, personnel on site can have their hands free to implement assistance directly, ask questions and process more sensory information than over the telephone. Every aspect of ASSIST 4.0 puts human beings on center stage; in future, people and machines should communicate with each other as naturally as they do in social networks.

Project Title
Mobile context-based assistance systems for Industry 4.0

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Research Studios Austria Forschungsgesellschaft mbH
Paris-Lodron-Universität Salzburg
XiTrust Secure Technologies GmbH

Period
Until 2016

Tailor-made capacity adjustment

An innovative decision support system optimizes capacity adjustment. Manufacturing costs are cut by up to six percent. Small and medium sized businesses, particularly sensitive to extreme fluctuations in demand, remain competitive.

In the age of globalization, manufacturing companies must be capable of operational and strategic flexibility. It is vital to be able to continuously adjust capacity in response to extreme demand fluctuations. At the same time, an eye must be kept on the costs. Small and medium-sized businesses in particular struggle with the cost challenge, as it is also coupled with minimal market power. Until now, capacity planning did not completely take into account the adjustment costs.

Degrees of freedom revealed

This prompted the research project "KoKa" to develop a system to support companies with their decisions on cost-optimized capacity adjustment.

The starting point was to evaluate data pertaining to companies' options with respect to adjusting operational capacity, and to parameterize the software based on the findings. Data gathered included adjustment measures such as work schedules, flextime agreements, equipment capacity, storage restrictions, outsourcing and production streamlining as well as the associated costs. In the course of this analysis, unnoticed or unknown degrees of freedom pertaining to capacity adjustment are revealed.
In the next step, demand data is fed into the software. It quickly calculates the least-cost combination of the existing degrees of freedom. The purpose of "KoKa" is to help planners find the best capacity adjustment strategy while considering all incost. Planners can override the results, and continuous optimization is possible. These functions make this decision support tool unique compared with other existing systems.

The prototype of the system, implemented by the project partner Melecs EWS GmbH & Co KG, allowed optimal distribution of the production volumes based on planning periods, resources and factories. Manufacturing costs were reduced by approx. six percent. When one considers that these account for between 20 and 30 percent of total manufacturing cost, the saving potential is immense. Now, high-wage countries such as Austria can remain front runners in the global marketplace thanks to technical innovation, flexibility and cost-effectiveness.

Project Title
Project Title:
Development of a decision support system for cost-optimized capacity adjustment

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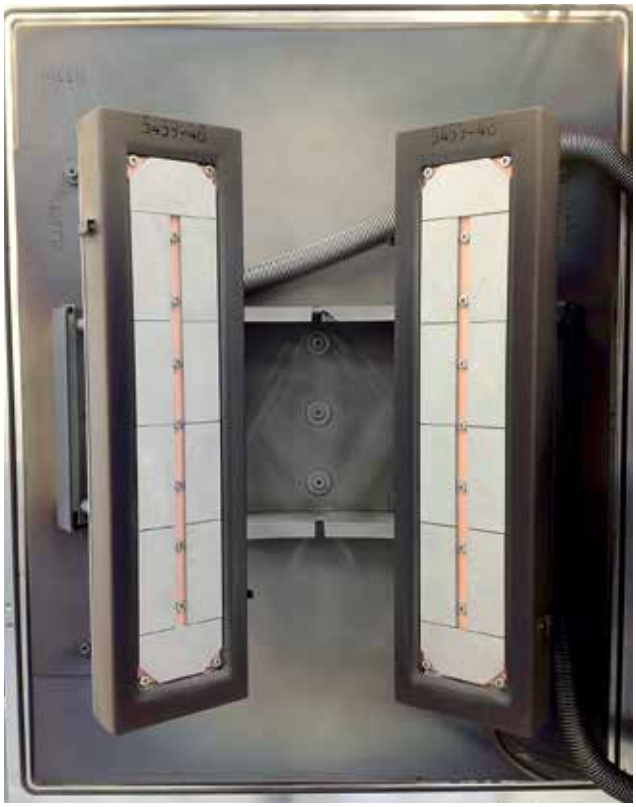
flexis AG

Period
2012 - 2013

Protective layers undergo endurance testing

New coatings for metal cutting tools will extend their service life. Research has its eye on the entire process, right back to recovering the coating material.



two titanium aluminum zircon square targets developed in the HIPERCUT project

Project Title
Targets and coatings for high performance cutting

Consortium Manager
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Period
2012 - 2014

Where wood is chopped, splinters must fall. This proverb not only applies to wood, the same applies to metalworking. And just as an ax becomes blunt, metal cutting tools also wear down. A thin coating, however, would make specialized tools more heat resistant and durable. The project HIPERCUT is dedicated to finding such a coating for cutting tools that can not only withstand high temperatures, but can also be applied reliably, seamlessly and precisely. At the same time, none of the components in the precious powder must be allowed to go to waste. The project therefore investigated several things at the same time: the coating (structure and composition); the deposit (during the coating process) and recovery of the materials deployed.

The research partners are therefore not just turning one screw, they are optimizing all process steps at the same time. Material and process are thoroughly examined, new coatings compared with forged material, tested many times and assessed for practical relevance.

Making traditional coatings more heat resistant

First, conventional aluminum nitride (TiAlN) coatings have to be rendered more heat resistant - up to a minimum of 1000° Celsius - with new alloys. This so that cutting tools can withstand the heat produced by friction longer, or that work pieces can be processed more quickly. The project results suggest that amalgamating TiAlN and zirconium extend the cutting tools' service life. These experimental indications will be consolidated and tested for industrial application. Another part of the project concerns new coating-powder mixtures and improving deposition on the tools, i.e. the coating itself. This is done by means of sputtering targets and metal powder mixtures using a magnetron cathode. For this reason cathodes are also being optimized on the computer, where the reaction process is exactly simulated for the new alloyed TiAlN layers.

Aluminium: Injection molding for industry

Aluminium components can now be industrially manufactured by means of metal injection molding. The new technology requires less material and energy.

Metal injection molding is a popular method to produce precision parts at low cost and with high material utilization. While this works perfectly with stainless steel, titanium and carbides, so far it has been a problem with aluminium. Al is difficult to sinter (i.e. fusing powder together at high temperatures) due to its stable surface oxides; therefore it has only been possible to injection mold aluminium at the lab scale.

For this reason, INDALMIM set out on the mission to develop the required process stages for the industrial application of aluminium metal injection molding, and to refine alloying techniques to the point where implementation by the automotive industry appears realistic. This involved finding solutions to the sintering challenge as well as the recurring problem of surface staining.

Up to 50 percent less material

Aluminium alloys have a particularly low melting point, which is why removing binders by means of traditional thermal methods is difficult since it overlaps with liquid phase sintering, causing melting. This must be avoided at all cost, otherwise carbon is picked up that would prevent sintering. The researchers have now achieved consolidation by sintering in a nitrogen atmosphere, the debound body containing low oxygen and carbon concentrations. A solution to the unattractive surface layers formed during the cooling phase was also found.

In the process of sintering aluminium alloys, particular care must therefore be taken to control the temperature and the partially reactive atmospheres. Thanks to this knowledge, serial production of components by means of industrial injection molding is possible. The new technology developed by INDALMIM uses relatively coarse, off-the-shelf - and therefore cheap - powders to even allow production of larger components. It can immediately be integrated into existing production lines and saves material by up to 50 percent; in the case of the energy-intensive metal aluminium, this means a significant reduction in energy consumption.
A patent for this technology has already been applied for.

Project Title
Industrial manufacturing of aluminium precision parts with metal injection molding

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Rupert Fertinger GmbH
BASF SE
Ecka Granules Germany GmbH

Period
2012 - 2015

Cryogenic conditions make aluminum easier to form

Aluminum alloys are increasingly used in car body manufacturing. In the future, lighter and more complex components might be formed at low-temperatures.

Lightweight construction is a continuous trend in car body manufacturing. A lower car body weight reduces fuel consumption and harmful emissions or helps to compensate for the heavy battery packs in electric vehicles. Therefore the automotive industry and its suppliers are in constant search of innovative materials and novel production of processes for car body components.

Aluminum sheet alloys play an important role in modern lightweight car concepts. However, compared with steel, their formability at room temperature is low. Sheet forming processes at elevated temperatures have been investigated intensely in recent years, but no cost-efficient serial production could be realized up to the present date. A significant improvement of the formability of aluminum sheets, however, can be achieved at cryogenic, i.e. very low temperatures. The novel cryogenic sheet forming process, which was studied in this project, might be an important step towards light, complex, highly integrated, single piece automotive parts which meet the harsh requirements of the future with regard to safety, cost-efficiency and environmental sustainability.

Freezing the production process

Within a co-operative research project, LKR together with scientific and industrial partners from Austria and Germany successfully set up a lab-scale process line for the cryogenic forming of high-strength aluminium alloys. Special measurement devices were constructed in order to determine the mechanical material properties at low temperatures down to -196°C. In addition, lubricants for cryogenic conditions were systematically tested and an innovative refrigeration technique for the cooling of the forming tool was developed. With the help of numerical Finite-Element models, the forming tool with cooling channels of a complex-shape mini B-pillar was designed and manufactured. The feasibility of cryogenic sheet forming was successfully demonstrated. Motivated by the present results the project partners aim at transferring the process to an industrial scale in a follow-up co-operation.

Project Title
Cryogenic aluminum sheet forming

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Fill GmbH
Linde Gas GmbH
voestalpine Metal Forming GmbH
voestalpine Polynorm GmbH & Co KG

Period
2013 - 2015

Photos: LKR

Ceramics in 3D-printing: The material of the future

High performance ceramics are temperature-resistant and highly durable. A new production method makes it feasible for small batches.

Technical ceramics possess outstanding material properties: they can withstand extreme temperatures, mechanical stress, and corrosive environments. No wonder that high performance ceramics are gaining more and more importance compared with materials such as metal and plastics.

The problem to date: producing high performance ceramic materials by conventional manufacturing methods is very expensive and time consuming. A challenge in times when product life cycles are becoming shorter and shorter, and the trend towards individualization points more to unique pieces and small batches. Moreover, the classic forming processes are limited when it comes to achievable complexity and precision, for small components in particular. This is the problem the project RACEMAN addresses.

Project Title
Rapid Ceramic Manufacturing

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Period
2012 - 2015

3D-printer for high-performance ceramics

RACEMAN's goal was to develop a 3D printer for high-performance ceramics, especially for single piece and small batch production. The resulting technology bears the name Lithography-based Ceramic Manufacturing (LCM) and allows for tool-free manufacturing with low material consumption. Already, a first material system for aluminum oxide - the most common high performance ceramic material – has been developed and is market mature. With the 3D printer CeraFab 7500, manufacturers of ceramic components can produce both operational prototypes as well as extremely sophisticated ceramic components with never before achieved material properties and qualities.

The components produced with LCM technology demonstrate the same material properties as conventionally manufactured components. The range of application is large: from mechanical and electrical engineering to aviation and aerospace through to medical engineering. Prototypes for research and industry can thus be produced quickly and inexpensively. A best practice example: the Assistocor project at the Technical University Vienna and the Medical University Vienna has developed a pneumatically-operated intracardiac catheter. The complex components for the device were made using the LCM process – in over 15 designs!

Photos: Hans Schubert

A competitive edge, as hard as steel

If Austria wishes to remain an attractive industrial location for high-tech companies, it needs top-notch steel manufacturing. An improved measuring method for steel slag makes a vital contribution to this.

Analyzing the quality of slag in the voestalpine Stahl GmbH steel mill using a LIBS device from the Johannes Kepler University, Linz

To be internationally competitive, attractive framework conditions and continuous improvement of production processes to boost efficiency are vital factors for innovation and manufacturing locations. This applies particularly to steelmaking, as producing premium steel is expensive due to the monitoring required at every stage in the process. As a modern, high-tech material, it is hard to imagine life without steel - be it for vehicle bodies, medical technologies, packaging or the construction industry.

Quality Assurance During Steelmaking Possible

The research program "Production of the Future" offers project partners from Austria and Germany a basis on which they can work together to improve the quality of steelmaking. The chemical composition of the slag, a by-product of steelmaking, is analyzed to determine its constituent elements. The analytical method used, laser-induced breakdown spectroscopy - or "LIBS" - is being taken to its next, decisive development phase by the project partners. The new measuring method is based on monitoring the interaction between the laser and the slags, and the plasmas thus produced. The research project's innovation value relies on the accuracy of the measurement as a result of improving the physical measuring method and the mathematical and statistical analysis of the complex data and spectra of the investigated slag. A measurement as precise as this has never before been possible, so that in future the quality of the liquid steel can be assessed even as it is being produced. Consequently, controlling the individual stages in the process will become faster, more accurate, and cheaper. The result is more efficient steelmaking through better quality and lower production costs.

Project Title
Calibration-free analysis of major and minor constituent elements in steel slag with homogenized laser-induced plasmas

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Humboldt University Berlin – Institute of Chemistry

Period
2013 - 2016

Surface polish with innovative character

Sometimes, the essential lies on the surface. Enhanced measurement methods have optimized C-MEM membrane production, and higher-performing fibers increase resource effectiveness.

Project Title
C-MEM Membrane Production

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ZFE Association for the promotion of electron microscopy

Period
2013 – 2014

Drinking water purification and wastewater treatment are crucial the world over. This is the job of membranes used for ultra and micro filtration. According to a study conducted by Frost & Sullivan, the membrane market grows by 15.1 percent a year.

Same same, but better. From the commercial aspect of membrane production, there is enormous competition from the likes of GE or Mitsubishi. SFC Umwelttechnik GmbH deserves to be in the same league. The company patented the unique mode of operation of its HDPE-produced, organic hollow fiber membrane. C-MEM is a special application of this membrane, which features micro-pores.

In the course of the CMEMPRO project the researchers were able to optimize membrane production. By integrating a quality assurance system, the quality of the finished fibers can now be inferred. This means that the fibers can be classified according to quality and hence assigned to specific applications. By adjusting the production parameters, the amount of waste material can be significantly reduced. And by improving the membrane surface (pore distribution) the project has succeeded in increasing the fibers' performance; the addition of a cooling system makes them more durable. This type of quality assurance by means of membrane classification puts SFC Umwelttechnik GmbH in the pole position in the race against its competitors in the membrane production sector.

From water treatment to algae harvesting

The result of recognizing the connection between fiber performance and stability for future production is an increase of fiber performance by 50 percent. By reducing reject material, energy consumption and waste, the improved C-MEM membrane production has also had a positive effect on the environment as well as on Austria as an innovative business location. With the expansion of C-MEM's traditional application areas from drinking water purification and wastewater treatment to medical technology, swimming pools or algae harvesting, the company has not only increased sales but has also secured and created jobs at its location in Salzburg.

Maintenance tool with algorithm feel

Bundling existing operational data reduces the cost of maintaining production equipment. A new, self-learning maintenance tool greatly boosts productivity.

Project Title
Feasibility study for an intelligent maintenance tool for more flexible production

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Other Consortium Partners
None

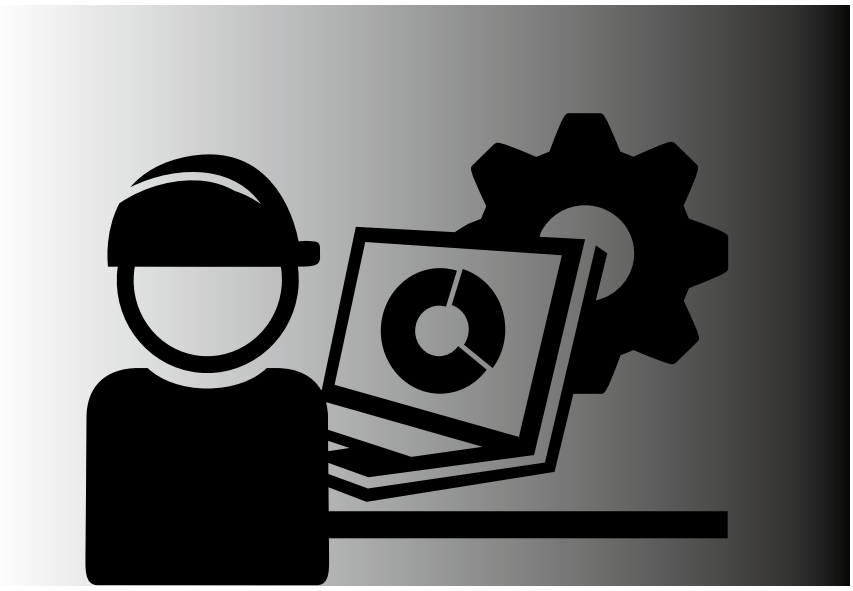
Period
2014

Maintaining production equipment is an often under-estimated cost factor. Chaotic warehouses and huge maintenance crews can result in wasted resources. Moreover, rigid maintenance planning according to fixed maintenance intervals based on manufacturer's specifications for the manufacturer's are hardly able to react to unexpected incidences. Manufacturing efficiency suffers from the negative impact on equipment availability, temporary storage and raw materials consumption.

Big Data helps the system learn

The IWS project has verified both the technical and economical feasibility of IPN's intelligent maintenance planning tool. Using this real-time predictive method, the maintenance intervals of industrial machinery can be defined based on the actual future state of the machinery. The maintenance tasks can be integrated into production flows. Adaptive algorithms able to recognize patterns and automatically detect the slightest changes in the equipment during production are responsible for this. They autonomously detect the factors relevant to the future state of the machines. The maintenance planning system continuously learns from the sensor and operational data streams fed to it from the company. Pattern recognition also takes into account intraplant expertise, securing it for the company in the long-term. "Big Data" refers to the large volume, high frequency and highly unstructured data streams supplied. To ensure that the information is analyzed efficiently, a form of "aging processes," in combination with bundling into statistical data, is applied to the existing data.
All results serve as input for downstream planning and monitoring systems, and can be displayed on standard PCs and mobile devices.

The intelligent maintenance planning tool replaces costly, external maintenance experts and cuts companies' personnel expenses. IPN has already brought in a large, Austrian industrial company that wants to offer Big Data applications for Industry 4.0 as a purely Austrian package.



On the safe side with nanotechnology

Attophotonics has developed new types of nano-coating production technologies for a wide range of applications, from anti-counterfeiting to quality control, from the food industry to the pharmaceutical industry.

Project Title
Intelligent sensory nano-color pigments and films for anti-counterfeiting and quality control

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Forster Verkehrs- und Werbetechnik GmbH
MONDI

Period
2012 - 2015

Forgery of holograms and other security features on banknotes or security badges is on the increase. In collaboration with industrial partners, Attophotonics has developed new technologies for the fabrication of nano-coatings e.g. on intelligent nano-color glitter and films. These special materials with their characteristic bright metallic colors have unique forgery-proof features: angle-dependent colors more distinct than those on euro bills; 3D glitter effect; 'no-copy' surface. Sensory properties allow them to be used for temperature-insensitive time indicator labels.
In Austria and Germany alone, economic damage arising from faulty food storage amounts to approx. 20 billion euros/ year. Sensory nano-color materials may help to stem this problem in the near future.

From lab know-how to technical application

The researchers translated nanotechnology know-how hitherto only available in the lab into manufacturing technologies. Processes with limited productivity such as centrifugation or spin have been overcome while environmental sutainability was increased at the same time by eliminating toxic chemicals. In the course of the project, Attophotonics achieved a number of breakthroughs in intelligent nano-color pigments and films research: e.g. the development of an electrostatic glitter printer which allows integrating nano-color glitter in printed matter, and the setting up of a machine with which coatings with a thickness of one molecule may be applied with nano-grade precision onto 20-30 cm wide films.

Two major enterprises, Forster (traffic engineering and advertising, printing technology for specialized products like security badges and flexible electronics) and MONDI (packaging and fine paper industry) secured their competitive advantage by participating in Attophotonics' research. A globally active Austrian steel-making company profited from implementing one of the nano-coating machines developed by Attophotonics. Cooperations between Austrian R&D companies and industrial enterprises in spin-off projects made the development of new basic technologies for high-tech products with export potential possible.

Towards a smart user interface

Regardless whether home appliances, automotive parts or vending machines – it will soon be possible to operate the plastic products of the future via their smooth surfaces by means of integrated and multi-functional interfaces.

New surface technologies will change tomorrow's products. Imagine, for example, a three-dimensionally molded, interactive device surface equipped with electronic, optical and touch elements. Simply speaking, the aim of the innovation is to convert simple films without any special function into three-dimensional molded plastic devices (smart plastics) with back-light and touch-sensing buttons.

To date, the integration of all these functionalities in a single 3D molded device with arbitrary shape is by no means state-of-the-art. The project "3D-MEOD" explores new possibilities for both electrical and optical components on foils that are deformable and ductile. They can hence be integrated into three-dimensional injection molded parts. (See ill.)

3D-MEOD investigates the technological foundations by means of a production and simulation platform for the new materials and processes required to produce the "user interface of the future". The goal of this research is an innovative, seamless and interactive user interface designed without restrictions for a wide variety of applications; with transparent, malleable, functional components for electronics, sensors, and lighting that can also withstand the harsh conditions of the molding process.

Essential: Interdisciplinary Know-How

The complexity of the project goals require the expertise of numerous project partners with complementary skills and profound know how in e.g. simulation and manufacturing methods. The entire value chain is sufficiently covered by a consortium consisting of specialized, high-tech companies and academic partners.

Project Title
3D-Molded Electro Optical Device

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Niebling GmbH
plastic electronic GmbH
Polymer Competence Center Leoben
Schöfer
SCIO Holding
Siemens AG
technosert electronic GmbH

Period
2014 – 2015

A mini lab the size of a credit card

Diagnosing diseases quickly and easily: a magnetic biochip makes it possible. Because conventional diagnostics can be too slow for those affected.

Infectious diseases call for swift treatment in clinical routine. Sepsis, i.e. blood poisoning, is the second most common cause of death in Austria's intensive care units after heart disease. Approximately 7,500 patients die of sepsis every year. If treated with antibiotics in time, most of these blood poisoning deaths would be prevented. However, conventional sepsis diagnostic methods take at least 48 hours; even modern, molecular biology based tests require six to eight hours. In the case of acute sepsis, this is far too slow to be able to begin targeted therapy in time.

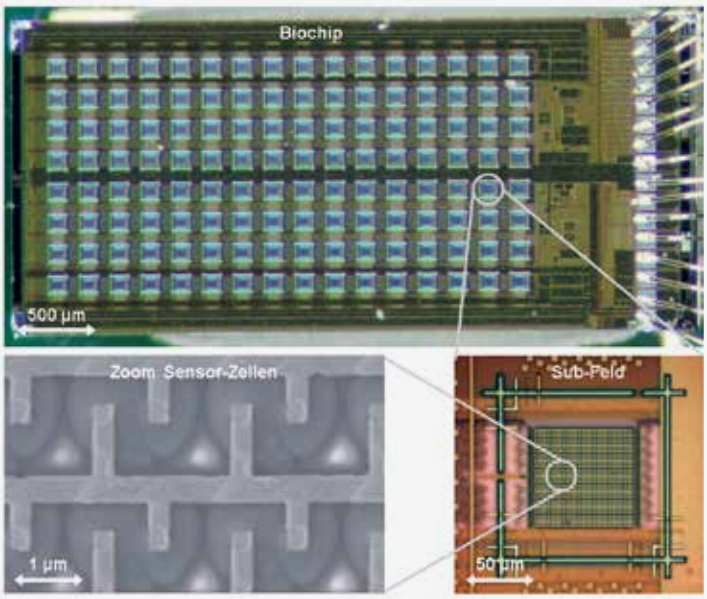
The MinoLab project has, therefore, set out to develop an easy-to-use diagnostic platform that delivers test results in under an hour, thereby making timely treatment possible.

Fully automated diagnostics

MinoLab combines a desktop device with a disposable plastic card. The card contains integrated fluidics and reagents designed to diagnose sepsis. The genetic proof of pathogens in the blood is delivered by so-called "beads" - magnetic, micrometer-sized particles. A magnet draws these beads to various reaction chambers on the card. If pathogens are found in the patient's blood, the beads bind to the pathogens. A magnetic biosensor chip on the card conducts the analysis.

The easy-to-use, affordable system is fully automatic, so that even non-medical people can operate it. From the time the sample is taken, it is targeted that only about an hour elapses until a result is obtained.

The project is a bi-national cooperation between German and Austrian partners, whereby the magnetic biosensor chip was developed in Austria. And sepsis diagnosis is only the beginning. Due to its modular design, MinoLab is also suitable for other diagnostic applications, for example to diagnose infectious diseases like Ebola, SARS, MRSA or HIV.



The magnetic biochip consists of 128 sub-fields, each of which contains 1,024 individual sensor cells. Thus, a total of more than 131,000 sensor cells are incorporated.

Project Title
Miniaturised Lab-on-a-chip system for the point-of-care analysis of infectious diseases

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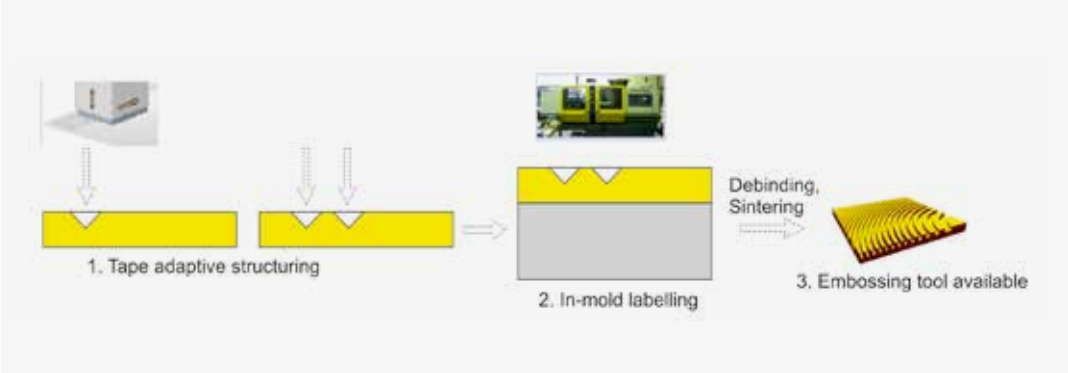
microfluidic ChipShop GmbH (D)
Danube Mobile Communications Engineering GmbH & Co KG (AT)

Period
2010 - 2013

The future of solar cells with improved light management

A new generation of solar cells and modules significantly increase efficiency. This is made possible by a technology developed to enable flexible, low-cost manufacturing of embossing tools for optimal surface structuring.



Manufacturing process for surface structuring suitable for solar cells and solar modules

To be competitive in the power market, the energy obtained from photovoltaic cells should currently only cost 0.5 euros/kWp. However, the price is actually many times higher. The aim of the project was therefore to increase the efficiency of photovoltaic cells and modules by optimizing their surface structure to minimize losses resulting from the shade created by the front metallization. The micro structuring allowed more light to be collected in the cell, thereby increasing its efficiency. At the same time, another objective was to reduce the cost of manufacturing the embossing tools needed to create this micro structure.

The result was a very promising, low-cost technology compared with conventional embossing tool manufacturing methods. A CEA research group developed a ceramic and polymer film, respectively, for the innovative embossing tools. The film was micro-structured step by step by different embossing tools until the desired surface is achieved. Finally, a powder injection molding technique from the French market leader in the field, Alliance-MIM, was applied. This concept is known as "in-mold labelling" technology. After debinding and sintering, the 3D embossing tool was used to structure the solar cells' surface. The research team at the TU Wien optimized the embossing tool numerically, besides developing a suitable patterning for the solar cell or the modules to improve overall light management.

0.1 percent increase sales significantly

The Austrian photovoltaic company Blue Chip Energy implemented the technology to improve the light management in the solar cell developed by the TU Wien. Efficiency increased due to the structuring of the thin layer over the metallization of the front side of the PV cells and a new micro structuring at the rear of the modules. With the help of the adaptive embossing at the front and at the back, even 0.1 % more efficient solar cells allowed the company to boost its sales by half a million euros per year at the time. Demand from the European market for this new generation of more efficient solar cells in conjunction with reducing production costs amounts to an estimated 15 million euros per year. The innovative technology can also be used to manufacture flexible embossing tools to produce surface structured precision parts, for example for the watchmaking industry.

Project Title
ADAptive embossing for surface structured solar CELLs and modules

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Blue Chip Energy (BCE), Austria

Period
2010-2013

Exhale – and detect diseases early on

Some diseases manifest themselves at a very early stage through changes in tidal air. A new method promises to pinpoint these gaseous substances.

The symptoms of COPD - chronic obstructive pulmonary disease – are coughing and difficulty breathing. It affects 10 percent of the adult population. At best, if diagnosed at an early stage, the onset can be prevented. Arteriosclerosis affects a third of the 45 - 75 age group. This disease accounts for 15 percent of deaths in Germany. These and other diseases, such as diabetes or kidney disease, have one thing in common: the onset – among other things – manifests itself through specific gaseous substances in tidal (exhaled) air.

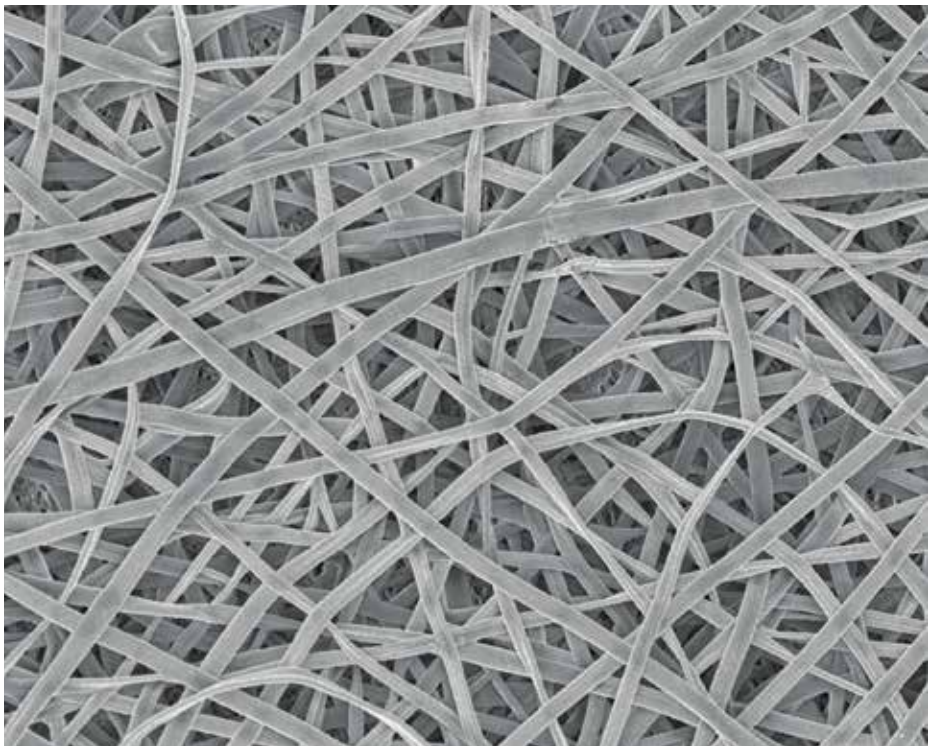
The aim of breathing gas analysis is to detect and analyze telling traces in tidal air. Unfortunately, tidal air only contains very low concentrations of some of these characteristic gases, making analysis extremely difficult. Normally, expensive, sophisticated analyzers are required. This is the very issue the APOSEMA project addresses.

High- Sensitivity Sensors for Gas Detection

Detecting different types of trace gas quickly and reliably by means of innovative measurement methods is the goal the Austrian and German APOSEMA project partners have set for themselves. The result is a new type of high-sensitivity sensor system that combines fluorescent and infrared detection for gas analysis in a single device. The product is based on nano-hybrid materials and photonic laser elements.

This device is designed to easily and consistently perform real time analysis of gases in tidal air known to be COPD and AC markers: oxygen (O2), carbon dioxide (CO2), nitrogen monoxide (NO) and the VOCs (volatile organic components) ethane, pentane, isoprene and carbon disulfide. Besides preventing and curing diseases, the innovation can also applied in sequential therapy.

However, the new sensors are not only restricted to applications for the medical sector. A number of other industrial processes need and stand to benefit from fast and sensitive sensor solutions: process control, process optimization, R&D. Environmental analysis also profits from the fast and efficient analysis method to monitor air quality.



Nanofibres for oxygen detection and analyte enrichment

Project Title
Advanced Photonic Sensor Materials

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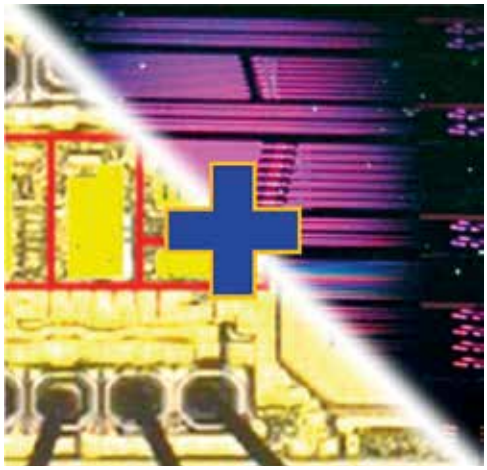
Joanneum Research Forschungsgesellschaft mbH, Austria
TecSense GmbH, Austria

Period
2014 - 2017

A new generation of chips in 3D

A chip that combines the best of two worlds: intelligent electronics meets fast photonics. The one-chip solutions developed by PHELICITI are scalable and can be produced cost effectively.



Conventional microelectric circuits have significantly improved over the past few decades. Today, 100 million transistors can be housed on a single microprocessor the size of a finger nail - affordable for everyone thanks to silicon chip technology. However, with information increasing at such a rapid pace, conventional electronics is already facing its limits. The solution to stay in the race for pace is photonics, a key enabling technology. It enables transporting massive capacities of ~100 Tb/s via fiber glass as thin as a strand of human hair, whether it's between the processor cores in a supercomputer or between continents. This equates to an increase by a factor of 10,000 compared with conventional electronic data links!

High performance on small footprint

Linking intelligent electronics and fast photonics poses a big challenge, which can be translated into a simple question: How to realize this optical transmission in an economically viable way? The PHELICITI project has found a path to cost-efficient and scalable production of this new generation of integrated chip technology.

High-frequency microelectronics and silicon-based photonics can be integrated on top of each other by means of wafer stacking, i.e. three dimensionally, on a single chip. Moreover, vertical high-frequency connections between the layers allow for a bandwidth in the range of 10 GHz and beyond. The result: fully fledged high-performance optoelectronic solutions that minimize the chip real-estate thanks to 3D stacking.

Another aim of the project is to establish a components library at photonic and electronic level. The technologic toolkit is designed to converge optoelectronic high-performance components. Thus, for example, a chip can be produced containing several transceiver units for telecommunications applications with high aggregated per-user data rates of up to 80 Gbit/s. All elements are compatible with CMOS semiconductor manufacturing processes, meaning that high yield, silicon-based production can be used as it is also applied for microelectronics in the consumer sector. Other areas of application in the fields of sensor technology and life sciences are already in the pipeline.

Project Title
Synergetic convergence of photonics and electronics through efficient 3D chip integration

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Period
2013 - 2016

UV light opens door to artificial tendons

With the aid of UV light, it was possible to significantly improve the cell compatibility of polymer films as support material for cell cultures. A model to grow artificial tendons for reconstructive medicine was created for the first time.

Reconstructive medicine is already able to create artificial body tissue by means of tissue engineering. To control the growth of the tissue cells, medicine uses so-called cell stretchers. The cells are seeded onto polymer films, which serve as the substrate for the cell cultures that undergo mechanical resilience testing in the cell stretcher. Formerly, the obstacle encountered in this procedure was the polymer films' limited cell compatibility.

This is the issue the industrial research project Cellstretch - a cooperation with university and ambitious, small companies - addresses. With the aid of ultraviolet irradiation, the researchers succeeded in making the surface of ductile polymer films biocompatible, so that they may be used as substrates during mechanical stimulation of the cells in a cell stretcher. The films were irradiated in a reactive atmosphere using a Xe2* Excimer lamp in deep UV light, changing the chemical composition of the surface and making the films particularly hydrophilic (water-receptive). Thus, the polymer films' cell compatibility was significantly improved.

Incubator for artificial tendons

As "proof of principle," CellStretch developed an artificial tendon model. This project was also successful. The cell stretcher was modified in such a way that it can also be operated in a cell incubator. This makes oscillating stretching over several days possible, and cells extracted in skin biopsies can be aligned on the polymer surface and stimulated to produce collagen fibers such as those found in tendons. Therefore CellStretch has succeeded in establishing, for the first time, a model to grow artificial tendons for reconstructive medicine.

Moreover, the project achieved a record in that the resulting cell stretcher can be operated for several days or even weeks in a cell incubator, so that the cells can be stimulated mechanically much longer than in the past.

Project Title
Bio-Functionalization of ductile polymer films for mechanical cell stimulation

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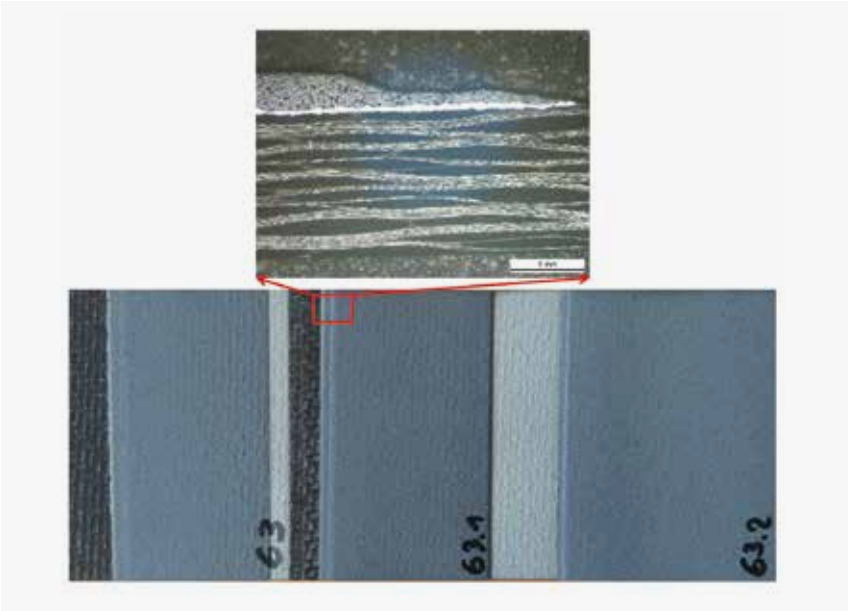
Period
2013 - 2014

Operating the cell stretcher in the incubator

Out with metal, in with CFC

The automotive and aircraft industry need materials that remain stable even at 600 degrees. An innovative CFC composite provides the solution and a replacement for metal.



Below: Coated CFC plate with thermal barrier layers of various thickness;
Above: Microscopic image of a polished cross section through the plate with undulated carbon fibers in polymer matrix in the lower and middle area, white and light gray barrier layers above.
On top and at bottom embedding material.

Project Title
Development of cost-effective CFC composites with thermal barriers and reflective layers

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BVT Beschichtungs- und Verschleißtechnik Gesellschaft m.b.H. (BVT)
Materials Center Leoben Forschung GmbH (MCL)

Period
2013 - 2015

The lightweight construction sector has a particularly large demand for temperature-resistant materials for high-output manufacturing. Reason enough to develop a cost-efficient, carbon fiber composite (CFC) featuring thermal barrier layers and reflective layers.

In materials exposed to extremely high temperatures, the binding matrix (the resin between the carbon fibers) degrades, weakening the composite as a result. Therefore the first production step was dedicated to modifying the resin system. Temperature-resistant, cost-efficient resin and new fiber tissue were deployed. This was followed by applying thermally functional barrier layers containing aluminum, titanium and zirconium oxide by means of a material-protecting technique never before used on polymeres, namely plasma injection. In the last step, an oxidation-resistant, infrared reflective layer was applied using physical vapor deposition. To achieve the necessary thermal shock resistance, the thermal expansion coefficient of the carbon fiber composite was aligned with that of the thermal barrier coating (TBC). Modern, state-of-the-art analytical methods combined with the scientific know-how of JOANNEUM RESEARCH and Material Center Leoben were responsible for the innovative material design featuring optimal layering with special mechanical and thermal characteristics.

CFC – the Material of the Future

Replacing metallic parts with CFC makes it possible to reduce the number and complexity of the components needed for lightweight construction, and benefits manufacturers and end users alike. The three-stage, hybrid production technique is particularly cost-effective because each stage - depending on the temperature resistance of the manufactured components - can be carried out singly or in combination. The temperature-resistant CFC composite can be deployed in the automotive industry, aircraft industry, the green power market and used for wear and corrosion protection. Secar Technologie forecasts an annual growth of between 20-30 percent by 2021.

Sophisticated plasma coating

Tubular, not planar: Tubular targets make the production of ultra-thin coatings more efficient, more cost effective, and kinder to the environment.

This research project is focused on developing a new production technology for innovative, low-defect and low-porosity tubular sputtering targets. Targets are the source material from which thin hard-coatings or sensor layers are created by deposition on substrates. Such targets are utilized in optical applications or in solar technology. The method implemented is a type of physical vapor deposition (PVD) - a vacuum-based coating technology - called sputtering.

An argon plasma is used to eject atoms from the target surface and these atoms are deposited on a substrate where they form the desired layer. The problem is that conventional planar targets are prone to form a so-called "racetrack" erosion zone in the target material. Tubular targets display a homogeneous erosion, thereby improving material utilization.

To reach the project goal, the researchers are developing a more efficient and more material-saving target manufacturing process in combination with a suitable plasma coating technique. Tubular targets are made from strategically important high value materials such as tantalum oxide or hafnium oxide which are fabricated using a rapid hot pressing process - a technique that is the backbone of the innovation: fast, cost-effective, and applicable in the production of a wide range of materials.

Project Title
High performance, material-efficient PVD coatings from innovative tubular targets

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RHP-Technology GmbH & Co. KG (RHP)

Period
2013 - 2016

More efficient raw materials utilization

The resulting tubular target is tested in a vacuum-coating pilot plant to measure the deposition rate and material consumption. The research team thereby seeks to discover ways to improve production of high-grade thin layers. Even the slightest improvement would result in cost savings and up to 80 percent efficient utilization of the elaborately extracted raw materials. At the same time, the energy balance is improved during production, which becomes not only faster but also cheaper.

Photos: RHB

Smart tubes are looking round the corner

Leak-proof, flexible, cheap and light: a new industrial manufacturing technique makes it possible to produce 3D fiber composite tubes for cars, cables and suspension.

Not an ounce too much: Weight reduction is becoming more and more important both on the road and in the air. At the same time, structural components and cables for the automotive engineering and aviation industries are subject to more exacting requirements. They have to reduce fuel consumption, ensure safe maneuvering and reliable performance.

A Tyrolean family-run business, Thöni, has been manufacturing hoses used by fire brigades and industry since 1970. Supported by the "Intelligent Production" funding initiative, the aim is to build a partly automated prototype for flexible serial production of sophisticated, fiber composite tubes for the lightweight construction industry.

In any shape or form, significantly lighter

To tackle the technological leap to efficient production of high-quality, sophisticated 3D tubes made from fiber-reinforced plastic, the traditional company enlisted the aid of competent partners. The Department of Polymer Engineering and Science with the Chair of Processing of Composites at the Montanuniversitaet Leoben bundles years of experience in exploring new applications, developing composites for specialized applications, and optimizing processes. The second partner is superTEX composites GmbH, a spin-off founded in 2011 by the University of Innsbruck. This was the birthplace of the splineTEX® process, which has since received a number of awards been patented several times. Seamless, carbon fiber-reinforced plastic tubes - also called CFRP or carbon tubes - are produced using liquid impregnation technology. Hardened hollow profiles of any shape can be formed from a flexible, semi-finished tube for pipes, structural components and springs. And although the same size, up to 40 percent lighter than steel components.

Until now, complicated metal molds and costly finishing processes were necessary for sophisticated 3D fiber composite structures. splineTEX fiber composite tubes with optical viewing are specifically designed for structural components used in automotive engineering, for example car body components, wishbone suspensions, lightweight conduit systems and fiber-reinforced springs.

Project Title
Automated production of 3D fiber-reinforced composite tubes

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Period
2013 - 2015

A thin strand

A new manufacturing method based on belt-casting technology aims to meet the demand for more sophisticated slide bearings made from aluminum composites.

Project Title
Highly Innovative Production of Efficient Radial BEARings

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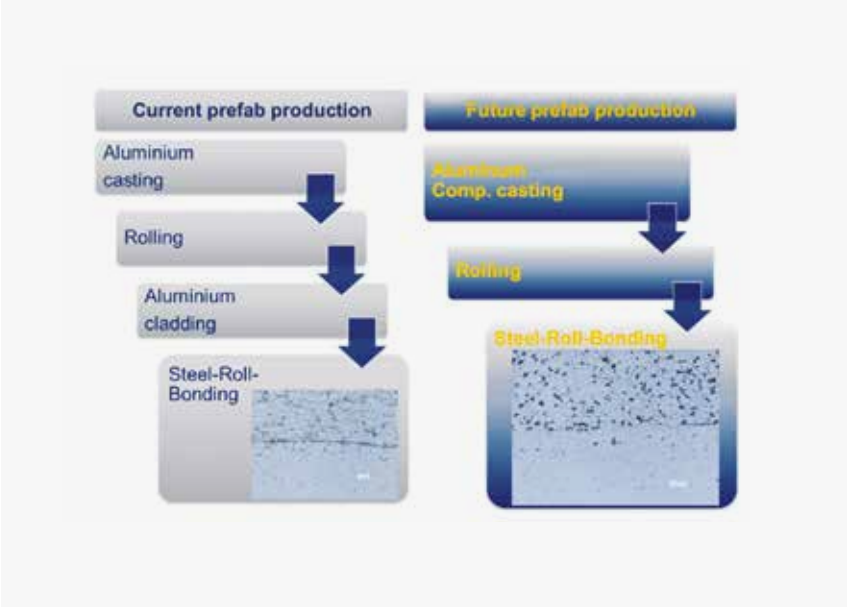
Leichtmetallkompetenzzentrum Ranshofen GmbH (LKR)
Chair for Forming Technology and Foundry Science (utg) TU Munich

Period
2013 - 2016

The demands put on slide bearings made from aluminum composites are growing. The materials and processes currently used in their production are stretched to their limits. The project HIPERBEAR 2.0 therefore seeks alternative material composites in addition to an innovative manufacturing route for aluminum-based materials used in slide bearing production.

The aim is to design a thin-strand composite casting process based on belt casting technology. First, the researchers developed different alloy combinations in experimental and numerical trials, after which the composite casting process was simulated and the plant technology set up. In the next step, prototypes of the slide bearings made from the new primary materials will be produced and tested.



No Liquefaction

On an industrial scale, currently only one composite casting method to produce composite casting blocks made from aluminum alloys is in use. However, this technique, developed by Novelis, requires hot rolling, which is not suited for making bearing alloys. The soft phase materials such as tin, bismuth or indium have a low melting point and would liquefy in the hot rolling process.

The new manufacturing route will, if the project proceeds successfully, result in considerable technological and economic advantages. For example, the new slide bearing types will have excellent new features, the process chain will become leaner and material will be employed more efficiently. Productivity will be boosted substantially. The innovative thin belt composite casting technique will be ideal for producing primary material for slide bearings due to the flexible casting formats, the castability of the heterogeneous materials and the combinability of contrastive alloys.

With the implementation of the technology, Miba Gleitlager Austria GmbH not only aims to make a name for the company, but to secure its long-term competitiveness whilst increasing its market share in aluminum-based slide bearings.

Photos: Miba Gleitlager GmbH, 2015

Environmentally friendly high-tech metal processing

The West still has a lot to learn about processing rare earth elements. New methods set out to remedy this - and save resources, too.

The so-called "rare earth" elements (REE) are vital to many high tech applications. The REE are a group of 17, chemically closely related elements with unique magnetic, optical, electrical and chemical properties. China dominates the REE world market from mining to metal production and is bent on monopolizing the entire value creation chain.

China curbed the export of REE drastically between 2010 and 2013, leading to a sharp rise in prices. The West has been able to counteract this to some extent with mines in the USA and Australia, at least improving the supply of so-called light rare earth elements. More difficult is securing the supply of heavy rare earth elements, specifically and above all yttrium, dysprosium, terbium and scandium. Even though an increasing number of alternative sources of these raw materials have been identified, such as recovery from recycling and new deposits, the extraction and separation expertise required to harvest these elements is lacking outside of China and with it, the ability to obtain high purity oxides for metal making and functional materials manufacturing.

Extracting REE from recycling material and new deposits

The Rerex project aims to tackle this problem, and not only with respect to the expertise required to extract recycled raw materials and explore new deposits. The new methods promise to save resources at the same time. First, the researchers developed different digestion and separation techniques to obtain REE in a soluble state; however, as a poly-metallic mixture. Unfortunately, because they are chemically similar, heavy rare earths are difficult to separate, making it difficult to extract high purity products. By means of specific modifications to the extraction processes, a completely new processing technology was developed compared with the current state of technology. Thus, REE compounds can easily be solubilized and separated while at the same time reducing byproducts and emissions.

Project Title
Recycling and extracting rare earth elements

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Other Consortium Partners
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Period
2012 - 2015

Photos: REREX TIAG

New source of rare metals

Raw materials such as zinc and indium are in greater demand by the high-tech industry than ever before. By means of leaching, metals can be recovered from mining residue.

Critical raw materials such as zinc, indium and gallium are vital to securing Europe's competitive advantage. They are needed by high-tech industry and this need is growing; however, their extraction is expensive. In tailings, i.e. the fine-grained mining residue in sludge after processing ores, zinc & co. remain partly unexploited. The usual extraction methods are cost-intensive; in the case of zinc, a combination of pyro-metallurgic and hydro-metallurgic techniques are required.

An extremely promising new way allows zinc, indium and gallium to be recovered from the tailings by means of bioleaching. The project investigated an optimized possibility to extract metals with bio-leaching. But first, several preparation steps were necessary to avoid damage to bacterial cultures.

Recovering method in lab scale

Among other things, bacterial cultures best suited for leaching had to be determined; ideal parameters such as pH-value and temperature defined; and ways sought to remove barren rock and interfering elements. Furthermore, it was examined how valuable metals could be enriched prior to leaching, because smaller amounts of material reduce costs. The savings are achieved by using fewer consumables and correctly dimensioned equipment. The challenge was the interplay of various disciplines such as mineral beneficiation, metallurgy, chemistry, biology and plant engineering.

In the end, a recovering process to extract metal from tailings was successfully developed in lab scale. Based on the results to date, a plant design will be set up as a basis for assessing the cost effectiveness of the researched processes. With this project, Austria firmly establishes itself as an expert in the field of extracting critical metals, increases its competitiveness and contributes to sustainability and environmental protection by recovering raw materials.

Project Title
Recovering zinc, indium and gallium from zinc tailings by means of bacterial leaching

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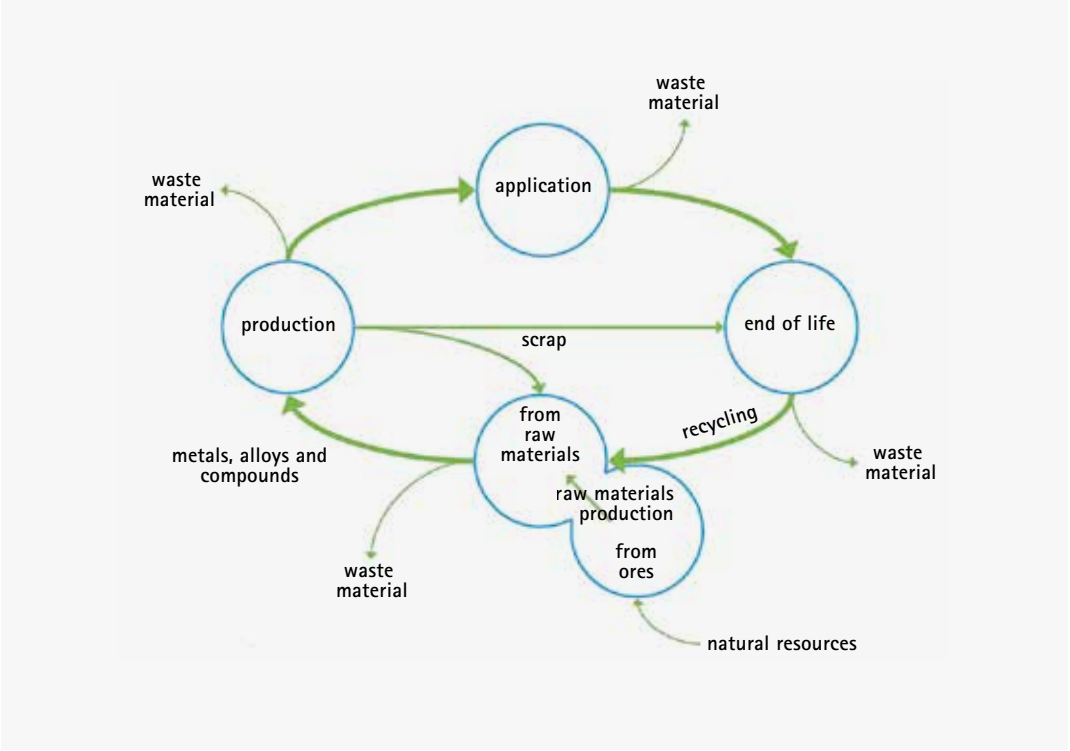
SPIEGLtec GmbH

Period
2013 - 2015

Precious raw materials

A new method recovers precious materials such as niobium or tantalum for high-tech applications. This reduces Austria's dependency on raw materials.



The Plansee Group produces metal powder, semi-finished products, ready-to-use components and tools made from thermally, mechanically, and chemically robust, high-tech materials for a variety of industries. Besides molybdenum and tungsten, the company also processes tantalum, niobium and rhenium, materials hard to replace in consumer electronics, medical and energy engineering or aviation.

Like new, thanks to thermal processing

The R²RM project targets recovering valuable substances that occur as a by-product of manufacturing. To recycle molybdenum-tantalum - used as a coating material for the electronic display industry - the project partners have opted for thermal processing. Under specific pressure and temperature conditions, molybdenum changes to a gaseous state that can be recovered as a molybdenum oxide and then refined into pure molybdenum powder. In the same way, tantalum oxide is refined into tantalum power. Both can subsequently be used like new.

Closed loop recycling such as this helps countries with limited natural resources, like Austria, become more independent; it also helps offset price fluctuations in the commodities market and secure supply for key customers in high-tech industries. In a next step, further successful process innovations could form the basis for efficiently recycling end-of-life products.

Project Title
Recycling and recovery of refractory metals

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Other Consortium Partners
Montanuniversitaet Leoben – Chair for Non-Ferrous Metallurgy

Period
2013 - 2015

Microalgae – the fuel of the future

In future, bio-fuels generated from microalgae could become feasible. Production and processing can take place in existing infrastructures such as refineries.

Microalgae under the microscope

The fuel industry is seeking alternative fuels with a smaller CO_2 footprint and positive life cycle assessment. Today's biofuels, however, compete with food production. The NeCruPro project examines whether oil-rich microalgae can substitute crude oil in industrial scales.

With the aid of light, CO_2 and nutrients, these organisms produce lipids that could serve as the basic raw material for biofuels. The issue of algae production was also addressed. This could be implemented at energy-intensive industrial locations such as power plants or cement works, whose flue gas, CO_2, wastewater and waste heat sources could be utilized. The biomass could be pre-treated and the oil and/or waste biomass processed in a conventional refinery.

Bridging the gap to primary industry

Laboratory testing and calculations have revealed that there is an existing potential in Austria for mircoalgal bio-fuels. Above all, the use of existing infrastructure, waste heat utilisation and appropriate biomass separation techniques are crucial points for feasible industrial production. A combination of mechanical enrichment and drying with waste heat appears the most reasonable; the dry biomass would be easy to store and to ship. At the refinery, the material would have to be processed by means of extraction. Another possibility would be hydrothermal liquefaction, which would render drying unnecessary.

The options regarding the integration of renewable raw materials into primary industry are as yet limited. The project attempted to bridge the gap and investigated to what extent existing facilities, refineries and logistics systems could be utilized for the production and processing of algae biomass.

Although the prevailing opinion is that large-scale production of crude substitute made from microalgae will only become profitable in ten to twenty years at the earliest, implementation paths are already being examined. If research continues to be promoted, Austria will be able to expand its pioneering position in environmental protection and set an example to other countries by implementing renewable biomass production chains in primary industry.

Project Title
"Next Generation Crude Production" - Industrial Biomass Production with Microalgae

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University of Life Sciences, Vienna – Institute of Environmental Biotechnology
Energy Institute at the Johannes Kepler University Linz

Period
2013 - 2014

Photos: www.ecoduna.com

Utilizing residues from biogas plants for a good cause

A new project aims to exploit synergies between biogas and cement production. This would make biogas production cheaper and at the same time recycle digested sludge.

The main goal of the project is to explore the potential synergies between industrial biogas and cement production. An efficient plant network such as this would close material and energy cycles and, unlike mainstream processes, enable cheaper biogas production. It could also make biogas production independent of state funding.

In Austria, approximately 70 percent of cement production is already fueled by secondary energy resources such as plastic waste, biogenic substitute fuels, old tires, or solvents. Biogas produced from organic waste material would lend itself as a new, CO_2-neutral fuel.

An alternative method for recycling of digestate

The ReNOx project is investigating possibilities to network biogas and cement plants at the same site based on a feasibility study. At the same time, it aims to develop a novel processing technique to recycle ammonia from biogas digestate and residues from municipal wastewater treatment plants. This treatment system, called "Ion-exchanger loop stripping", is used to recapture surplus ammonia from digestate and sludge liquor for industrial NOx-removal from flue gas. At the same time, clean water is produced that can, in turn, be re-used in the biogas plant without ammonia inhibition or nitrogen reversal.

Obtaining a product (an agent to remove NOx) from organic residues is an innovative approach indeed. Operators of biogas and wastewater treatment plants could stand to benefit from a marketable product (denitrification agent) by recycling their own digested sludge. This alternative way of recycling ammonia from digestates in a non-agricultural context would, in addition, avoid the necessity of storing huge quantities of the material over the winter months.

Agriculture, in turn, is often characterized by over fertilization, ammonia and greenhouse gas emissions, and subsequently, groundwater contaminated with nitrates as a result of spreading digested sludge over the fields. Now, with the possibility of industrially utilizing surplus ammonia the whole year round, agricultural materials flows could be combined with those of industry to mutual advantage.

Project Title
"ReNOx" - Industrial utilisation of biogas and digestate

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Project Coordinator
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Christof International Management GmbH
Lithos Industrial Minerals GmbH
Sanitary district Knittelfeld and environs
University of Natural Resources and Life Sciences Vienna - Institute of Environmental Biotechnology
Energy Institute, Johannes Kepler University Linz

Period
2014 - 2017

Biogas plant

Photos: Cowatec AG

We need know-how, networks and IT security

Many of Austria's medium-sized businesses have great innovative capacity. However, to implement Industry 4.0, research and development in areas such as process development, IT infrastructure and security are necessary, says Hartmut Hoffmann in an interview.

Where do you consider the strengths in Austrian production research lie?
In my opinion, the industrial landscape and business research activities are very impressive in Austria. I see a lot of innovative companies here. This puts Austria on par with, for example, Switzerland and Germany. There are very many "hidden champions" in Austria, that is, companies not particularly well known and yet world leaders in their fields. These are about 150 medium-sized companies, most of them involved in production technology. This is where I see Austria is very strong, with an industry structure largely insensitive to economic changes. It's not the big companies that make a country so strong, because the big players are sensitive. It's more the small and medium-sized ones. Often these are companies with a turnover of only 50 to 100 million per year. Establishing Industry 4.0 is a great challenge that can't be paid for with companies' petty cash. One goal of the Production of the Future is to set up self-optimizing production processes for networked production, thereby securing global competitiveness. This of course requires an amazing amount of innovative capacity. But I have every confidence in the Austrian medium-sized businesses.

What sectors of Austrian industry do you consider pioneers in the production of the future?
At least 50 percent of these innovative companies are involved in production technology. These are companies from many different sectors: tooling, mechanical engineering, measurement technology, sports equipment manufacturing, automotive industry and their suppliers, plastic components, cable car systems, lighting technology, as well as the steel industry and power station engineering. These companies are already strong in the product innovation area but the challenge Industry 4.0 poses now is to continue accelerating process innovation and to connect production with IT.

What roles do Austrian universities and research facilities play in developing the production of the future?
For example, the Technical Universities in Vienna and Graz, the Montanuniversitaet in Leoben, the Universities of Applied Science not to mention the many non-university research institutes play a very essential role. The Kepler University in Linz or the University Innsbruck also demonstrate vast production expertise. Often, of course, it is individuals with their institutes that are especially outstanding. But with the new format of endowed chairs in the "Production of the Future", entirely new conditions have been created to stock up on human resources for Industry 4.0 at the universities. The fact that companies

are participating in funding these measures shows what a high standing industry has in Austria. These are good preconditions for a successful 4.0.

When production, suppliers and customers are linked on the internet, security risks increase. To what extent must production research take the issue of IT security into account?

You have to make very sure you stay a step ahead of the hackers, but this doesn't only apply to Austria. But I think awareness of this issue is slowly growing. The man-machine dialog that takes place in automated production has to be protected with new security concepts that immediately sound the alarm so that machines and tools are not destroyed or the information tapped.

This is where TÜV also plays an important role. Companies and research institutes have to develop concepts and software tools to prevent data theft and to ensure security. Systems have to be developed to guard against such attacks. Big companies with a large number of engineers and IT specialists on their payrolls can probably cope with this, but it is much more difficult for medium-sized companies. These are companies that, although they may be world leaders in their fields, only have about 100 employees. Here, the government should be prepared to step in and support them with IT security research and the necessary implementation.

For which infrastructures – e.g. broadband – must Austria take measures to ensure that innovation in the field of production happens quickly?

These super companies, the innovative heartbeat of countries such as Austria, are usually located in rural areas. The government must assist them with establishing ultrafast networks to keep up with the research and development carried out by companies located near or in the cities. Ministries, maybe even foundations, have to be called in to help. Product innovation, production processes, service, logistics are all areas that cannot function without a fast IT network.

Are changes necessary in the education provided by universities and vocational schools to prepare employees for Industry 4.0?

Changing education is a great challenge. One would really have to start in grade school and encourage young people to focus more on the MINT subjects, that is, mathematics, IT, natural (physical) science and technology, to equip themselves with the structured, analytical thinking they will need for Industry 4.0.

Likewise, IT and communication technology must be included in the vocational school curriculum, because what the factory of the future needs, simply speaking, is different jobs. These require interdisciplinary education and continuing professional development without which Austria, Switzerland and Germany cannot survive as industrial and business locations. Low wage countries like India, China and Taiwan are catching up. But what do we do with those who don't make it? We don't need so many people to sweep the factory floors, and this will probably be done by robots eventually anyway. The topic is a double edged sword. To preserve our standard of living we have to make sure innovation stays at the forefront. And innovation means that everyone must be given the opportunity, to the best of their abilities, to be involved in Industry 4.0. Some good approaches are already in place in Austria, for example the learning and innovation factories where learners are shown practical examples of how they can prepare for the challenges of the future.

INTERVIEW: SONJA BETTEL

Hartmut Hoffmann

was Professor of the Chair of Molding and Casting Technology and Head of the Institute for Materials and Processing at the Technical University Munich (TUM). He is an appraiser for a number of German ministries and societies, among them the German Research Society DFG, where he was a member of the expert council. Hoffmann is also in high demand internationally as an expert and appraiser. He has been supporting the bmvit project "Production of the Future" with regard to strategy and content since 2011.

Photos: Astrid Eckert & Andreas Heddergott/TU München

Statements to the program

Paul Hartmann

Dr. Paul Hartmann,
Director
JOANNEUM RESEARCH -
MATERIALS

"Austrian manufacturing research, supported by "Production of the Future", addresses important international trends such as generative manufacturing or smart sensors, thereby positioning itself advantageously to take on the global challenges of our times. The strength of Austria's R&D landscape in applied research is particularly well emphasized."

Gottfried Strasser

Prof. Dr. Gottfried
Strasser
Head of the Centre
For Micro and Nano
Structures
At the Technical
University Vienna

"In my opinion the chief strength of BMVIT's "Production of the Future" is that product ideas are implemented in close collaboration with Austria's internationally active academic landscape and the Austrian industry, thereby securing a competitive advantage for all involved."

Hans Kurt Tönshoff

Prof. Dr. Hans Kurt
Tönshoff,
Leibniz University
Hannover

"With the program "Production of the Future", BMVIT and FFG succeed in encouraging small and medium-sized Austrian enterprises to work together with universities and research institutes, thus making them fit for a cooperation in the European framework. Research promotion is the essential leverage effect in global competition."

Martha Mühlburger

Dr. Martha Mühlburger, Vice Rector of the Montanuniversitaet Leoben

"The BMVIT program "Production of the Future" makes it possible to create and establish new research fields in the cooperation science and business to invigorate industrial manufacturing in Austria. The new key project Generative Manufacturing reinforces Austria's position as a leading global competitor in innovative materials and manufacturing processes."

Christian Brecher

Prof. Dr. Christian Brecher, Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University

"Manufacturing is our economies' backbone and an employment driver. The national BMVIT program "Production of the Future" excellently promotes cooperation between the predominantly medium-sized manufacturing industry and research institutes to create new products and innovations that companies can put into practice in the long term."

Wolfgang Eickhoff

Dr. Wolfgang Eickhoff, CEO Manufuture-AT

"With its consistently practiced 'bottom-up' approach, the RTI initiative "Production of the Future" significantly contributes to research funding being employed where industry needs it most. This ensures that the funds are invested efficiently and accelerates the time period between innovation and the product market launch."

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