botenstoff

SPECIAL

Smart Materials

human.
technology.
styria.

Interview with Paul Hartmann

When materials think for themselves – how smart materials are changing medicine

Implants that are designed to adapt to changing bodily conditions. Wound dressings that are designed to identify when the healing process is stalling. Sensory textiles that directly record health values. The concept that has long been a staple of science fiction is now a reality in many areas of medicine, thanks to the development of "smart materials." These intelligent materials are created at the intersection of materials science, micro- and nanotechnology, surface technology, photonics, and electronics.

This development is particularly in Styria dynamic: MATERIALS Institute at JOANNEUM RESEARCH has the key word already in its name and is one of the leading institutions in Europe when it comes to pioneering production processes, functional surfaces and sustainable material solutions.

In this interview, Univ.-Prof. Dr. Paul Hartmann explains what makes smart materials so special, what role high technologies play in this - and why we are only at the beginning of a medical revolution.

Mr. Hartmann, could you please give us your professional definition of "smart materials", particularly in the context of medicine?

Smart materials provide certain functionalities that go beyond their genuine materials properties. Such functionalities are, for example, sensing of vital parameters or the support of healing processes. The materials are combined in a smart way or used for applications that are not possible otherwise.

What role do technologies such as micro- and nanotechnologies or functional surfaces play in this context?

Miniaturisation of more complex devices is key for application in life science. This requires micro- and nanotechnologies to build the device or to provide functional surfaces that are in contact with human tissue. Functionality in this context may be bio- or hemocompatibility, bacteriocidic activities or providing a substrate for cell growth.

Can you give us examples of where smart materials are already being used in the healthcare sector - for example in the field of implants, wound care or wearables?

It is known, that favourable wound healing is characterised by characteristic pH values. We have developed medical swaps with special immobilized pH indicators (similar to the Lacmus paper known from chemistry labs), which can be used to assess the wound healing process.

Bone implants can be coated by thin films of silver and magnesium in a way that the antimicrobial activity of Ag and the bioresorbable properties of Mg are optimized to achieve a better biocompatibility of implants.

Wearables using innovative and highly sensitive piezosensors can monitor heart rate and even resolve the time sequence of blood-pressure signals. The list can be extended.

How important is the combination of materials research with production and surface technologies for the development of smart materials?

Smart materials for surface applications have to be designed for reasonably cheap production processes (like, e.g., inkjet printing or thin film coating). In medical applications, also regulatory aspects play a crucial role. Therefore, producability of technological solutions needs to be considered from the very beginning. This is why our institute covers also manufacturing technologies.

To what extent do concepts such as "green electronics" or "green photonics" contribute to the sustainability of intelligent health solutions?

The attribute "green" is of course also related to sustainability per se. The concepts cover materials and processes that are more environmentally friendly than classical approaches and can provide a significantly reduced carbon footprint. Silicon-based electronics, for example, requires very high primary energy and begins to be replaced in first niche applications by more sustainable printed and organic electronics. Photonics over all has a high potential to reduce energy consumption for production processes, or for sensing and data transfer, similar to the glass fiber cables delivering the internet cost- and energy-efficiently to our houses.

> "Miniaturisation of more complex devices is key for application in life science."
>
> **Paul Hartmann**

What role does MATERIALS Institute at JOANNEUM RESEARCH play in the development and implementation of these technologies?

In green electronics we try to develop functional materials and processes that can be additively printed to environmentally friendly substrates, such as paper or cardboard, which can replace classical circuit board technology in some applications. Using our Roll-to-roll-UV-Imprinting technology we have demonstrated environmentally friendly lab-on-a-chip devices or diagnostic test strips on thin foils with a dramatically reduced weight of the waste compared to classical injection molded test strips. Our role is to do R&D, feasibility studies, demonstrators and prototypes for company partners who are then able to take up the result and develop innovative products.

How can research results from the laboratories be translated into marketable products - keyword technology transfer?

Our approach is to include the company partners in R&D projects already in an early stage, and to assess the requirements from the market systematically. Still, especially in medical applications the path to marketable products is very long. In product development, regulatory requirements have to be considered from the very beginning, and here we are also integrating the expertise of our company partners, who have to take the lead in product development projects. This close cooperation is also helpful at the end for technology transfer.

What are the most significant challenges you currently anticipate in the fields of research and development? Do you foresee obstacles stemming from technology, regulation, or society?

The answer is: Lack of money, a risk-avoiding attitude, and too much administrative burden (even in less regulated environments). Technological obstacles can usually be solved by providing enough money and resources. The problem is that many challenges related to climate change or even to general health issues require immediate investments in R&D and technology development, while the benefits will come only after many years. The risks of such a long-term pay-back process is usually not taken by companies, and even not by governments who frequently think in election periods.

If we look to the future: What is your vision for the use of intelligent materials in medicine over the next 10 to 20 years?

Smart or intelligent materials have always been a companion of medicine, starting with the long history of pharmaceutical technologies up to the recent success of mRNA-based vaccines or personalized cancer treatment. While new materials and solutions will gradually enter the medical markets and become accessible also to the “average patient”, I see the role of research institutions like us in expanding the horizon of new approaches by leveraging the cooperation of first-class institutions and industry for the benefit of mankind and the environment. This motivates me again and again, every day.

> “I see the role of research institutions like us in expanding the horizon of new approaches by leveraging the cooperation of first-class institutions and industry for the benefit of mankind and the environment.“
>
> **Paul Hartmann**

JOANNEUM RESEARCH

More Than Coverage: Smart and Functional Wound Dressings

Chronic wounds and burns present major challenges in medical care. Chronic wounds often delay in the healing process due to underlying conditions like poor circulation, diabetes, or infection. They require long-term, multidisciplinary treatment and are prone to complications such as biofilm formation and antibiotic resistance. Burns, on the other hand, range from superficial to full-thickness injuries, causing severe tissue damage, fluid loss, and a high infection risk. Both wound types demand personalized therapies, advanced dressings, and consistent monitoring.

Modern wound care goes beyond simple coverage. Key trends include dressings with antibacterial, pro-healing, and diagnostic properties – supporting not only protection but also active healing and real-time assessment.

Recognizing these needs, COREMED, together with partners such as the EVOMEDIS company, the Medical University of Graz, and the JOANNEUM RESEARCH institutes MATERIALS and HEALTH, is actively involved in advancing wound dressing technologies. Research efforts focus on integrating functionalities like infection control, healing support, and smart monitoring into next-generation materials. On one side the functionalization of a commercially available bacterial nanocellulose- (BNC-) dressing with pH-sensing properties allowing for real-time wound monitoring was investigated. As pH changes are a key indicator of wound status, this innovation enables early detection of complications. In a feasibility study, a pH indicator dye was incorporated into the BNC matrix, followed by preclinical trials confirming its ability to monitor wound pH continuously and non-invasively through visible colour changes. On the other side, also the integration of antiseptics was explored – such as polyhexanide, octenidine, and povidone-iodine – into BNC dressings. These substances, commonly used in clinical practice, were tested for release kinetics and antimicrobial efficacy. Results demonstrated substance-specific release profiles and reliable antiseptic effects upon functionalization.

These developments underscore the potential of BNC-based wound dressings as versatile tools for both monitoring and therapy. They represent an important step toward smarter, more responsive wound care solutions. By combining expertise from biomedical research, materials science, and clinical practice, COREMED and partners contribute to shaping the future of wound care – making treatment more efficient, targeted, and patient-centered.

This work receives funding by the FFG in the project Metering LOC (925922).

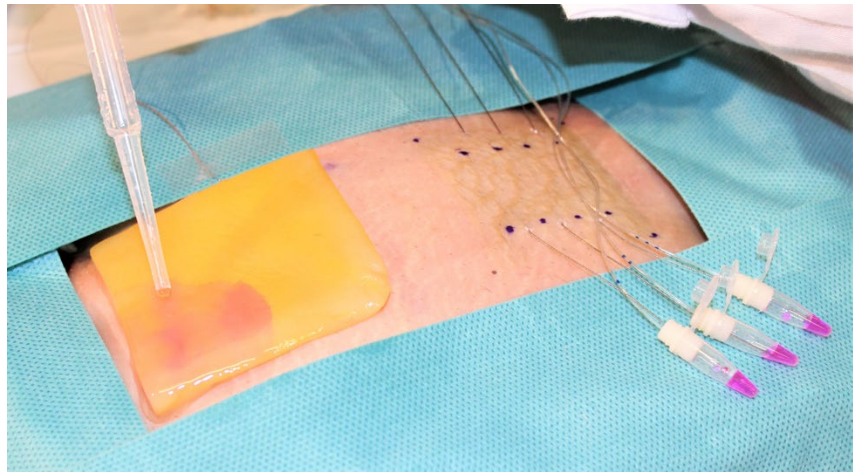
References:

Nischwitz SP, Bernardelli de Mattos I, Hofmann E, Groeber-Becker F, Funk M, Mohr GJ, Branski LK, Mautner SI, Kamolz LP. Continuous pH monitoring in wounds using a composite indicator dressing - A feasibility study. Burns. 2019 Sep;45(6):1336-1341. doi: 10.1016/j.burns.2019.02.021. Epub 2019 Jul 30. PMID: 31371230.

Nischwitz SP, Tuca AC, Groeber-Becker F, Funk M, Birngruber T, Mautner SI, Kamolz LP, Holzer JCJ. Delivery of antiseptic solutions by a bacterial cellulose wound dressing: Uptake, release and antibacterial efficacy of octenidine and povidone-iodine. Burns. 2020 Jun;46(4):918-927. doi: 10.1016/j.burns.2019.10.006. Epub 2019 Oct 23. PMID: 31653329.

Luze H, Bernardelli de Mattos I, Nischwitz SP, Funk M, Tuca AC, Kamolz LP. The Impact of Antiseptic-Loaded Bacterial Nanocellulose on Different Biofilms-An Effective Treatment for Chronic Wounds? J Clin Med. 2022 Nov 9;11(22):6634. doi: 10.3390/jcm11226634. PMID: 36431111; PMCID: PMC9692265.

de Mattos IB, Holzer JCJ, Tuca AC, Groeber-Becker F, Funk M, Popp D, Mautner S, Birngruber T, Kamolz LP. Uptake of PHMB in a bacterial nanocellulose-based wound dressing: A feasible clinical procedure. Burns. 2019 Jun;45(4):898-904. doi: 10.1016/j.burns.2018.10.023. Epub 2018 Nov 30. PMID: 30509765. A

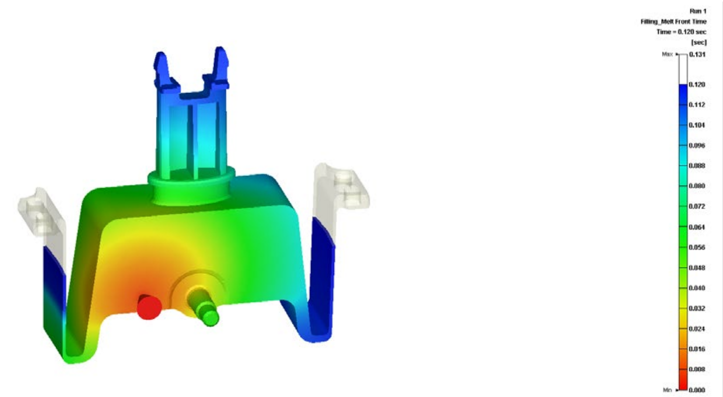


Colour change of indicator-functionalized BNC dressing in an ex vivo model.

PAYER

Flexible Hinge for Converting Rotation into Translation:

Innovation in Personal Health Products



In the world of personal health products, such as razors and toothbrushes, mechanics play a crucial role in functionality and user-friendliness. A remarkable innovation in this field is the flexible hinge, which enables the conversion of a rotating motion into a translational motion. This technology offers numerous advantages and opens up new possibilities in product design and manufacturing.

A flexible hinge, specifically developed for converting rotation into translation, is used in many modern razors and electric toothbrushes. These products need precise movements for effective cleaning and care, and a flexible hinge is a dependable component to ensure this.

A key aspect of this technology is the production of the hinges from plastic through injection molding. Wall thicknesses of less than 0.6 mm and tolerances of less than 20 µm are achieved. This precision is crucial to ensure the desired functionality and durability of the products. One more key benefit is the reduction of complex welded structures to a single component. With this approach PAYER not only streamlines the manufacturing process but also lowers production costs and enhances product reliability.

The flexible hinge is characterized by its long durability and can withstand more than 300 million load cycles. This impressive lifespan is particularly important as the hinges are used in more than 20 million devices per year. This demonstrates the high demand and importance of this technology in the consumer health sector.

Plastic, an often-underestimated smart material, plays a central role in the production of these hinges. Due to its flexibility and strength, plastic is ideally suited for applications that require high precision and durability. Additionally, the use of plastic enables cost-efficient production and contributes to reducing the weight of the final products.

Combination of simulation, toolmaking, and component design is crucial for the success of this technology. By using modern simulation software at PAYER, the movements and loads of the hinges can be precisely analyzed and optimized during the development phase. This allows potential problems to be identified and resolved early before production begins.

Toolmaking also plays an important role. High-precision tools are required to produce the complex geometries of the hinges with the required tolerances. This requires close collaboration between the engineers responsible for the component design and the toolmaking specialists. It is only through this teamwork at PAYER that the hinges can meet the stringent standards for precision and functionality.

The component design must be meticulously planned to ensure the desired movements and load-bearing capabilities. Both the material properties and the manufacturing processes play a critical role in this. By using plastics specifically engineered for these applications, the hinges can achieve the necessary balance of flexibility and strength.

PAYER a contract manufacturer, with years of expertise in manufacturing such flexible hinges, is well-equipped to meet these demanding requirements. With our extensive knowledge and experience in plastic processing, we can guarantee that the hinges meet the highest quality standards and reliably perform their intended functions.

Overall, the flexible hinge that converts rotation into translation provides several benefits for personal health products such as razors and toothbrushes. By reducing the number of components, precise manufacturing, and the interplay of simulation, toolmaking, and component design, these products can be created more efficiently and reliably. This innovation enhances the user-friendliness and performance of modern personal health products, aligning them with the needs of users.

Author:
Rene Zengerer
PAYER International Technologies GmbH

QUS

Smart Materials – The Fabric of the Future

How QUS is shaping performance and prevention across industries

Smart materials are on the rise. Across industries—from aerospace and medicine to fashion and sports—researchers and innovators are turning passive surfaces into intelligent systems. What was once static becomes dynamic: clothing that measures, reacts and even communicates. The potential is vast, the transformation already underway.

At QUS, we started in professional sports—designing garments that track vital signs like heart rate, respiration, and movement data with medical-grade precision. But very soon, it became clear: this is bigger than sport. When sensors become part of the textile itself, and when that textile becomes washable, wearable and unobtrusive, then entirely new use cases emerge—especially in fields where health, safety and performance intersect.

Smart textiles as a tool for performance — and protection

Our mission is to integrate high-precision measurement into everyday apparel. QUS garments are indistinguishable from standard sportswear but deliver continuous data through embedded sensor fibers and a compact on-board unit. This allows coaches, athletes—and increasingly also safety officers and medical professionals—to access real-time insights into physical strain, recovery, and anomalies.

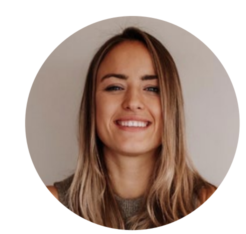
The transition from performance enhancement to health protection is natural. In high-risk occupations or extreme environments, QUS smart textiles help detect early signs of exhaustion, overheating or cardiac irregularities—before they become critical. In military training and field operations, the data supports command centers in real time decision-making and long-term health monitoring. In workplaces, it enables a new layer of safety that doesn't interrupt workflows.

Why integration matters

Unlike many wearables, QUS relies on deep integration of smart materials: the textile itself is the sensor. This makes our garments not just washable, but scalable—and compatible with existing clothing systems. Whether it's a firefighter's suit, a soldier's base layer or a simple Sports-Bra. QUS technology blends into what's already there. That's what makes it so powerful.

From fitness to frontline: The future is woven

Smart materials are not a trend. They are a shift in how we think about technology and its role in everyday life. At QUS, we believe the future of health and performance monitoring lies in the fabric itself—lightweight, invisible, and intelligent.



Author:
Susanne Bracun
QUS

Medical University of Graz

Research and Development at the Medical Science City Graz in the Field of Skin Transplantation and Skin Replacement Materials

Extensive skin defects, such as those caused by burns, require large-scale skin replacement technologies. Continuous improvement of innovative methods for skin expansion and skin substitution has made it possible for burn victims with more than 80 percent of their body surface affected to have realistic chances of survival today (Notice: In Graz a European verified Burn Center is located at the LKH-University Hospital Graz).

In the past, full-thickness skin defects were routinely treated with autologous skin grafts. However, the use of this method depends on the availability of a sufficiently large area of undamaged skin to serve as a donor site for grafts. To overcome this limitation, research and development efforts in our institutions in Graz are focused on finding alternative methods to ensure survival even for patients with damage affecting more than 50 percent of their body surface.

Allogeneic Grafts

If there are not enough donor sites available, allogeneic grafts (skin from organ donors) can be used as a temporary skin substitute. (Notice: Therefore, over the past years a specialized Skin Bank was established at the LKH-University Hospital Graz).

Xenogeneic Grafts

Since the mid-1950s, xenografts (e.g., pig skin) have often been used for temporary coverage of large wound areas. After transplantation, the xenograft initially establishes nutritional contact with the wound bed. While the dermis is initially revascularized, it is typically broken down over time and replaced by collagen structures.

In recent years, fish skin has increasingly been used for wound conditioning (Pic. 1) instead of pig skin due to several reasons. These acelluar fish skin grafts are now used not only for large-scale burns but also for the treatment of chronic wounds, as they can modulate and significantly influence directly the wound healing process.

Synthetic Materials

In addition to biological materials, purely synthetic materials are increasingly being used. Development and application focus on materials that are also components of the extracellular matrix (ECM), such as collagen, hyaluronic acid, and others. Furthermore, various polymers/polymer composites (including polycaprolactone [PCL], polyurethane [PU], silicones, polylactic acid compounds [PLA/PGLA]) as well as "natural" materials like silk proteins and bacterially produced cellulose (Pic. 2) are in use too. Synthetic substitute materials should ideally mimic the functions of the natural ECM. These include influencing cell proliferation, cell migration, and cell differentiation. But these modern materials can also be used as a dressing to deliver antiseptic solutions over several days to infected wounds too.

Common Manufacturing Methods

Common techniques for producing biomaterials include freeze-drying, salt leaching, gas foaming, and electrospinning.

Our main research focus is the development and testing of new skin substitutes and their translation into the clinical routine.

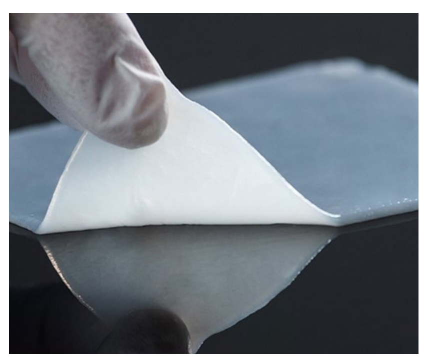
If you want to know more about our research and development activities contact:

Univ. Prof. Dr. Lars-Peter Kamolz MSc, Division of Plastic, Aesthetic and reconstructive Surgery, Department of Surgery, Medical University Graz

COREMED - Centre for Regenerative Medicine and Precision Medicine, JOANNEUM RESEARCH Forschungsgesellschaft mbH

Tel.: 0316/385 14685
E-Mail: lars.kamolz@medunigraz.at

Pic. 1 Acellular Fish Skin Grafts



Pic. 2 Bacterial produced Cellulose

Ottronic

Active Infrared Thermography for Biomechanical Analysis of Human Femora

Authors:
Mario Gschwandtl &
Lara Ertl, Ottronic

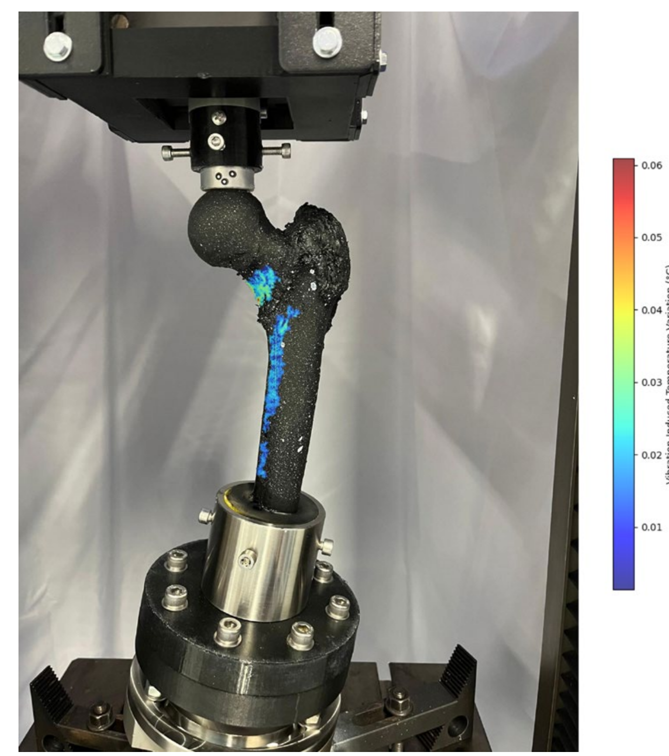
Ottronic is active infrared thermography to ensure the highest quality standards in internal inspections of polymeric encapsulations of their customer specific electronics and high-performance drives. This non-destructive testing (NDT) method is applying a controlled thermal stimulus, such as light pulse, heat or mechanical loads, to a component and measuring its thermal response (heating) by infrared cameras. Thus, internal flaws like cracks, voids, etc. or structural inconsistencies that are invisible to the naked eye can be revealed.

Within the scope of Lara Ertl's master's thesis at the Institute of Biomedical Imaging at the Graz University of Technology Ottronic has now successfully transferred this innovative application to the medical sector in order to visualize stress distributions in bone during biomechanical testing. Thereby, Prof. M. Uecker (supervisor) as well as Prof. Niels Hammer from the Chair of Macroscopic and Clinical Anatomy at the Medical University Graz greatly contributed greatly to this work.

Together, a novel method for precise determination of stress distributions in bones during a dynamic biomechanical test was established. For the validation two human femora were tested under cyclic loading - one intact, the other with an intramedullary nail – at the laboratories of the Chair of Macroscopic and Clinical Anatomy at the Medical University Graz, while thermographic data were acquired using a novel software for the image acquisition. Thereby, Lara Ertl enabled the efficient sampling of motion-corrected thermal images; enabling the consistent and accurate determination of stress distributions of both femora.

Based on the results detailed comparisons between the native and implanted femur were facilitated and significant differences in macroscopic stress distribution in both femora were found. Thus, a strong potential for implant research was discovered, as it enables the identification of stress peaks and load transfer zones in bone-implant systems under real physiological loading.

On this basis, follow up activities with Prof. Niels Hammer and tthe team at the Biomedical Engineering Department at Fraunhofer ITEM in Hannover, which focus on the analysis of the bone-implant-interfaces by acoustic emission measurements. By combining both approaches, changes in osseointegration in the bone-implant interface as well as the resulting overall macroscopic stress in the bone can be analyzed. Paving the way to a significant advancement in implant development.



bisy

Mycelium-bound materials in the Construction Sector?

Within the framework of the research project "Torf als potenzieller Baustoff?" ("Peat as a Potential Building Material?"), the Institute of Structural Design at Graz University of Technology in collaboration with the companies SonnenMoor and bisy GmbH investigated the potential of peat, enforced by fungal mycelia as a natural and fully biodegradable building material for the first time.

Peat and various agricultural residues in different formulations - were sterilized prior to inoculation with selected fungal mycelia, which grew throughout the material substrate under sterile conditions to get it ready to be shaped. For this purpose, the intergrown substrate block was broken up, fungus-specific nutrients were added, and the loose material was placed in prefabricated molds. Following a further growth phase, the material was removed from the mold and dried, making it ready for use.

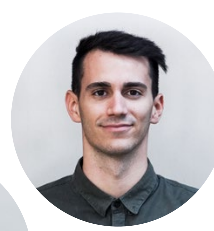
To ensure the necessary clean working environment and access to necessary biotech expertise, the research was conducted at the bisy research facilities in Gleisdorf. The resulting prototype materials were tested for tensile and compressive strength in the Laboratory for Structural Engineering at TUGraz. The gained knowledge and results for the first time offered an initial insight into the technical performance of a peat-based substrate in combination with fungal mycelium.

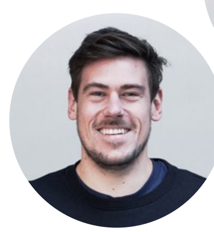
As a potential field of application for this material a temporary pavilion that met the requirements of the competition and exhibition of innovative lightweight structures at the IASS Surrey 2021 Expo was designed and built. After initial tests with different fungi for the cross-linking of shredded card box material, Pleurotus ostreatus, commonly known as the oyster mushroom, was chosen due to its rapid hyphal growth, tough structural characteristics [1] and also since spore formation can be easily controlled. Considering the properties needed for a potential construction material capable of performing in a lightweight structure competition, a composition including shredded cardboard was selected. This approach upcycles cardboard packaging and thus contributes to environmental sustainability.

Working with mycelium-bound materials as load-bearing structures for this project provided an initial limited insight into their full potential and the pavilion was presented at the Expo. In order to complete the study, a stability test under full weather exposure will be performed in summer 2025.

[1] Ionna Protopapadaki, Samuel Kalika, "Building with mushrooms" criticalconcrete.com, April 23, 2018. [Online]. Available: https://criticalconcrete.com/building-with-mushrooms/. [Accessed May 01, 2025].

Authors:
Helmut Kalcher,
Wolfgang Humer





BNN

BNN brings center of European initiatives in Advanced/Innovative Materials to Graz as coordinator of EU-project InnoMatSyn

The field of Advanced/Innovative Materials (AdMa), of which "smart materials" is a sub-category, is one of the key strategic priorities of the European Commission. To maximize the impact of science, research and industrial uptake, the Graz-located non-profit research organization BioNanoNet Forschungsgesellschaft mbH (BNN) is coordinator of the EU-project InnoMatSyn, which is supported with 4 million Euro in EC-funding and implemented in collaboration with 14 partners. The project plays a pivotal role in creating synergies between regional, national and European initiatives for AdMa to boost their impact, in support of development of safe and sustainable materials.

The project will provide an interconnected materials ecosystem, AI-based knowledge repository, technology leakage risk assessment, and support for joint funding calls. As of the launch of the project, InnoMatSyn has received a great deal of support from stakeholders from all over Europe.

"This leading position in the European AdMa-ecosystem on top of BNN's coordination role of the Austrian AdMa-community (see ATIMA) is a unique opportunity for Austria, especially for Styria and the south-east region of Austria, to further develop the ecosystem and to gain visibility and attention as a key player in the field of advanced materials including smart materials," said Andreas Falk, coordinator of InnoMatSyn and CEO of BNN. "For us [BNN] it is a great recognition of our expertise and position in Europe that we have been entrusted with the coordination of this EU-project."

"With InnoMatSyn, we have set the ambitious objectives to synergistically connect regional, national and European (funding) initiatives in the field of Advanced/Innovative Materials." Furthermore, technology leakage risks assessment guidelines will be established, a knowledge repository about competences, projects (calls, results) and publications will be created, and all this will enable the development of a sustainable European Research-, Development- and Innovation-Ecosystem in the field of Advanced/Innovative Materials.

The InnoMatSyn consortium at the Kick-Off Meeting in Vienna, 4 March 2025

BNN invites all stakeholders to engage in shaping the future of AdMa initiatives by registering to our stakeholder list (online in summer 2025). Follow InnoMatSyn on LinkedIn to become part of the community and stay up-to-date on InnoMatSyn activities and achievements for the AdMa-ecosystem in Europe!

Coordinator:
Andreas Falk, BNN (BioNanoNet Forschungsgesellschaft mbH), coordinator of InnoMatSyn project

InnoMatSyn project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement no. 101204218. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

InnoMatSyn

SteadySense

Smart Materials in Continuous Temperature Monitoring: Enhancing Patient Comfort and Care

The integration of smart materials into continuous temperature monitoring is transforming healthcare delivery. Innovative materials and combinations thereof enable the development of wearable sensors that offer accurate, real-time data collection while ensuring exceptional comfort for patients. Unlike traditional spot-check methods, smart material-based solutions provide uninterrupted monitoring, which is essential for timely detection of fever and infection—key factors in preventing complications and improving outcomes.

One of the most significant advancements is the integration of intelligent sensors into skin-friendly materials that allow patients to wear wireless sensors for a week or more without feeling uncomfortable or even realizing they are wearing a sensor. Devices like SteadyTemp® exemplify this progress, offering discreet, non-invasive monitoring that adapts seamlessly to the patient's daily life. This is particularly beneficial in both acute care and long-term monitoring scenarios, reducing the need for frequent manual temperature checks and allowing patients to rest and recover without unnecessary disruptions. Important for such intelligent sensors is on one hand the safety and security in the medical application and on the other hand the producibility in mass manufacturing. Both is achieved by a sophisticated construction, proven base materials and an experienced supply chain.

From the patient's perspective, these wearable solutions not only eliminate the inconvenience of repeated measurements but also provide peace of mind through constant oversight. For healthcare providers, the continuous data stream—automatically integrated into the Hospital Information System (HIS)—supports faster clinical decisions and more targeted interventions.

Compared to conventional non-invasive thermometers, smart wearables provide more reliable temperature readings due to consistent sensor placement. They also improve operational efficiency by automating routine tasks, freeing up medical staff to focus on critical care needs.

In short, smart materials are enabling a new standard of patient-centered monitoring: comfortable, reliable, and efficient. By aligning technology with human needs, they are making healthcare smarter, more responsive, and more compassionate.

Author:
Peter Gasteiner

JOANNEUM RESEARCH MATERIALS

Roll-to-Roll UV imprinted Lab on Chip devices for exact blood metering

In vitro diagnostic (IVD) technologies have revolutionized healthcare.

However, their limitation to centralized laboratories became a critical weakness during the COVID-19 pandemic, as rapid and affordable diagnostic options were lacking. This highlights the need to bring lab-quality diagnostics directly to end users—so-called point-of-care (PoC) testing.

Lab-on-chip (LoC) technologies have long promised to fill this gap but have yet to penetrate the IVD market. Their limited success is due to high complexity, cost, and poor scalability. As a result, they have failed to bridge the gap between simple lateral flow assays (LFA, limited performance) and complex bioassays (high sensitivity, quantitative results, but restricted to laboratories). Due to the lack of better alternatives, LFAs remain dominant in the market.

Blood is the most commonly used sample matrix in clinical diagnostics. Capillary blood sampling via dried blood spots (DBS) is a minimally invasive alternative to venipuncture and is widely used for newborn screening, drug monitoring, and infectious disease diagnostics. However, current DBS self-sampling tools lack user-friendliness, are prone to contamination, and suffer from poor reproducibility and hematocrit (Hct) effects—limiting clinical usability.

Mass production is key to successful LoC product development and commercialization. Injection molding (IM) is the most widely used microfabrication method for IVD chips but covers only chip body production. Post-processing remains labor-intensive and complex.

Roll-to-roll (R2R) imprinting, in contrast, offers major advantages:

1. Parallelized micro- and nanostructuring with high throughput [2][3]
2. Inline post-processing (e.g., biofunctionalization, sealing of chips)
3. Low material cost—ideal for disposable LoC chips

Our Approach

In this work, we address the limitations of current lab-on-chip technologies through targeted innovations.

Our goal is to develop a closed microfluidic system for precise liquid handling, including up to 50 µL dosing, efficient mixing, and spatially separated detection zones. Fluid flow is controlled using finger-activated valves, removing the need for external pumps or complex hardware.

We fabricate chips using UV nanoimprint lithography (UV-NIL) with a custom UV-curable resin optimized for microfluidic use. Specific regions are biofunctionalized via roll-compatible microspotting to enable DNA and biomarker detection. As a proof of concept, we implement a glucose detection assay.

We demonstrate a fully integrated LoC platform for complex, quantitative assays. The chip features programmable fluid pathways and localized detection areas and is operated simply via fingertip pressure. Using a glucose-derivative model, we validate its suitability for DNA detection.

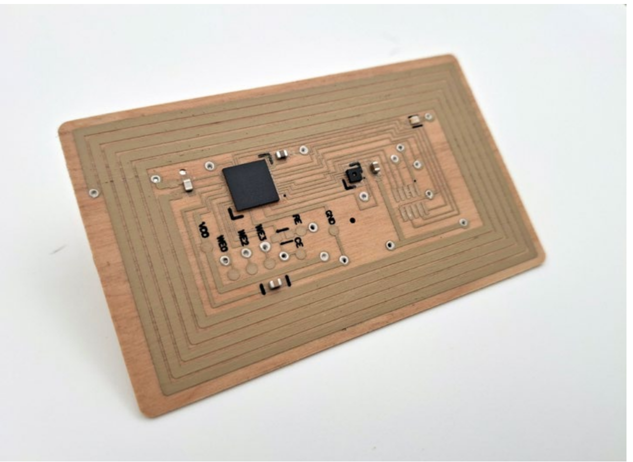
This work receives funding by the FFG in the project Metering LOC (925922).

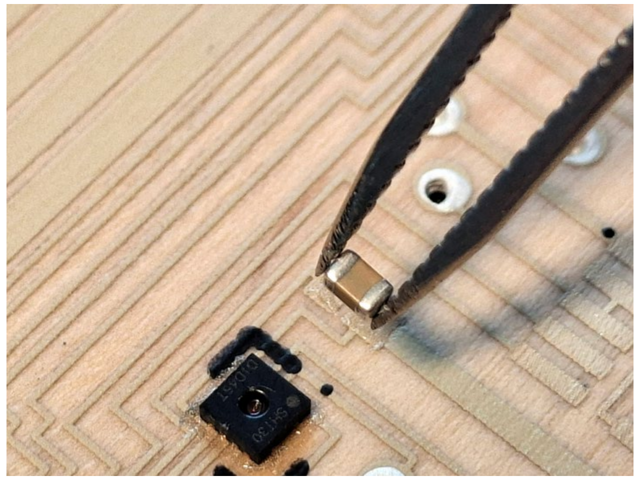
Authors:
Anja Haase, Laura Angermann-Krammer, Barbara Stadlober

Infineon | Holzforschung Austria

Revolutionizing Electronics with the Natural Elegance of Wood

Wood is a fascinating material with a hierarchical structure that offers high strength and flexibility but is still comparatively light. It is a natural composite of cellulosic fibers that are strong in tension and are embedded in a matrix of lignin that lends its high compressive strength. Furthermore, wood is also aesthetically very appealing, which makes it an ideal choice for a variety of applications such as timber construction, furniture or flooring. Wood is also a renewable and sustainable material when responsibly sourced and managed. Nevertheless, the combination of wood and electronics is still a rather rare combination.





In the EU-funded HyPELignum project, wood and wood-based materials are investigated as a substrate for printed electronics. Among the key outcomes of this project are eco Printed Circuit Boards (ecoPCBs) based on wood. Conductive paths are printed onto the wood substrate using either inkjet or screen-printing technologies. The main idea of the plywood ecoPCB is to print the desired circuitry in each veneer layer of the plywood before gluing them together. The different layers are connected using vias thus mimicking the structure of a conventional multilayer PCB. Waterborne primers are used to homogenize the penetration behaviour and fill out pores of the birch wood used for this purpose. The screen-printing technology is also investigated for the use in timber construction (moisture and strain sensing) and in furniture (touch sensing, VOC measurements using a novel biomimetic smell sensors).

ASIG2G Microchip:
Sustainable Electronics and Medical Innovation

Infineon's ASIG2G microchip prototype developed by the Graz Explorative Research team powers these wood-based electronics with its highly integrated architecture for multi-channel electrochemical measurements. Its compact design reduces material usage, aligns with sustainability goals, like the Green Deal and supports battery-free operation.
The chip's versatility extends to the healthcare sector, enabling Lab@Home diagnostics. It can quantify biomarkers such as glucose, potassium, and lactate or differentiate between viral and bacterial infections using CRP tests. Its system-on-chip design integrates multiple functionalities, paving the way for compact, energy-efficient point-of-care devices and wireless sensors for personalized medicine.

In conclusion, the combination of sustainable wood substrates and the ASIG2G microchip showcases how eco-friendly materials and cutting-edge electronics can redefine the future of technology and healthcare.

Project number: 101070302 | www.hypelignum.eu

Authors:
Boris Forsthuber, Christian Hambeck

EVOMEDIS

Cool Innovation:
Freeze-Dried Cell Therapy To Heal Serious Wounds

Author:
Martin Funk

While severe burns have become relatively rare in Europe, they remain common in less developed countries, particularly among children. Addressing this global health challenge, EVOMEDIS aims to provide effective, accessible treatment with EVOCellic, an innovative cell-based therapy.

EVOCellic is a ready-to-use wound healing product composed of allogeneic keratinocytes—skin cells crucial for tissue regeneration. These cells are preserved using a novel freeze-drying process, enabling the smart material to be stored at 4°C in standard refrigerators for up to three months, unlike traditional cell therapies that require -80°C storage or liquid nitrogen. This greatly simplifies logistics, storage, and global distribution, making it particularly valuable for low-resource settings.

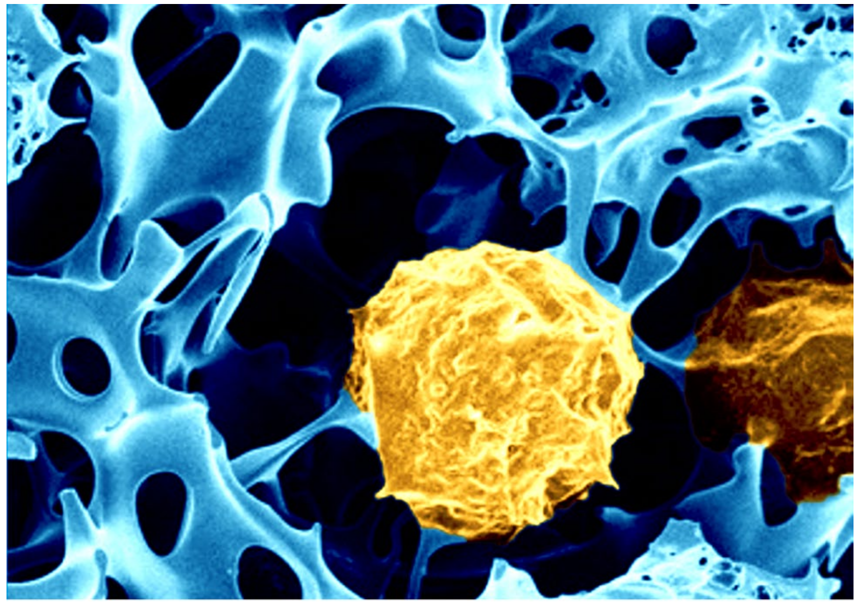
The keratinocytes in EVOCellic are embedded in a matrix with a flexible size of up to 1000 cm². They contain a high concentration of growth factors, which remain stable after freeze-drying. When applied to hard-to-heal wounds, EVOCellic supports rapid and effective healing by stimulating the body's natural regeneration process—encouraging proliferation and migration of keratinocytes and fibroblasts to close the wound and repair damaged tissue.

The lightweight, water-free formulation also benefits transportation, allowing for more sustainable and scalable packaging solutions. These advancements support EVOMEDIS's dual mission: making high-quality treatment widely available and doing so in an environmentally conscious way.

EVOCellic has received Orphan Drug Designation (EU/3/22/2637) from the European Medicines Agency for treating deep dermal burns and chronic wounds, which affect over 60 million patients in industrialized countries.

The product is currently undergoing pre-clinical evaluation in collaboration with COREMED and the Department of Surgery at the Medical University of Graz. The next phase, focused on aligning the production process with GMP standards for Advanced Therapy Medicinal Products (ATMPs), is taking place at the Department of Blood Group Serology and Transfusion Medicine at the same university.

By combining cutting-edge science with practical deployment, EVOCellic offers a promising new solution for patients suffering from severe burns and chronic wounds—especially in regions where advanced wound care has long been out of reach.



EVOCELLIC