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# ICMS Highlights

**ORGANIC NEUROMORPHIC DEVICE  
ACTS AS A ROBOTIC "BRAIN"**

**ZOOMING IN ON THE  
BIOCHEMISTRY  
OF SUGARS AND CELLS**

**PRESTIGIOUS NWO GRAVITATION  
FUNDING FOR NEW TU/e  
POLYMER RESEARCH CENTER**

**ICMS**

INSTITUTE  
FOR COMPLEX  
MOLECULAR  
SYSTEMS

**TU/e**





## INTRODUCTION

# ICMS Highlights



**As life returns to normal, scientific research in Eindhoven is also picking up the pace. It is now evident that in one of the most challenging periods of our lives, seeds for scientific success were sown by many community members. We can now celebrate those accomplishments, which enable additional investments in science and people in the fields of Advanced Materials and Engineering Health. Some of our recent achievements:**

Researchers of different TU/e Departments joined forces in a NWO Gravitation proposal on Interactive Polymer Materials. More than 15 M€ has been awarded. Thanks to the National Growth Fund, the consortium on revolutionary research on self-thinking molecular systems can start materializing their ambition, as well as iScreen (part of another National Growth Fund program, PharmaNL).

We are proud of the accomplishment of Carlijn Bouten who was granted an ERC Advanced Grant for her proposal on living heart muscle. Reinoud Lavrijsen was named Teacher of the Year 2022 and Bert Meijer became a member of the National Academy of Sciences and received the Van 't Hoff medal. And last but not least, Luc Brunsveld was selected as a member of the Royal Netherlands Academy of Arts and Sciences. We are very pleased to welcome David Mooney (Harvard University) as an honorary doctor at TU/e.

We look forward to collaborating with Richard Post, our recently appointed ICMS Fellow, and the new committee members of the PhD Outreach program.

We hope you will enjoy reading this edition of the ICMS Highlights.

For more information, please visit our LinkedIn page.

**Jan van Hest**  
*Scientific director*

**Monique Bruining**  
*Managing director*

## Colophon

Please check our website  
for our upcoming events.  
[www.tue.nl/icms](http://www.tue.nl/icms)

### EDITORIAL

ICMS Highlights is the half-yearly magazine of ICMS for ICMS members, colleagues, collaboration partners, policy makers and affiliated companies.

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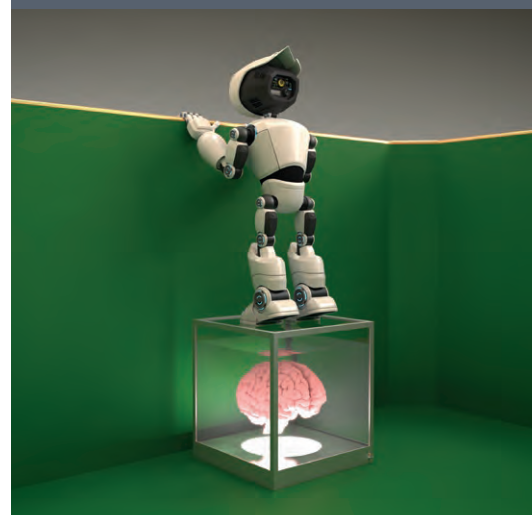
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**COVER** "Human-like brain  
helps robot out of a maze"

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# Biomonitoring business

Rafiq Lubken

Processing natural biological materials, like milk or potatoes, into food products means dealing with natural variation. These can cause fluctuations in quality, yield, and productivity. This is where TU/e spin-off company Helia Biomonitoring comes in. They develop sensors that can quantify molecular concentrations in real-time, for example off-flavor compounds in potatoes or high value proteins in milk, so that food manufacturing processes can continuously be adapted and optimized. The company originated from the Molecular Biosensing group at TU/e. No wonder two of their recent PhD graduates, Tina Lin and Rafiq Lubken, now work for Helia.

Tina Lin and Rafiq Lubken both recently finished their doctoral research in the group of Menno Prins, professor of molecular biosensing in the departments of Biomedical Engineering and Applied Physics, TU/e. And now, both are employed by Helia, where they work on the development and commercialization of the biosensors. First sector of interest is the food industry. "How to monitor and control food production processes using real-time molecular information," Lubken explains.

### POTATO PROCESSING

"At the moment, we collaborate with two large industrial food companies," Lubken continues. One of these is Avebe, a multinational potato starch and potato protein manufacturer. They are interested in measuring molecular quality parameters during potato processing, such as off-flavor compounds. Real-time measurements can help to improve productivity, yield, and quality of their production processes. Helia is now developing a sensor to measure molecular concentrations prior to and during the actual processing of the potato product stream.

Another partner is FrieslandCampina, a large multinational dairy cooperative. Their interest is in the extraction of specific proteins from milk. "Designing processes in such a way that every last bit of these proteins is extracted from the milk would take too long," says Lubken. "But if the extraction time is too short, then the yield is low and you lose precious protein." An optimum is hard to find, because milk is a natural product, with natural variations. Lubken: "Our sensor helps to adapt the processes in real-time, to ensure optimal process settings even when input properties fluctuate."

### QUALITY CONTROL

"At Helia, I focus on the fabrication of our sensors and I make sure that the quality meets the customer's demands," says Lin. "I also work on developing assays for novel applications. This means I am still doing experiments which are similar to my PhD research." As a PhD student, Lin worked on developing a sensing technology that enables continuous monitoring of different molecules. This novel sensing technology is called Biosensing by Particle Mobility (BPM). The technique uses microscopically small particles to which molecules can bind. "The binding of even a single molecule can lead to a significant change of the particle motion," Lin explains. "We can detect these motion changes with a microscope." She showed fluctuating concentrations of small molecules can be monitored using BPM. "The main difference between my PhD work and my work at Helia is quality control," she says. "During my PhD, quality control was not as important. As long as you can reproduce the results, it does not matter if two out of ten experiments fail. However, for a company that is not acceptable. We need to make sure that ten out of ten sensors work."

### TRAFFIC JAM

Lubken also worked on BPM during his PhD. He focused on single molecular interactions in the BPM technique. "The motion changes we see are caused by single molecules. I investigated what one can do with this single molecular resolution,"

he explains. "You can compare it to a traffic jam. To understand a traffic jam and the impact it will have, it is not enough to know the length and delay time. You need to zoom in. What does the traffic jam consist of? Trucks, cars? And how many people are inside and what is the cargo? When you zoom in, you obtain a lot more information about the problem. The same applies to our sensing technology with single molecular resolution; if you zoom in you discover more detailed information about the concentration measurement technique." During his PhD research Lubken figured out that the single molecular resolution can be used to measure different molecules at the same time – this is called multiplexing. He also showed that single molecular resolution can be used to improve the sensitivity and response time of the sensor. Lubken's work at Helia is quite different from his PhD research. "I am now involved in the research without doing experiments," he says. "I am also working on business development for Helia: we are currently investigating the next applications of the sensor technology. I switched from working with BPM-sensors in an academic setting to making it work as a product that will be easy to use, reliable, and valuable in the hands of our customers."



Tina Lin





# Submarines to fight cancer



Tania Patiño Padial

**Tania Patiño Padial started working on micro and nano robots that are able to swim at the Institute for Bio Engineering of Catalonia (IBEC) in Barcelona. These may be used for targeted drug delivery in humans. She now continues her research as an assistant professor at ICMS. "The crux lies in multidisciplinary communication. The robot design and motion are physics, the fuel system is chemistry, the biocompatibility and targeting are microbiology and the drug delivery is pharmacology."**

With smart nano-bio devices we try to mimic nature, for example by creating motile systems," Patiño Padial explains. The selection of the right engine to induce motility is far from trivial. Enzymes are natural catalysts that can generate motion by converting chemical energy into movement. Another option is to use a platinum coating that can be used as an inorganic catalyst for a reaction fueled by hydrogen peroxide. Bubbles are formed that set the device in motion.

At IBEC, Patiño Padial fitted out this enzymatic transport system with the enzyme urease, which catalyzes the hydrolysis of urea into ammonia and carbon dioxide. It was the ideal set-up against bladder cancer, as the bladder can act as a giant fuel tank for the device. "We injected it in the bladder of mice and followed the functionality through medical imaging," says Patiño Padial. "The directionality proved challenging. Furthermore, most applications will not be in the bladder, but in the bloodstream. It was a nice proof of concept, but there were enough remaining challenges."

## INTEGRATE FUNCTIONALITIES

In the Francesco Ricci Lab at the University of Rome, Patiño Padial subsequently worked on DNA as a nanomaterial. "It's nice material to play with," she says. She aimed at an optimized shape and more controlled design of the nanobots. "My plans at ICMS head in the same direction: to use synthetic DNA like Lego. I could use that to optimize the location of the recognition, fuel and motion parts. The key to overcome present challenges is to integrate multiple functionalities through immuno- and tissue-engineering and computational modeling."

## IDEAL ENVIRONMENT

This should for instance enable the "nano-submarine" to recognize and activate immune cells against cancer. Patiño Padial: "3D cell culture studies and mice models will eventually lead to a robot that really does that in humans. The complementary skills of the groups of Jan van Hest, Tom de Greef and others at ICMS and with the links to the Radboud University Medical Center in Nijmegen, create the ideal multidisciplinary environment for this type of research."

# Rebuilding bone

Fascinated by the dual qualities of bone strength and regeneration, assistant professor of Biomaterials Processing (Orthopedics) in the Department of Biomedical Engineering, Miguel Castilho has taken up the challenge of engineering a biomaterial replacement for bone that can be used instead of metal to treat patients suffering from chronic disease and bone injury.

During his masters in mechanical engineering, Castilho was intrigued by the biological side of engineering, leading him to change direction and undertake a PhD in biomedical engineering. Castilho: "As well as discovering a passion for biology, I was also inspired by my sister's career as a nurse. The desire to help people and make a direct difference to their lives was a driving force in me deciding to switch tracks."

Bones are a fascinating challenge for a biomedical engineer, says Castilho. "The way bones are constructed makes them strong enough to bear weight, but because they are also composed of living tissue, they are intelligent enough to regenerate and self-repair." Replicating these two facets requires a deep knowledge of the biological composition of the living tissue to understand its regenerative properties, as well as an equally deep knowledge of how the tissue is organized and hierarchically arranged to give it its strength and resilience.

## MICRO TO MACRO

Castilho uses 3D printing technology to engineer biomaterials that can support load, trigger endogenous regenerative processes and that can be reabsorbed harmlessly into the body. "3D printing has become very



Miguel Castilho

sophisticated. It provides us with a tool to control the structural composition of material from the micro up to the macro scale."

The research extends beyond the musculoskeletal system and also explores how regenerative processes can be engineered in other parts of the body, for example blood vessels and heart. Within an EU funded project, he is working with colleagues to engineer a 3D printed biomaterial patch seeded with cardiomyocytes; the cells that make the heart beat. Once patched onto the heart, it should trigger self-renewal of damaged heart tissue and restore pumping function.

## CLINICAL CONTEXT

Fundamental to Castilho's research is a multidisciplinary approach. A guest appointment at the University of Utrecht Medical Centre frames Castilho's research in a clinical context. There, the patients' needs are guiding the work, whilst at TU/e he can focus on the fundamental science. "My skills lie in the processing and engineering aspects of the biomaterials. I hope to build on the rich knowledge of polymer chemistry and mechanics at ICMS and apply that to my highly interdisciplinary research. Of course, I would also love to share my knowledge of biomaterials design and fabrication with other researchers at TU/e and add value to many other areas of scientific discovery."





# Organic neuromorphic device acts as a robotic “brain”

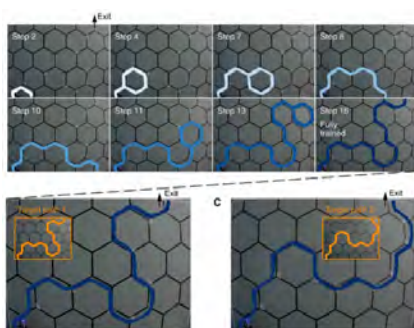
Imke Krauhausen (left) and  
Yoei van de Burgt (right)

Neuromorphic devices based on organic semiconductors hold great potential for adaptive autonomous robotic systems. PhD student Imke Krauhausen of the Neuromorphic Engineering group led by Yoei van de Burgt provided a proof of principle with a Lego robot that can find its way out of a maze. All by itself, without the need for computers and algorithms. The research was published in Science Advances.



## "OUR SCIENCE ADVANCES PAPER PROBABLY IS THE FIRST PROOF-OF-PRINCIPLE OF THE NEUROMORPHIC APPROACH AT A SYSTEMS LEVEL"

The video is fascinating. A small Lego robot is wandering through a hexagon-based maze, trying to find its way out. Of course, it fails at first, going round in circles or hitting a dead end. But assisted by the helping hand of its trainer it tries again, and again. And it improves. After just sixteen efforts it is fully trained and can exit the maze on its own. The achievement becomes even more impressive when you realize how the robot manages all this. It's not connected to a computer, there's no microchip inside. It does, however, contain a small device built from a semiconducting polymer. This, in fact, acts as its "brain." "It is a neuromorphic device that provides an adaptive connection between the sensors and the motors of the robot," says Imke Krauhausen. "You can compare it to the nervous system in our body. There, nerves provide a feedback loop between our sensory system and our muscles. Our device



Neuromorphic robots

serves the same function." She goes on to explain that the device also operates in a similar way. "That is the neuromorphic part: the properties of the polymer change permanently as a result of the training input. This resembles the way human neuronic synapses are reinforced during learning. And indeed, our robot is also capable of learning."

In the maze experiment, the robot turns right by default and visual cues on the walls indicate where to turn left. The cues are positioned in such way that they guide the robot to exit the maze. At first the robot does not "know" this, but every corrective intervention by the trainer induces a permanent change in the neuromorphic device. Thus, it learns, step by step, to obey the visual clues. "What's more," Krauhausen adds, "once it has learned to navigate its first target path, it can follow any other path without errors. So, the knowledge it has acquired is generalizable."

### SENSORIMOTOR INTEGRATION

Krauhausen is a PhD student at both ICMS and the Max Planck Institute for Polymer Research (MPI-P) in Mainz (Germany). At the latter, she works with Paschalis Gkoupidenis of the Molecular Electronics group, where the focus is mainly on the semiconductive polymers and devices. At the Neuromorphic Engineering group of Van de Burgt, the focus is on actual systems. In fact, the Science Advances paper probably is the first proof-of-principle of the neuromorphic approach at a systems level. "I think we are the first to use organic electronics for sensorimotor integration in a robot performing in a real-life situation," says Van de Burgt. To him, it is a perfect example of the future of organic neuromorphic devices. He envisions applications in autonomous robots, adaptable

bioelectronics and brain-inspired smart point-of-care diagnostic devices. "The work of Imke shows the potential of using an organic neuromorphic device in an actual system. It's easy to tune while maintaining a high stability and it needs little power, a battery suffices. And it works without any connection to a computer or a network. This opens up many possibilities for autonomous operation. Think for instance of intelligent sensing applications, where a sensor can autonomously perform a learning and classification protocol."

### HYBRID SYSTEMS

Another interesting feature is that the neuromorphic device can potentially be integrated with cells and biological systems. This is in fact relatively easy since its inner workings involve electrons and ions, just like the human nerve system. "If nerve cells present ions or an ionic current to the neuromorphic polymer, its characteristics can be changed. We have already established that we can tune neuromorphic devices with neurotransmitters from cells," says Van de Burgt. "Furthermore, the polymers can be very biocompatible. So, there's a range of beautiful characteristics to work at an interface between cells and artificial devices. If you take that a step further, you can think about using nerve cells to control a robotic arm, to optimize its operation. Then you have a hybrid system where part of it is a machine, but the other part is biological."

In her current project, Krauhausen is in fact already working on a robotic arm. "We are trying to integrate more sensors and handle more inputs to the neuromorphic device. We also want to explore if we can use more than one device in the system. Because of course, for the future, the challenge is to scale this concept towards ever more complex systems."



Human-like brain helps robot out of a maze.



From left to right Mert Astam, Pengrong Lyu, Thierry Slot, Tom Bruining

# Workshop of wonders

Assistant professor of Chemical Engineering Danqing Liu has dedicated her career to the discovery and development of smart responsive materials. Her desire to see these materials integrated into bio-inspired soft robots led her to set up an Advanced Fabrication Facility or “workshop” within her lab. We were granted a look behind the scenes of the workshop to see how fundamental science is being enhanced by the workshop’s ability to build devices that rapidly test the application potential of responsive smart materials.

The ambitions of the Stimuli-responsive Functional Materials and Devices group (SFD) don’t stop at the creation and adaptation of responsive materials. “Our expertise lies in creating these materials, but beyond that we were curious to learn how our materials react when integrated into mechanical soft robotic devices,” says Danqing Liu. Bridging the gap between materials and their application became a priority for her group and thanks to a combination of equipment and expertise, Liu now has

a functioning mechanical and engineering workshop within her lab. That workshop is employed in two ways. Firstly, the workshop enables the group to develop techniques to produce increasingly sophisticated materials. Secondly, prototype devices are created that can nimbly test the materials application. Developing proof of concept devices in the lab will accelerate the field of soft robotics thereby reducing the time needed to bring soft robots into general use in industrial, domestic and healthcare settings.



## PRIME CONDITIONS

Liu: "This year, we have some exceptional academics on our team who have the skills and experience in mechanical and electrical engineering to create physical devices that advance our discoveries." Now, postdoctoral researcher Thierry Slot steps into the picture. Whilst focusing his academic career on chemistry and materials science, Slot continues to cultivate a lifelong passion for electronics. "As a child, I was always interested in engineering. Then and now I spend my spare time building electronic devices and robots to help solve problems." Alongside Slot was masters student Tom Bruining, who was also keen to develop the workshop idea thanks to his broad knowledge of mechanical engineering.

The workshop is a fascinating combination of heavy tools that are commonly found in a standard mechanics workshop and high-end equipment such as laser cutters, 3D and 4D printers and a state-of-the-art Digital Mirror Device. Add to this, many off-the-shelf programmable electronic circuit boards and the environment of a chemistry department. What emerges is a functioning mechanical and electronic workshop capable of building devices to test the limits of materials and push the boundaries of discovery.

## PRECISION AND ACCURACY

Illustrative of the workshop's ability to advance scientific discovery is the creation of the Fiber Drawing Machine. Focused on drawing fibers to create responsive materials, Bruining needed to increase the accuracy of his drawn fibers to increase its potential for use in soft robotic devices. Utilizing the resources of the workshop, with a leading role for the 3D printer to print the component parts, building on their joint mechanical and electronic engineering knowledge, Slot and Bruining built a Fiber Drawing Machine that could draw fibers with greater precision and accuracy than the previous method of hand drawing.

The lab now benefits from a Fiber Drawing machine that accurately controls parameters such as temperature, distance, speed and acceleration. Slot: "The machine also allows us to do tricks. We can give the fibers additional characteristics by rotating or stretching them." These extra characteristics enrich the material properties and open-up new applications. By bringing the workshop into the lab, it became possible for the team to build this Fiber Drawing Machine and put it to use within the span of a master thesis project, something which previously would not have been possible.

## PUTTING THEORY TO THE TEST

The workshop's workhorse is the 3D printer that enables the rapid production of prototype devices and component parts. "Using the 3D printer, I can print a mechanical structure or device onto which I can integrate my responsive material," explains PhD student Mert Astam. "I can make this device perform functions that have only been theorized, but not yet tested." Enabling the rapid testing of his hypotheses helps Astam and the team to really put theory into practice.

The ability to precisely shape responsive materials is crucial if they are to be integrated into robotic devices. Precision alignment of molecules during the shaping process determines how the material reacts when exposed to stimuli: Does it grab, turn or twist? It is the workshop's 4D printer that enables this precision shaping. Responsive materials are fed into the 4D printer, which is programmed to precisely print materials into the desired shapes. Once printed, the materials are flat, but after actuation with heat or light they perform specific movements. "Before acquiring the 4D printer, we could only make basic shapes using molds that limited the materials application potential," says PhD student Pengrong Lyu. He then uses the workshop's other assets to

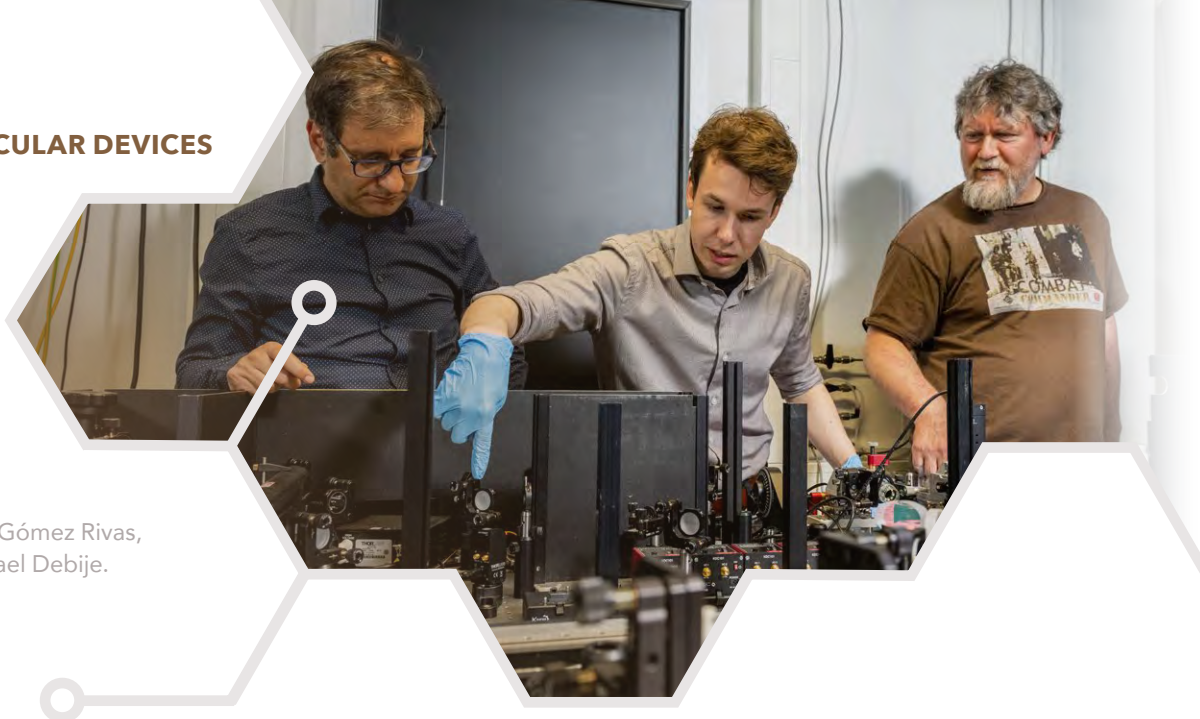
make prototype mechanical devices upon which to integrate his precisely printed materials. The lab is one of only a small number around the world that utilize the 4D printer to print responsive materials.

## PUT TO GOOD USE

To produce increasingly intricate and minute shapes, the workshop also benefits from having a Digital Mirror Device (DMD), which takes precision printing of advance materials to the next level. One of the hugely exciting things about the DMD is its ability to print at microscopic resolution. Lyu: "If you think about making soft robotic devices that can go inside the body to precisely deliver drugs, the DMD would make it possible to produce a responsive material small enough for such use." Scientists in the lab can choose the appropriate printing device based on the size and complexity of the shape needed.

"Whilst we are principally fundamental materials scientists, we also feel the responsibility and have the desire to see these materials being used for the good of society," Danqing Liu concludes. She envisages many application possibilities from self-cleaning soft skins on solar panels to an untold number of biomedical applications. "Using the workshop to strengthen our fundamental understanding of these incredible materials will help to promote and broaden their use."





From left to right Jaime Gómez Rivas, Erik van Heijst and Michael Debije.

# Tuning optical resonance using liquid crystals

**Authoring a scientific publication is already quite an achievement for a master's student and in Erik van Heijst's case, the research was also highlighted and featured on the cover of the Journal of Applied Physics (Vol.131, Issue 8). A great completion of his graduate project which he conducted in the ICMS groups Photonics and Semiconductor Nanophysics (Department of Applied Physics) and Stimuli-responsive Functional Devices (Department of Chemical Engineering and Chemistry). His supervisors were Jaime Gómez Rivas and Michael Debije, respectively.**

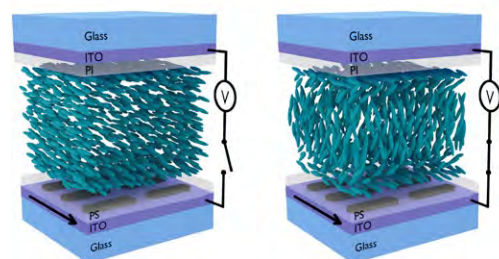
The project was initiated by Van Heijst himself, who has a keen interest in nanophotonics. "It was one of the toughest courses of my studies, but I found it great fun! It was taught by Jaime so I really wanted to graduate with him." Since the talented student had already decided to major in both chemistry and physics, he also approached Debije. "His work on devices is very application-oriented and also kind of tied in with the photonics topic. So, the three of us sat together to find me a subject that would suit both groups."

## LASING AND OPTICAL SENSING

It didn't take long. The idea came up to use liquid crystal polymers (a subject in Debije's group) for dynamically tuning the resonance characteristics of optical cavities containing metallic nanoparticle arrays (an interest of Gómez Rivas). Such active control of resonant systems is important for the realization of tunable devices that can

be exploited for light emission, lasing, and optical sensing applications. It was up to Van Heijst to identify the right materials, design a device, and make it work. At the physics group, his main focus was on modelling and simulating the device. At the chemistry department, he set out to actually create it. It wasn't a smooth ride, as in certain configurations the resonance disappeared altogether. But by the time the simulations revealed an optimal device, Van Heijst also had found a manufacturing method to produce it. "Then things moved fairly quickly. The first device was not quite optimal, but already the second version provided the measurements that are at the heart of the paper."

It's a nice proof-of-principle of how to actively control and tune the light produced by nanoparticle arrays, Van Heijst says. But since the results are from a specific nanoparticle array with a specific type of liquid crystal, it remains to be seen if and how the concept can be generalized. "On the other hand, we present a relatively simple, flexible and easy to fabricate device concept. So, if simulations show how to make any other system work, there's a good chance that you can indeed pull it off."







Joost van der Tol

# Atomic Force Microscopy: A versatile diagnostic tool for supramolecular systems

Creating new macromolecular materials is one thing, but checking the results down to molecular resolution is out of reach for conventional optical microscopy. Enter the Atomic Force Microscope: a tiny, cantilevered needle ending in a tip that is only a few atoms in diameter, which can feel the repulsion or attraction of individual atoms on a surface. Scanning a surface with an AFM will produce a computer generated image, similar to how an old-fashioned needle gramophone creates music by scanning the grooves in a record. Joost van der Tol uses AFM for his own research, but also helps out other groups who need AFM services.

Van der Tol, PhD-student in the Macro-Organic Chemistry group, experiments with monomers that assemble into one-dimensional, supramolecular fibers. Although this is still very fundamental research, ultimately the goal is to create functional materials with special properties. Bio-compatible materials, self-healing coatings and flexible electronics are potential applications.

One of the key issues when working with supramolecular materials is "processability": these complex molecules self-organize in a solution, but is the final product, like a coating on a surface still exactly the same on the molecular level? Van der Tol: "AFM often delivers supporting evidence: did I really make what I intended

to make?" Using AFM, he can even test the mechanical properties of nanoscale morphologies, like the loss tangent and the stiffness.

## LOT OF PRACTICE

Getting good AFM images, which can identify individual macromolecules, takes lots of practice. No problem for Van der Tol because he finds working with ICMS's new AFM "super cool". So, other researchers now come to him to get their samples scanned. One of them was Ievgen Kurylo from the Stimuli-responsive Functional materials & Devices group. Kurylo wanted to determine the *in situ* change of the mechanical properties of an adaptive coating upon illumination with UV light. This research could lead to better haptic performances of electronic devices.

## SAMPLE PREPARATION

Although the physical principle of an AFM is fairly simple, there are hundreds of different tips and a large array of parameters to play around with. Samples can be scanned using the electrical or magnetic force between the tip and the surface, while another option is using an oscillating tip – the so-called tapping mode. The extreme sensitivity of an AFM also implies that the sample has to be extremely clean and pure. Van der Tol: "Preparing your sample is arguably more important than the measurement itself." But in skilled hands, the AFM is a diagnostic tool with nanometer resolution that does a lot more than just scratch the surface.



ADVANCED ANALYSIS  
OF COMPLEX  
MOLECULAR SYSTEMS

Roger Riera



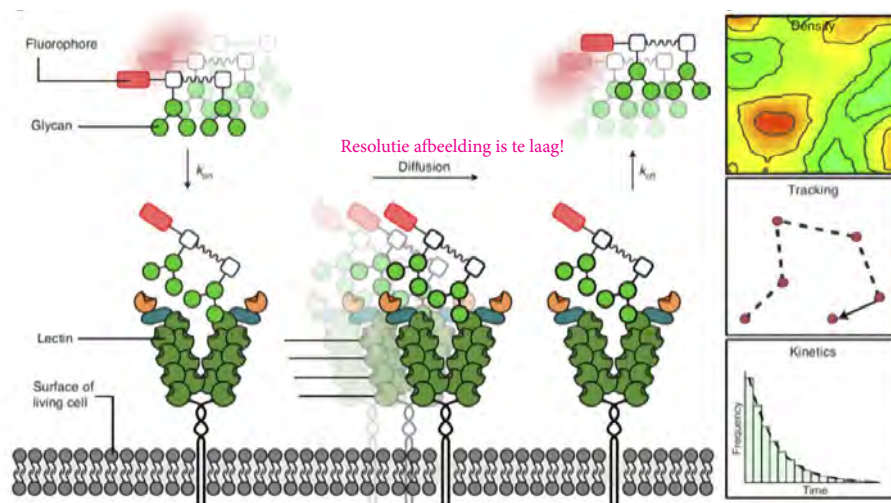
Lorenzo Albertazzi

# Zooming in on the biochemistry of sugars and cells

Researchers at the Nanoscopy for Nanomedicine group led by Lorenzo Albertazzi used single molecule super-resolution microscopy to unravel cellular interactions involving sugar molecules. Dubbed Glyco-PAINT, the method is of great relevance to glycobiologists and glycochemists. It can, among others, elucidate the relevance of glycan structures in an immune response, or in the uptake of therapeutic proteins and vaccines in targeted delivery systems. The paper, with PhD candidate Roger Riera as first author, was featured on the cover of Nature Chemical Biology.



Scheme of the Glyco-PAINT procedure. A probe consisting of a fluorophore (depicted in red) linked to a glycan cluster (green) becomes visible when binding to the cell surface glycan receptor. Imaging the bound fluorescent ligand is used to determine the on-cell receptor density, tracking receptor movement, and quantify the binding kinetics of the glycans. Image taken from the Nature Chemical Biology paper.



With his research, Lorenzo Albertazzi aims to obtain a molecular understanding of human biology using optical microscopy and nanoscopy. Based both at TU/e and the Institute for Bioengineering of Catalonia (IBEC) in Barcelona, his group literally zooms in on the receptors of cell membranes. By mapping multiple parameters at the single-molecule level, they hope to contribute to an understanding of the physicochemical properties of cellular interaction. To Albertazzi, the latter is crucial: "We don't do research just for the method itself. We are looking for relevance."

### ONE MOLECULE AT A TIME

The techniques for single molecule detection form part of a range of novel optical techniques that are referred to as super-resolution microscopy. The underlying principle is based on capturing the light of single fluorophores (molecules able to emit light), and thus building an image "molecule by molecule," like a pointillistic painting. This results in unsurpassed resolution, down to the nanometer scale. "You can literally see one molecule at a time," says Albertazzi. He goes on to explain that a super-resolution approach called DNA-PAINT is based on the use of fluorescent single-strand DNA probes. These bind to corresponding DNA strands attached to a sample – a cell, for instance – and the bound probes can then be detected by the microscope. DNA-PAINT is widely used and has become one of the workhorses of super-resolution imaging. However, the DNA interaction in the method has no biological relevance, it is just used as a tool. Albertazzi: "This brought us to the idea to use non-DNA probes, namely probes based on molecules that are themselves

involved in relevant biochemical interactions. Then, getting the super-resolution image would enable us to learn about the particular interaction itself."

The researchers found a perfect case in the interactions between glycans (complex sugar molecules) and cellular receptors that are based on the glycan-binding protein lectin. The idea arose from a long ongoing collaboration with Leiden University researchers that have a keen interest in the role and function of glycans in human cellular biochemistry, in particular regarding the immune system. "So, we brought together two fields: our Leiden collaborators developed the fluorescent sugar probes and we focused on the super-resolution microscopy," says Roger Riera. He joined Albertazzi as a PhD candidate in 2018 and spent the better part of his doctoral research on developing the new method that has now been dubbed Glyco-PAINT.

### MAKING IT ALL FIT

The method works like a charm and is relatively easy to use, Albertazzi says. "Anyone with some experience in the field of super-resolution microscopy can make this work." Which is not to say that developing the method was easy. As Riera explains: "You have to make sure that it all fits together. The sugar probes, the dyes and so on. To detect their signal, everything has to be in accordance with the microscope, the lasers, the optics, etcetera. And then, when you study the live cells there's a whole range of proteins and molecules that can interfere with the glycan measurements and evoke false results. We had to do a lot of controls and filter out the non-specific interactions, to



make sure that what we are seeing is really what we want to see. Everything has to be just right to obtain meaningful results. I think more than half the time of the project was spent on finding the right settings. But once we had it working, the results kept on coming.”

#### TARGETED INTRACELLULAR DELIVERY

The researchers were able to see how the lectin receptor moves over the cell surface and determine its diffusion coefficient. “We also established that different sugar structures present different binding kinetics,” says Riera. “All this brings us closer to understanding the structure-activity relationship and obtain a more detailed and comprehensive characterization of the cellular interactions.” Such insights are relevant to understanding the body’s immune response to certain pathogens, for instance viruses, in which sugar clusters can play a role. Another area of interest is the targeted intracellular delivery of cargo such as therapeutic proteins and vaccines. Such delivery systems often depend on the sugar-binding lectins. Indeed, the researchers were able to use Glyco-PAINT to directly correlate the cellular uptake of

sugar clusters to the different binding parameters in living cells. “The results suggest that effective uptake requires sufficient binding and residence time of the sugar clusters on the receptor,” Riera explains. “Glyco-PAINT thus can assist in designing sugar clusters for optimal intracellular targeting.”

As the first method to establish quantitative kinetic parameters of the weak interactions of complex sugars with lectins in living cells, Glyco-PAINT opens possibilities for many studies of lectin-sugar interactions. Might the Nature Chemical Biology paper become one of those many-cited papers presenting a new research approach? “Well”, Albertazzi says, “Glyco-PAINT won’t ever be as relevant as DNA-PAINT because it is far more specific. But there’s a whole community of glycobiologists and glycochemists studying the role of sugars in many domains and applications. I already got contacted by scientists active in glycoscience to collaborate, or to speak at a conference. They’re very much interested. I won’t promise that Glyco-PAINT will lead to a Nobel prize discovery, but I really think this will be a great improvement for the field.”

**“ONCE WE GOT THE  
MICROSCOPE TO WORK,  
THE RESULTS KEPT ON COMING.”**



# Presenting: The new PhD Outreach Team

The PhD Outreach team: Imke Krauhausen (chair), Stijn Hofstraat (co-chair), Anahita Amiri (administration), Ana Ortiz-Perez (events & communication), Zhongquan Chen (communication), René de Bruijn (treasurer)

The COVID pandemic made matters worse, says Imke Krauhausen. "I started my PhD two months before the COVID pandemic broke out, when hanging out together after work was normal. And then all that stopped for almost two years." Now, Imke is one of the six members of the new PhD Outreach Team, which has the task of improving the cohesion of this group, and stimulate engagement and social contacts.

They succeed the first PhD Outreach Team, which was initiated by ICMS managing director Monique Bruining. Starting such a team was considered a necessary antidote to the social isolation inflicted by COVID restrictions, especially on PhDs who had recently arrived in Eindhoven from other countries. The first year's main

event, the PhD Paper Award, is to be continued, says the team. In the first round, five contestants are selected by an expert committee for the on stage event in November. "You have to present your research in five minutes in layman's terms," explains Outreach Team member Ana Ortiz-Perez, "next, there will be a vote by the public, as well as by the expert committee."

## BOOK CLUB

It is perhaps not surprising, that the team will also continue to schedule barbecues and similar social events. But new ideas include a book club and skill sessions. In the book club, the plan is not to read and discuss the latest novels, but non-fiction books that are relevant to PhD life. For example, books that discuss essential professional skills or books that might

help when your career gets into the doldrums and mental health issues must be dealt with. Skill sessions should give the PhD student better tools to progress to the next stage of his or her career, for instance how to use LinkedIn to your best advantage.

Team members serve a one year term – as volunteers. How much time do these already busy PhD students dedicate to outreach work? Team member Stijn Hofstraat: "Usually, it's only a few hours a week. But I'm sure that will increase a lot in the final weeks up to the PhD Paper Award."







# The sweet promise of sugar polymers

Even though she is still in the early stages of her career, Lu Su already gained research experience on three continents. Within the ICMS framework at TU/e she studies the fundamentals of multicomponent supramolecular polymerizations, including sugar polymers. Why are sugar polymers so hard to synthesize? In her quest to improve applications, she highly values the open collaboration in Dutch science. This explains her next step as assistant professor at LACDR in Leiden, where she also aims to enjoy life with her family in the local community.



## SCIENCE PAPER

Very recently, Su and her team discovered a counterintuitive phenomenon in a multicomponent supramolecular system. "It's about gel-sol-gel-sol transitions upon dilution in water. The upcoming Science paper on it emphasizes the critical role of concentrations in multicomponent systems and are useful to understand several phenomena in biology."



Lu Su  
Assistant professor at LACDR in Leiden

"If you want to be a great scientist, be a great, honest person." This is the most important thing that her former professor Ming Jiang taught Su at the prestigious Fudan University in Shanghai where she got her PhD. Assistant professor Guosong Chen taught her, that if you want to develop fast, you need to work hard.

In her field of polymer science, Su was the first at her research group to dive into carbohydrates and enter the world of sugar polymers. This specialization led her to Karen Wooley's group at Texas A&M University in College Station, Texas. "I worked on the synthesis of glycopolymers, macromolecules with versatile applications. They can be used to mimic natural materials. This offers a simplified model to study multivalent carbohydrate-protein interaction."

## OIL & DRUGS

When synthetic glycopolymers are incubated with macrophages, the response of these large immune cells can be measured. "The body itself is too complex to study this interaction in isolation. This simplification enables better understanding of how glycopolymers and cells interact. It offers a workable model to study targeted drug delivery in the body," Su says.

A similar biomaterial can be synthesized and used for an entirely different application as well. "It is amazing what can be done with sugars. They are abundantly available and they are degradable, which is a vital aspect," she states. "In Texas, we produced magnetized micelles, nanoparticles of polyglucose carbonates with a hydrophilic and a hydrophobic part. These were deployed to clean up tiny amounts of remaining oil after cleaning up the large crude oil spill in the Gulf of Mexico at that time. The nanoparticles absorb the oil and can be collected afterwards with a magnet." During her stay in Texas, Karen Wooley was a role model for Su. She showed what women can achieve in science. "It also taught me what societal impact your work can have."

## COLLABORATIVE ATMOSPHERE

The biomaterial and mechanism used against oil spills have similarities with sugars used for drug delivery, says Su: "You can use micelles to load oil, but also to load drugs. For the latter application, the micelle has a positively charged hull that penetrates the tumor, where it subsequently unloads its cargo of chemotherapeutics." That is the goal, but these sugars are hard to synthesize. Most of the polymers made for this purpose failed. But why? "That question got me interested in the fundamentals of supramolecular chemistry. It brought me to Bert Meijer's lab at the TU/e and ICMS." Working here was an eye-opener for Su. "In Eindhoven, education and collaboration get priority. It offers a very nice working environment. You share facilities and discuss your work with colleagues and your supervisor. Is there certain knowledge you need in Nijmegen? Then visit Nijmegen to have an open exchange with scientists there. I really love this collaborative scientific atmosphere in the Netherlands."

## WORK-LIFE BALANCE

So, when the opportunity emerged to move to Leiden for an assistant professorship, Su jumped to the occasion. She will start in May at Matthias Barz' group at the Leiden Academic Centre for Drug Research (LACDR). It means a return to applied research: "They are very good at synthesis and molecular design of polymers for targeted drug delivery. The focus is on polypeptides used for drug delivery in heart disease. Control of the mechanical properties and dynamics of this material is a vital aspect I'll be working on. The fact that my father is a heart disease patient makes it extra special to work on this." She made her career decision in close collaboration with Bert Meijer, Su reveals: "Should I aspire to develop my own group or rather become part of a large existing group? The latter will allow me to spend more time with my partner and my child. Together we can get to know local society. These are valuable aspects for me at this point in life. Later on, I can gradually form my own group over time. I'm happy with that."



ALLIANCES



# Online dynamics during the 6th ICMS-IBEC joint symposium

Scientists from the Institute for Bioengineering of Catalonia (IBEC) and the Institute for Complex Molecular Systems (ICMS) gathered behind their laptops for the sixth edition of the ICMS-IBEC symposium

A joint symposium is a great way to foster new collaborations and strengthen existing ones. The symposium offers master students, PhD-students and postdocs involved in the exchange program an opportunity to present their research. The results of joint research projects are also presented to the audience. The event held on the 23th of March is the 6th edition in a series of joint symposia with the first one organized in 2018, marking the start of the still ongoing collaboration between IBEC and ICMS. A collaboration that covers both scientific research and education. This year, it was again an online meeting. "Hopefully, next time we will meet in person again, in a dynamic setting," symposium chair Jan van Hest (ICMS) stressed.

## JOINT VENTURES

Yet, even online it was a dynamic gathering. Several scientists discussed their successful joint ventures. Duo-presenters Shidong Song and Richard Post demonstrated an engineered motile system using stochastic distribution of enzymes. ICMS post-doc Sertan Sukas developed Traction Force Microscope-based technique to study the effects of shear and pressure on cell behavior and is now looking for collaborations with potential users of his platform. Tania Patiño Padial, who made the transfer from the IBEC-group of Samuel Sánchez and started last year a tenure track as assistant professor at ICMS, gave a clear overview of her work on biomedical nanobots.

## COMPETITION WINNER

This edition also featured pitches of participants of the exchange program. In this event, ICMS-master students who did (part of) their internship at an IBEC-research group were portrayed. They discussed a variety of topics, ranging from a 3D printed mouse bladder for the testing of micro-robots and the development of a microfluidic herringbone device to improve cancer detection to blood-brain barrier models and cell-laden hydrogels. PhD-student Roger Riera Brillas closed the online symposium by presenting his research on single-molecule imaging in live cells, using a point accumulation in nanoscale topography (see glyco-PAINT page 17-18) super-resolution microscopy method. For his outstanding work, Riera Brillas was recently named as winner of the ICMS PhD paper competition.



# Key publications

NOVEMBER 2021 – APRIL 2022

## 01. A FABRICATION STRATEGY FOR RECONFIGURABLE MILLIMETER-SCALE METAMATERIALS

H.D. McClintock, N. Doshi, A. Iniguez-Rabago, J.C. Weaver, N.T. Jafferis, K. Jayaram, R.J. Wood, J.T.B. Overvelde  
Adv. Funct. Mater. 31, 2103428 (2021)

## 02. CAGE LENGTH CONTROLS THE NONMONOTONIC DYNAMICS OF ACTIVE GLASSY MATTER

V.E. Debets, X.M. de Wit, L.M.C. Janssen  
Phys. Rev. Lett. 127, 278002 (2021)

## 03. COUPLED LIQUID CRYSTALLINE OSCILLATORS IN HUYGENS' SYNCHRONY

G. Vantomme, L.C.M. Elands, A.H. Gelebart, E.W. Meijer, A.Y. Pogromsky, H. Nijmeijer, D.J. Broer  
Nat. Mater. 20, 1702-1706 (2021)

## 04. CUCURBIT-LIKE POLYMERSOMES WITH AGGREGATION-INDUCED EMISSION PROPERTIES SHOW ENZYME-MEDIATED MOTILITY

S. Cao, H. Wu, I.A.B. Pijpers, J. Shao, L.K.E.A. Abdelmohsen, D.S. Williams, J.C.M. van Hest  
ACS Nano 15, 18270-18278 (2021)

## 05. DISTINCT EFFECTS OF HEPARIN AND INTERLEUKIN-4 FUNCTIONALIZATION ON MACROPHAGE POLARIZATION AND IN SITU ARTERIAL TISSUE REGENERATION USING RESORBABLE SUPRAMOLECULAR VASCULAR GRAFTS IN RATS

V. Bonito, S.E. Koch, M.M. Krebber, D.A. Carvajal-Berrio, J. Marzi, R. Duijvelshoff, E.B. Lurier, S. Buscone, S. Dekker, S.M.J. de Jong, T. Mes, K.R.D. Vaessen, E.M. Brauchle, A.W. Bosman, K. Schenke-Layland, M.C. Verhaar, P.Y.W. Dankers, A.I.P.M. Smits, C.V.C. Bouten  
Adv. Healthcare Mater. 10, 2101103 (2021)

## 06. EFFECT OF CO-SOLVENTS ON THE CRYSTALLIZATION AND PHASE DISTRIBUTION OF MIXED-DIMENSIONAL PEROVSKITES

A. Caiazzo, K. Datta, J. Jiang, M.C. Gelvez-Rueda, J. Li, R. Ollearto, J.M. Vicent-Luna, S. Tao, F.C. Grozema, M.M. Wienk, R.A.J. Janssen  
Adv. Energy Mater. 11, 2102144 (2021)

## 07. ENGINEERING TRANSIENT DYNAMICS OF ARTIFICIAL CELLS BY STOCHASTIC DISTRIBUTION OF ENZYMES

S. Song, A.F. Mason, R.A.J. Post, M. De Corato, R. Mestre, N.A. Yewdall, S. Cao, R.W. van der Hofstad, S. Sanchez, L.K.E.A. Abdelmohsen, J.C.M. van Hest  
Nat. Commun. 12, 6897 (2021)

## 08. FLOWER-LIKE COLLOIDAL PARTICLES THROUGH PRECIPITATION POLYMERIZATION OF REDOX-RESPONSIVE LIQUID CRYSTALS

X. Liu, M. Moradi, T. Bus, M.G. Debije, S.A.F. Bon, J.P.A. Heuts, A.P.H.J. Schenning  
Angew. Chem. Int. Ed. 60, 27026-27030 (2021)

## 09. ORGANIC NEUROMORPHIC ELECTRONICS FOR SENSORIMOTOR INTEGRATION AND LEARNING IN ROBOTICS

I. Krauhausen, D.A. Koutsouras, A. Melianas, S.T. Keene, K. Lieberth, H. Ledanseau, R. Sheelamanthula, A. Giovannitti, F. Torricelli, I. Mcculloch, P.W.M. Blom, A. Salleo, Y. van de Burgt, P. Gkoupidenis  
Sci. Adv. 7, eabl5068 (2021)

## 10. SINGLE-MOLECULE IMAGING OF GLYCAN-LECTIN INTERACTIONS ON CELLS WITH GLYCO-PAINT

R. Riera, T.P. Hogervorst, W. Doelman, Y. Ni, S. Pujals, E. Bolli, J.D.C. Codee, S.I. van Kasteren, L. Albertazzi  
Nat. Chem. Biol. 17, 1281-1288 (2021)

## 11. SMALL PEPTIDE-PROTEIN INTERACTION PAIR FOR GENETICALLY ENCODED, FIXATION COMPATIBLE PEPTIDE-PAINT

R.P. Tas, L. Albertazzi, I.K. Voets  
Nano Lett. 21, 9509-9516 (2021)

## 12. ULTRALOW DARK CURRENT IN NEAR-INFRARED PEROVSKITE PHOTODIODES BY REDUCING CHARGE INJECTION AND INTERFACIAL CHARGE GENERATION

R. Ollearto, J. Wang, M.J. Dyson, C.H.L. Weijtens, M. Fattori, B.T. van Gorkom, A.J.J.M. van Breemen, S.C.J. Meskers, R.A.J. Janssen, G.H. Gelinck  
Nat. Commun. 12, 7277 (2021)

## 13. 2D/3D HYBRID CS<sub>2</sub>AGBIBR<sub>6</sub> DOUBLE PEROVSKITE SOLAR CELLS: IMPROVED ENERGY LEVEL ALIGNMENT FOR HIGHER CONTACT-SELECTIVITY AND LARGE OPEN CIRCUIT VOLTAGE

M.T. Sirtl, R. Hooijer, M. Armer, F.G. Ebadi, M. Mohammadi, C. Maheu, A. Weis, B.T. van Gorkom, S. Häringer, R.A.J. Janssen, T. Mayer, V. Dyakonov, W. Tress, T. Bein  
Adv. Energy Mater. 12, 2103215 (2022)

## 14. 4D PRINTING OF LIQUID CRYSTALS: WHAT'S RIGHT FOR ME?

M. del Pozo, J.A.H.P. Sol, A.P.H.J. Schenning, M.G. Debije  
Adv. Mater. 34, 2104390 (2022)

## 15. A SINGLE-MOLECULE VIEW AT NANOPARTICLE TARGETING SELECTIVITY: CORRELATING LIGAND FUNCTIONALITY AND CELL RECEPTOR DENSITY

L. Woythe, P. Madhikar, N. Feiner-Gracia, C. Storm, L. Albertazzi  
ACS Nano 16, 3785-3796 (2022)

## 16. CAN SUPER-RESOLUTION MICROSCOPY BECOME A STANDARD CHARACTERIZATION TECHNIQUE FOR MATERIALS CHEMISTRY?

S. Dhiman, T. Andrian, B.S. Gonzalez, M.M.E. Tholen, Y. Wang, L. Albertazzi  
Chem. Sci. 13, 2152-2166 (2022)

## 17. CONTROLLING THE LENGTH OF PORPHYRIN SUPRAMOLECULAR POLYMERS VIA COUPLED EQUILIBRIA AND DILUTION-INDUCED SUPRAMOLECULAR POLYMERIZATION

E. Weyandt, L. Leanza, R. Capelli, G.M. Pavan, G. Vantomme, E.W. Meijer  
Nat. Commun. 13, 248 (2022)

## 18. COOPERATIVITY AS QUANTIFICATION AND OPTIMIZATION PARADIGM FOR NUCLEAR RECEPTOR MODULATORS

P.J. de Vink, A.A. Koops, G. D'Arrigo, G. Cruciani, F. Spyraakis, L. Brunsveld  
Chem. Sci. 13, 2744-2752 (2022)

## 19. EXPANDING QUASIPERIODICITY IN SOFT MATTER: SUPRAMOLECULAR DECAGONAL QUASICRYSTALS BY BINARY GIANT MOLECULE BLENDS

Y. Liu, T. Liu, X.-Y. Yan, Q.-Y. Guo, H. Lei, Z. Huang, R. Zhang, Y. Wang, J. Wang, F. Liu, F.-G. Bian, E.W. Meijer, T. Aida, M. Huang, S.Z.D. Cheng  
Proc. Natl. Acad. Sci. U. S. A. 119, e2115304119 (2022)

## 20. MONOLITHIC ALL-PEROVSKITE TANDEM SOLAR CELLS WITH MINIMIZED OPTICAL AND ENERGETIC LOSSES

K. Datta, J. Wang, D. Zhang, V. Zardetto, W.H.M. Remmerswaal, C.H.L. Weijtens, M.M. Wienk, R.A.J. Janssen  
Adv. Mater. 34, 2110053 (2022)

## 21. ONE-POT SYNTHESIS OF MELT-PROCESSABLE SUPRAMOLECULAR SOFT ACTUATORS

S.J.D. Lugger, D.J. Mulder, A.P.H.J. Schenning  
Angew. Chem. Int. Ed. 61, e202115166 (2022)

## 22. REVEALING DEFECTIVE INTERFACES IN PEROVSKITE SOLAR CELLS FROM HIGHLY SENSITIVE SUB-BANDGAP PHOTOCURRENT SPECTROSCOPY USING OPTICAL CAVITIES

B.T. van Gorkom, T.P.A. van der Pol, K. Datta, M.M. Wienk, R.A.J. Janssen  
NAT. COMMUN. 13, 349 (2022)

## 23. THE INTRINSIC PHOTOLUMINESCENCE SPECTRUM OF PEROVSKITE FILMS

T.P.A. van der Pol, K. Datta, M.M. Wienk, R.A.J. Janssen  
Adv. Opt. Mater. 10, 2102557 (2022)



# TU/e grants honorary doctorate to David Mooney

David Mooney

For a long time, Harvard's David Mooney has been a much valued advisor and peer to ICMS researchers. His capacity for crossing scientific borders, pioneering mindset and inspiring leadership have now been acknowledged with an honorary doctorate of TU/e.

On May 12, the TU/e witnessed a very special PhD ceremony. Three distinguished scientists were installed as honorary doctors in recognition of their outstanding achievements as researchers, teachers, mentors and all-round leaders in their respective fields. One of them was David Mooney, professor of bioengineering at Harvard University's Wyss Institute and a well-known name and face within ICMS, particularly for those who work in biomaterials and regenerative medicine. Carlijn Bouten and Patricia Dankers acted as honorary promotor. Having two promotor at such a ceremony is quite uncommon, but it immediately illustrates the wide scope of Mooney's research, as Bouten pointed out in her laudatio. "Your research is at the interface of materials science, engineering and medicine. You embody all the disciplines in one person. This definitely says something about your fantastic capabilities of crossing scientific borders," she said.

## TRICKY DISC

A very appealing example of Mooney's cross-border perspective and pioneering mindset is the preclinical development of the first vaccine ever to beat melanoma. Already in 2009, together with his team, he designed a tiny disc-like material filled with tumor-specific antigens. The disc can be inserted under the skin, where it activates the immune system to trick the body into destroying the tumor cells by itself. Next to Mooney's impressive track record in science, Dankers emphasized his leadership in a broader perspective. "David is a role model and source of inspiration to students and researchers around the world. We thank him for his inexhaustible contribution to the Dutch research field of regenerative medicine."

## CAREER ADVICE

Prior to the official ceremony, a gathering of Master's students, PhD candidates, postdocs and advanced researchers could experience Mooney's approach to mentorship and career development during a so-called College Tour event where the audience asked questions on career development. It was a very open and interactive session where Mooney and the two other new honorary doctors - Margot Gerritsen of Stanford University and Klavs Jensen of MIT - shared the choices they faced along the way and what success means to them. They all had the same advice to the audience: don't get blinded by status or reputations, but try to find out what really interests you and focus on that. That is all the planning you need.



# ICMS Annual Symposium 2022



◀ Laura De Laporte (Aachen University) develops smart microgels that create anisotropic environments for nerve regeneration. These so-called anisogels are hybrid material that contain miniscule, magnetic rods that can be orientated in a certain direction to generate anisotropy in the gel-based matrix.



▲ Levena Gascoigne presented the PhD outreach program and the winner of the paper competition.



◀ Roger Riera Brillas, PhD student in the group of Lorenzo Albertazzi (BMT), presented his work on glyco-PAINT, a new super-resolution microscopy technique that allows quantitative analysis of transient interactions at the single-molecule level. For this work, published in Nature Chemical Biology, Riera was named the winner of the PhD Paper Award in December 2021.



▶ Martin van Hecke (Leiden University) enlightened and entertained the audience with his studies into the behavior of crumpled objects. How does a material respond to a stimulus, does it always follow the same pathways in that response and are these pathways reversible or does the material get back to its original state via a different route? Intriguing questions that left the audience with some serious food for thought.

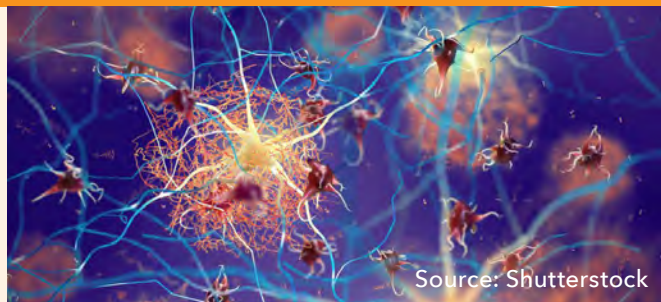


▲ Dylan Mostert, PhD student in the group of Carlijn Bouten (BMT), explained her approach to re-engineer the structural anisotropy in the extracellular matrix of the heart. Myocytes (heart muscle cells) need this anisotropy to function. After a myocardial infarction, fibroblasts infiltrate the matrix and remodel its structure. As a result, the heart cannot contract properly anymore, leading to loss of function. Mostert is creating an in vitro myocardial environment using methacrylated recombinant collagen peptide (RCP-MA), a synthetic peptide based on human collagen, as the material for the matrix. The stiffness of RCP-MA can be tuned through chemical modifications, creating a suitable environment for myocytes.



◀ Does your reaction require high concentrations of your catalyst? Then you might want to consider going down to the nanoscale, suggested Joost Reek (University of Amsterdam). He presented the Nanoconcentrator; it sounds like something an evil Marvel character may use, but in reality it is a very friendly way to enhance catalytic efficiency. By encapsulating the catalysts in nanospheres, you create local high concentrations, leading to very fast reactions in those spheres.

# News, awards & grants



## Two ICMS researchers receive Veni grants

**THE DUTCH RESEARCH COUNCIL (NWO) HAS AWARDED TWO ICMS RESEARCHERS A VENI GRANT. PETER COSSAR AND FABIAN EISENREICH WILL EACH RECEIVE A GRANT WORTH 280 K€. THIS FUNDING WILL BE USED BY THE YOUNG RESEARCHERS TO EXPLORE THEIR OWN RESEARCH IDEAS FOR A PERIOD OF THREE YEARS, FOR AN INNOVATIVE APPROACH IN DRUG DISCOVERY AND FOR MAKING CHEMICAL REACTIONS MORE SUSTAINABLE WITH SUNLIGHT.**

NWO awarded 89 Veni grants within the domains Science (ENW) and ZonMW. The Veni grant is part of the NWO Talent Program and each year, it is awarded to promising early-career researchers. Due to COVID-19 and a computer hack at NWO, awards for the scientific domains had to be split this year. For the next rounds of the Veni awarding scheme, all awards take place at the same time. Two ICMS TU/e Veni laureates will use their funding to perform challenging research in several disciplines.

## Reinoud Lavrijsen Teacher of the Year 2022



Reinoud Lavrijsen has been elected Teacher of the Year 2022 by the Dutch National Students Association. In Utrecht, the associate professor at the TU/e Department of Applied Physics came away with the national title. Lavrijsen: "I am extremely happy to have been elected subject geek."

Reinoud Lavrijsen Teacher of the Year 2022. During the mini-lecture he gave for the jury. Photo: Rein Wieringa

**Peter Cossar** (department of Biomedical Engineering) would like to alter the dynamics of aggregated disordered pathogenic proteins in such a way that they could be disposed of by the cell in a "protein cage."



Neurogenerative diseases such as Alzheimer's and Parkinson's are frequently caused by an aggregation of disordered proteins within neural cells. The unstructured nature of disorder proteins prevents therapeutic intervention as small molecules are unable to bind to these so-called Intrinsically Disordered Proteins (IDPs). TU/e researcher Peter Cossar, a postdoctoral researcher in the Biological Chemistry group of Luc Brunsveld, employs innovative approaches for drug discovery. His Veni research will focus on capturing IDPs in a protein cage and hijacking the cell's native disposal system to remove the disease-causing protein. Cossar intends to develop bifunctional drugs that can both capture the disease-causing protein in a cage and enable the protein to be tagged for degradation by the cell.

**Fabian Eisenreich** (currently working at the Department of Chemical Engineering and Chemistry) is interested in making chemical reactions more sustainable.



Each year, the chemical industry produces a vast amount of organic waste. Astonishingly, more than 80% of the produced waste is attributed to just a single source: organic solvents. Green and sustainable chemical technologies are urgently required to minimize our future environmental footprint. Fabian Eisenreich, who is inspired by biological processes like photosynthesis, would therefore like chemical reactions to take place in water, instead of organic solvents. In his Veni research, Eisenreich will develop tailor-made, water-soluble nanoreactors that contain powerful photocatalysts. In these bioinspired reactors, chemical reactions will take place in pure water fueled by the power of (sun)light. With this innovative approach, he would like to contribute to the advancement of sustainable and green chemistry.



## Ambagon: TU Eindhoven spin-off raises 75 million to develop new cancer treatments

**NEW MEDICINES TO FORM THE BASIS OF VARIOUS CANCER TREATMENTS IN THE FUTURE.**



The biotechnology start-up Ambagon Therapeutics has raised 75 million euros (85 million dollars) in a financing round. With the money, the Dutch-American company will develop medicines that can be used to better treat cancer in the future. Ambagon was founded in 2020 on the basis of a number of years of research at TU Eindhoven by Eline Sijbesma, Loes Stevers and others.

An example of the TU/e-based research that has acted as the foundation for Ambagon comes from Eline Sijbesma. In her research, she created a molecular glue that provides a starting point for the development of drugs to treat breast cancer. The glue also offers good prospects for the development of medicines for, among others, diabetes and cystic fibrosis. The results were published in Nature Communications in 2020.

Founders Luc Brunsveld (left) and Christian Ottmann.  
Photo: Leonie Voets

## Research on immune system response and low-cost energy storage awarded ERC grants

**ERC STARTING GRANTS FOR ANTHAL SMITS AND ANTONI FORNER-CUENCA**

For TU/e researchers Anthal Smits and Antoni Forner-Cuenca the new year has started with great news as each has been awarded European Research Council (ERC) Starting Grants worth 1.5 million euros. Smits will use the funding to work on immune system response to implants. The researchers can use the funding for their research over the next five years. With his ERC Starting grant, Antoni



Anthal Smits

Antoni Forner-Cuenca

Forner-Cuenca aims to make an impactful contribution to the field of electrochemical science by investigating new low-cost energy storage technologies.

# Theses

NOVEMBER 2021 – APRIL 2022

**A computational approach for high-throughput virtual screening of organic electroactive compounds for aqueous redox flow batteries**

QI ZHANG

**November 1, 2021**

PhD advisors:  
R.A.J. Janssen  
S. Er

**Microwave cavity resonance spectroscopy of ultracold plasmas**

MARK VAN NINHUIJS

**November 2, 2021**

PhD advisors:  
O.J. Luiten  
J. Beckers

**Supramolecular polymers under the magnifying glass: on the interplay between structure, dynamics and function**

SANDRA SCHOENMAKERS

**November 30, 2021**

PhD advisors:  
E.W. Meijer  
A.R.A. Palmans

**Shaping polymeric nanocarriers for immunotherapy**

ANNELIES WAUTERS

**December 3, 2021**

PhD advisors:  
J.C.M. van Hest  
L.K.E.A. Abdelmohsen

**Functionalized anisotropic polyolefins**

SIMON HOUBEN

**December 7, 2021**

PhD advisors:  
A.P.H.J. Schenning  
D.J. Broer  
Z. Borneman

**A multi-scale investigation of tendon- and ligament disorders**

MARC VAN VIJVEN

**December 8, 2021**

PhD advisors:  
K. Ito  
J. Foolen

**Controlled block copolymer segregation for functional coating surfaces**

STEFAN GOVERS

**December 9, 2021**

PhD advisors:  
A.C.C. Esteves  
R. Tuinier  
G. de With

**Supramolecular injectable hydrogels for local cardiac therapy**

MAAIKE SCHOTMAN

**December 9, 2021**

PhD advisors:  
P.Y.W. Dankers  
L.K.E.A. Abdelmohsen

**Tumor markers in diagnosis and therapy monitoring of lung cancer**

REMCO DE KOCK

**December 14, 2021**

PhD advisors:  
V. Scharnhorst  
L. Brunsveld  
B. Deiman

**4D printing of liquid crystals**

MARC DEL POZO PUIG

**December 22, 2021**

PhD advisors:  
A.P.H.J. Schenning  
C.W.M. Bastiaansen  
M.G. Debije

**Continuous biomolecular sensing with single-molecule resolution: explorations of bioanalytical functionalities**

RAFIQ LUBKEN

**January 14, 2022**

PhD advisors:  
M.W.J. Prins  
A.M. de Jong

**Modeling and optimization of polymer extrusion**

MICHELLE SPANJAARDS

**January 21, 2022**

PhD advisors:  
P.D. Anderson  
M.A. Hulsen

**Internal catalysis in dynamic covalent networks**

HUI ZHANG

**January 28, 2022**

PhD advisors:  
R.P. Sijbesma  
J.P.A. Heuts

**Single cell approach towards immune signaling dynamics**

NIDHI SINHA

**February 10, 2022**

PhD advisors:  
C.V.C. Bouten  
J. Tel

**Antimicrobial supramolecular biomaterials: from molecular design to screening**

MONIEK SCHMITZ

**February 15, 2022**

PhD advisors:  
P.Y.W. Dankers  
S.A.J. Zaat

**Biofunctionalization strategies for continuous monitoring biosensors**

YU-TING LIN

**February 22, 2022**

PhD advisors:  
M.W.J. Prins  
A.M. de Jong



**Nanoporous filtration membranes based on columnar liquid crystals**

PATRICIA MARIN SAN ROMAN

**February 25, 2022**

PhD advisors:  
R.P. Sijbesma  
D.C. Nijmeijer

**Bis-urea based supramolecular hydrogels as extracellular matrix mimics**

JIE LIU

**March 3, 2022**

PhD advisors:  
R.P. Sijbesma  
P.Y.W. Dankers

**Performance analysis of external gear pumps in polymer extrusion**

VINCENT DE BIE

**March 11, 2022**

PhD advisors:  
P.D. Anderson  
M.A. Hulsen

**Mechanofluorescent visualization of stresses in polymers and composites**

ANNELORE AERTS

**March 22, 2022**

PhD advisors:  
R.P. Sijbesma  
J.P.A. Heuts

**Cholesteric liquid crystals in additive manufacturing**

JEROEN SOL

**March 30, 2022**

PhD advisors:  
A.P.H.J. Schenning  
M.G. Debije

**In situ vascular tissue engineering: methods, models, and mechanisms**

SUZANNE KOCH

**March 30, 2022**

PhD advisors:  
C.V.C. Bouten  
A.I.P.M. Smits

**Microscale engineering of active systems: exploiting dynamicity to induce motility**

SHIDONG SONG

**April 1, 2022**

PhD advisors:  
J.C.M. van Hest  
L.K.E.A. Abdelmohsen

**Artificial organelles based on hybrid protein nanoparticles**

SUZANNE TIMMERMANS

**April 6, 2022**

PhD advisors:  
J.C.M. van Hest  
P.P.A.M. van der Schoot

**Targeting cellular surface receptors using DNA nanostructures**

GLENN CREMERS

**April 8, 2022**

PhD advisors:  
T.F.A. de Greef  
L. Albertazzi

**In vitro models for investigating vascular flow: a toolbox for recreating the vasculature on chip**

ANDREAS POLLET

**April 12, 2022**

PhD advisors:  
J.M.J. den Toonder  
M. Mischi

**Strong light-matter coupling in organic crystals**

MATTHIJS BERGHUIS

**April 20, 2022**

PhD advisors:  
J. Gómez Rivas  
A.G. Curto

**Exploring the morphology, chemistry, and mechanics of biogenic silica in diatoms**

MOHAMMAD SOLEIMANI

**April 21, 2022**

PhD advisors:  
R.A.T.M. van Benthem  
H. Friedrich



# Decoy-receptors as the Trojan Horse

Take an actual problem and solve this by using Synthetic Biology. That is the essence of the international iGEM student competition. The TU/e's 2022 team are still brainstorming on which autoimmune disease to treat, they do know how: Create a synthetic receptor that detects auto-antibodies and subsequently activates a signaling process to control the immune system. If they can stimulate the formation of decoy receptors that collect auto-antibodies as well as the degradation of malfunctioning B-cells, this could turn into a breakthrough in treating autoimmune diseases.

Enthusiastic, motivated and determined; that is the TU/e iGEM'22 team in a nutshell. "We want to make a synthetic receptor to treat autoimmune diseases," says Team Manager Jolien Marcelis (22). Professors associated with TU/e consult and guide the students throughout their project. One of them read an article about how Long COVID could trigger autoimmune diseases. The team started to delve into it. What is the problem? How can it be fixed? It was decided then and there to focus on autoimmune diseases and come up with a solution that fits within the field of Synthetic Biology.

## IMPACT ON HEALTHCARE

"Ever since I was a little girl, I was amazed by DNA and genetics," says Marcelis who is a master student in Biomedical Engineering. Through different committees and participating in a former student team, she gained the practical experience to manage this project. She loves the

potential of Synthetic Biology and the opportunities it brings for future medicine. "I like to make an impact in healthcare and I strongly feel that with iGEM, I can contribute to this."

Kim Wintraecken (22) is the Design Coordinator and a master student in Industrial Design. Her study background helps her visualize iGEM's vision and mission, and she can utilize her experience in the communication with stakeholders. "I know what questions to ask to retrieve valuable information for our concept." She joined iGEM because she wanted to contribute to society and healthcare with her designs. "The practical experience is a huge benefit."

## DETECT AND DEACTIVATE

So far, most autoimmune diseases can't be cured. "We want to create a synthetic receptor that can detect auto-antibodies, and thereby activate a signaling process where both the auto-antibodies

and the malfunctioning B-cells are deactivated," Marcelis explains. This means they must combine two systems. First, synthetic receptors that can detect molecules that in turn activate a signaling process. Second, generate decoy receptors which subsequently collect the auto-antibodies that cause the autoimmune disease.

With a multidisciplinary team, they try to counter the reputation of iGEM being specifically for Biomedical Engineering students. Wintraecken: "Our team is amazing and we learn a lot from each other. The drive we have as a team makes it worthwhile and fun. We're very motivated to contribute to research of Synthetic Biology." The team is happy to receive ideas and suggestions. Marcelis: "We always like to discuss topics that concern our project. Feel free to reach out!"

Contact the team at [iGEM@tue.nl](mailto:iGEM@tue.nl)





# The value of postdocs

Ignasi Jorba  
Masdén

Two years ago, just before the COVID pandemic hit, Ignasi Jorba Masdén joined TU/e. More specifically, the group of Carlijn Bouten, where he works on the development of in vitro models to characterize mechanical properties of soft (cardiac) tissues, and studies how these tissues and cells behave in modelled environments. Soon after his enrollment, he entered the Postdoc Association (PDA) board, (sponsored by the TU/e Institutes, EIRES, EAISI, EHCI and ICMS) where he is in the postdoc paper committee. “The postdoc Best Paper Award does not solely highlight the researcher, but also shows the value of us postdocs.” Early 2022, Jorba was awarded an ICMS Fellowship.

Jorba obtained his PhD at the Institute for Bioengineering of Catalonia (IBEC) in Barcelona. “The aim of my thesis was to characterize the mechanical properties of soft tissues in order to understand and predict how cells will behave in their environment.” IBEC works in close collaboration with ICMS, which made him apply here. He builds on his past expertise to develop in vitro models to understand how tissue mechanical properties shape cardiac cell behavior.

#### SHARED INTERESTS

He became aware of the PDA and their events and eventually joined the

PDA board. “I wanted to contribute to the postdoc community. Everyone works in very different scientific fields, but we all have the same worries and interests in terms of career development or personal well-being.” The association brings people together to share their thoughts and ideas. Through the paper competition, they try to create recognition for postdocs within and outside of TU/e. “It’s worth mentioning on your resume as well, which can be interesting when applying for another positions.”

To participate in the competition, researchers have to be first author on

a paper that was published within the last 18 months and they have to be currently working at TU/e. Participants are scored on the scientific quality of their research, the (potential) social impact, and how they present their results. This year will feature the second edition of the competition and 23 researchers participate. A good amount, considering there are approximately 250-300 postdocs. “We received papers from all departments, that means we’re achieving what we aim for: to be transversal around TU/e and make everyone feel like they can be part of it.”

# The importance of asking questions



Richard Post

“Not everything can be directly learned from data. You need to consult the experts in that specific field to discuss the underlying assumptions”, says Richard Post, a mathematician who builds bridges between mathematics and biochemistry within the ICMS community. He is currently finishing his PhD in statistics on the heterogeneity of causal effects, under supervision of Edwin van den Heuvel. Post was awarded an ICMS Fellowship in April 2022. He will continue his causality research with as many collaborations as possible within the institute.



"Mathematics is abstract, but generic at the same time. Whether you're trying to solve a chemical, economic or a marketing problem, they are essentially the same, just the variables are interchangeable."

Post studied Industrial and Applied Mathematics (IAM) at TU/e with a specialization in statistics, probability and operations research. For his ICMS projects, he mainly works with Remco van der Hofstad. He also collaborates with the group of Jan van Hest on stochasticity in dynamic recruitment of receptors stimulated by the multivalent binding of supramolecular polymers (more on this in the joint interview with Shidong Song on page 34).

#### ARTICULATE

While Post was already quite familiar with biochemistry thanks to his parents who are biologists, his knowledge in this area has grown exponentially thanks to his ICMS colleagues. "Solving complexity requires multidisciplinary research. If we really want to solve today's problems, we need collaborations between scientists with different backgrounds who can build bridges. To do multidisciplinary science, you need to be articulate in describing your view and ideas, and not be afraid to acknowledge if something is not clear. When collaborating with an expert in a field you know little about, it is crucial to ask questions. Otherwise misconceptions will arise and progress stagnates."

#### COFFEE

With his Fellowship Post hopes to emphasize the importance of mathematics representation within the institute. "It has a strong core and focus on biochemistry and biomedical sciences. I also hope to be able to be the spokesperson for mathematics students and stimulate them to consider opportunities within ICMS. I look forward to getting to know people within the community. I cannot start projects will all scientists, but I would like to have a cup of coffee with as many as possible and brainstorm about possibilities."

## Eurotech Postdoc: Alexander Gräwe

A one-step virus test that quickly reveals how infectious a person is. That is the goal of Alexander Gräwe's project. He will start in July, and is fairly confident that the project will succeed.

The test will use new, to be developed modular protein nanoswitches that recognize and bind to unique molecular patterns at the virus surface. Upon binding, the nanoswitch is forced open, disabling an inhibitor, causing the protein to produce a bioluminescent signal. A nasal swab from a patient put in a solution with these proteins will produce a light signal proportional to the amount of live virus, which can then be analyzed by a smartphone. The resulting insights into the molecular interactions with viral surfaces may also help in developing new vaccines or antiviral medicines.

Gräwe will collaborate with Maarten Merckx's group at TU/e, Bruno Correia's group at EPFL in Lausanne, and the group of Robert de Vries at Utrecht University. First, he will develop this test for Influenza A virus, but the construction principle is generic, and according to Gräwe, quite easy to fine-tune for corona and many other viruses.



Alexander Gräwe





# Enzymes on the move

**Multi-disciplinary research team makes artificial cells move and can control their motility.**

One important function of living cells is that they can move in response to stimuli. PhD students Shidong Song and Richard Post studied enzyme distribution on the membrane of artificial cells in collaboration with scientists from the Institute of Bioengineering of Catalonia (IBEC). In a joint Nature Communications paper, they now describe for the first time how stochastic enzyme movement could control motile behavior of artificial cells.





Tissue repair, control of inflammation or wound healing. In many processes, cellular movement is essential. In response to chemical or mechanical stimuli, cells can migrate to the desired location in the body. A characteristic that we also like to incorporate in our artificial cells, says recently graduated biophysicist Shidong Song. During her PhD-project in the group of Jan van Hest, she tried to improve artificial cell systems. "We would like to synthesize a cell that is as functional as possible. Cellular movement plays a leading role. We therefore went back to the basics and asked ourselves: what makes a particle move?"

#### **SHARING KNOWLEDGE**

Song was the first PhD-student in the exchange program of ICMS and collaboration partner IBEC, established to foster research by sharing knowledge and infrastructure. The number of participating PhD-students is still growing, strengthening the institutional-level alliance. "Our group has a lot expertise in the field of artificial cells, the group of Samuel Sánchez in Barcelona is leading in the study of motion and motile behavior of micro- and nano-motors. In the beginning of my PhD-project, I visited the Sánchez lab for several months to learn the fundamentals in this field and brought new methods back to Eindhoven."

#### **MIMICKING REAL CELLS**

Song's artificial cells have a fluidic, moving cell membrane, similar to the lipid membrane of living cells. By modifying enzymes with a fluorescent tag, Song was able to visualize how enzymes move along the artificial membrane. In one of these experiments she found that asymmetrical and dynamic distribution of the enzymes might play an important role in the generation of particle movement. To understand whether this was a systematic observation, she enlisted the help of mathematician and ICMS-colleague Richard Post. The combination of biophysics and mathematics proved to be very successful. Together they showed for the first time that motile enzymes on the artificial cell surface can induce motion of the cell.

#### **LEVELS OF RANDOMNESS**

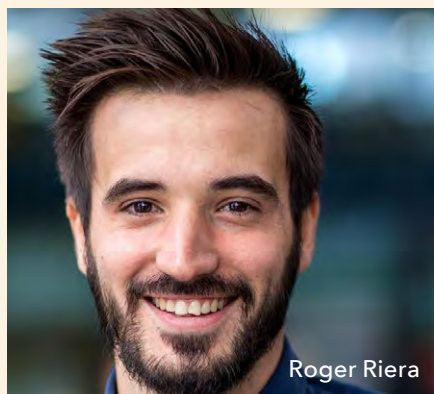
Core of our approach is the fact that we impart stochasticity – something that occurs randomly – to generate motion, Post explains. "Enzymes are dynamic and can move freely over time on the surface of our particles. Sometimes the enzymes are close to each other, at other particles a more evenly distribution can be observed. Randomness could be subdivided into three levels, each explaining a part of the motile behavior of the particle. Shidong's experimental observations were the basis of mathematical models that I developed to predict motile behavior of the particles; Shidong went back to the lab to test them. The most exciting finding was that we can interfere with particle motility by playing with the degree of asymmetry of enzymatic distribution on the cell surface. This could be crucial in future engineering systems, being able to mimic some sort of motility and thus generate typically slow or fast moving particles."

### **"WE CAN INTERFERE WITH PARTICLE MOTILITY BY PLAYING WITH THE DEGREE OF ASYMMETRY OF ENZYMATIC DISTRIBUTION."**

#### **UNIQUE COMBINATION**

Both Song and Post emphasize that their teamwork, originated within ICMS, is quite unique. "The combination of biophysical experiments and stochastic mathematical models is not common. However, this generation of complex science increasingly requires discussion between disciplines. ICMS started pioneering with this approach, and as young scientists we can only benefit. Because we already proved that it can open many new doors and we are convinced that it will take engineering of artificial cells to the next level. A very exciting one."

# News, awards & grants



Roger Riera

## The second ICMS PhD award concludes with a sweet win for Roger Riera

**THE ICMS PHD AWARD CELEBRATED ITS SECOND EDITION FRIDAY 10TH OF DECEMBER IN AN ONLINE FORMAT. FIVE PHD STUDENTS WERE SELECTED TO SHOWCASE THEIR RESEARCH WORK IN A FIVE-MINUTE PITCH DURING THE AWARD FINALE.**

Roger Riera from the department of Biomedical Engineering won the PhD award with his research on sugar receptor mapping using advanced microscopy.

The ICMS PhD award celebrated its second edition Friday 10th of December in an online format. Five PhD students were selected to showcase their research work in a five-minute pitch during the award finale. Roger Riera from the department of Biomedical Engineering won the PhD award with his research on sugar receptor mapping using advanced microscopy.

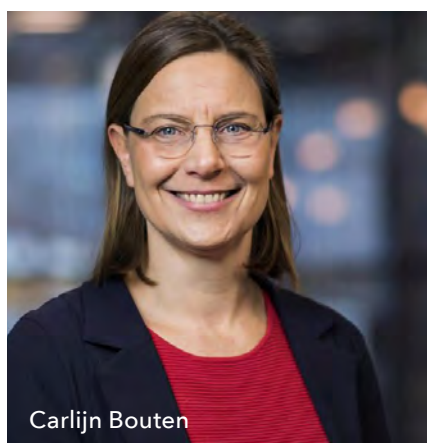
## Truly revealing when a material becomes “glassy”

**NEW FINDINGS ON THE GLASS PHASE OF “ACTIVE MATTER” ENDS AN INTENSE DEBATE IN THE SOFT MATTER PHYSICS COMMUNITY.**

Is it in a liquid phase or a “glassy” phase? This question has been the subject of intense debate as physicists try to understand the behavior of so-called “active matter” – a relatively new type of matter where particles use “a little internal engine” to move. With a new observation – published in the prestigious journal Physical Review Letters – TU/e researchers, Liesbeth Janssen and Vincent Debets from the department of Applied Physics, now resolve all contradictory results at the same time, thereby paving the way towards a better understanding of cell behavior in diseases like asthma and cancer.



## ERC Advanced Grant for Carlijn Bouten



Carlijn Bouten

**RESEARCH INTO RESTORING ORDER IN DAMAGED HEART MUSCLE TISSUE IS REWARDED WITH PRESTIGIOUS ERC ADVANCED GRANTS WORTH 2.5 MILLION EUROS.**

Professor Carlijn Bouten has been awarded a personal ERC Advanced Grant for her promising, but high-risk research proposal. She will investigate how the organization of heart muscle tissue can be restored when the heart muscle heals after an injury.

This grant of €2.5 million is awarded by the European Research Council (ERC) for research by leading scientists who wish to pursue an original high-risk, high-reward research proposal. The researchers and their teams can use the funding for their research over the next five years.



## Bert Meijer member of the National Academy of Sciences

**BERT MEIJER IS THE VERY FIRST TU/E PROFESSOR TO BE ELECTED A MEMBER OF THE NAS.**



In early May 2022, the National Academy of Sciences (NAS) in the United States of America granted professor Bert Meijer international membership of the academy. Membership for non-US citizens is extraordinary. Currently, there are only 13 other living Dutch members. Meijer is the very first TU/e professor to become a member of the NAS.

## Tom de Greef wins TU/e Ground-breaking Researcher Award 2022



On the very first TU/e Research Day, we celebrate science. This year, for the first time, we presented the TU/e Science Awards. This was also the first year we handed out the TU/e Science Awards. With these awards we recognize and reward our own scientists in different stages of their careers. The winners of the awards are Ruud van Sloun (exceptional uses of AI in imaging), Tom de Greef (development of a molecular computer, using DNA-technology) and Eva Demerouti (well-being and performance of employees).

Winners Tom de Greef, Ruud van Sloun and Eva Demerouti.  
Photo: Bart van Overbeeke

# News, awards & grants

## National Growth Fund awards 1.6 billion euros to projects in which TU/e is involved



Digital Ecosystem Mobility and Smart City (DEMS) also received an allocation. Photo: jamestehart via Shutterstock

### **EIGHT PROJECT PROPOSALS TO WHICH TU/E CONTRIBUTES WILL RECEIVE INVESTMENT IN THE SECOND ROUND OF THE GOVERNMENT'S INVESTMENT FUND**

Through the National Growth Fund, the government is investing €20 billion between 2021 and 2025 in projects intended to ensure long-term economic growth. In the second wave, €5 billion is being allocated to 28 project proposals. Over 1.6 billion of this will go to projects in which TU/e plays a role in the category of research, development and innovation. A portion of these grants will become available immediately; the rest of the amounts are subject to additional conditions.

Below are the projects in which ICMS is involved.

#### **Self-thinking molecular systems**

The top science consortium for Self-thinking molecular systems will receive up to 97 million euros conditionally. They are working at the interface of molecular chemistry and digital techniques such as AI, focusing on faster

computing power, known as "neuromorphic computing", and radical innovations in materials that can, for example, repair themselves. This project is led by a consortium in collaboration with the German Max Planck Institute.

#### **Duurzame MaterialenNL**

The Duurzame MaterialenNL (Sustainable Materials NL) program connects three materials clusters in the Netherlands: energy materials, construction materials and circular plastics. The investment from the National Growth Fund in the project is a conditional allocation of up to €220 million for the plastics research.

#### **PharmaNL**

The PharmaNL proposal focuses mainly on technical facilities for startups in the pharmaceutical industry. The maximum conditional investment from the National Growth Fund in the project is 80 million euros.



## Luc Brunsveld elected as member of the Royal Dutch Academy of Sciences

**PROFESSOR IN CHEMICAL BIOLOGY LUC BRUNSVELD AND PROFESSOR OF MECHANICS OF MATERIALS MARC GEERS WILL BE FORMALLY INAUGURATED AS NEW MEMBERS OF THE ACADEMY ON SEPTEMBER 12.**

Luc Brunsveld, professor of chemical biology, and Marc Geers, professor of mechanics of materials, have been elected as new members of the Royal Dutch Academy of Sciences (KNAW). Election to the Academy is a huge honor, given that KNAW is the most important Dutch society for top scientists. Membership within KNAW is for life, and the pair are among the 22 new members this year.

### **Luc Brunsveld**

Luc Brunsveld (1975) has developed a unique method to study and manipulate protein complexes as composite units. His strength is that he connects synthetic and supramolecular chemistry and knows how to use these to address current biomedical challenges.

His work ranges from fundamental biophysics and mathematical concepts to the discovery of new drugs. Brunsveld is also the co-founder of an innovative biotech startup: Ambagon Therapeutics in Eindhoven and San Francisco, a drug discovery Biotech focusing on protein-protein interaction stabilization.

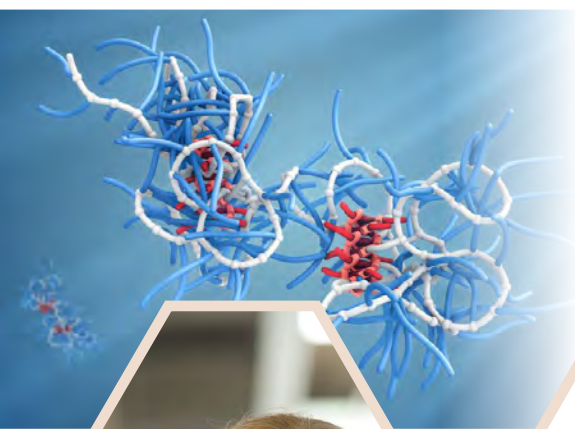


Based on groundbreaking scientific knowledge of protein interactions, his academic group and the company are developing a new class of drugs against cancer and other diseases. Through this activity, Brunsveld has shown himself to be a true supporter of valorization.

"The KNAW aims to be the forum, voice, and conscience of science in the Netherlands. It is an honor to now be a part of this more than 200 year old institution to help shape the future of science within the Netherlands," says Brunsveld, who is based in the department of Biomedical Engineering at TU/e.



# Prestigious NWO Gravitation funding for new TU/e polymer research center



Patricia Dankers

The new Interactive Polymeric Materials Research Center receives more than 15 million euros to develop new dynamic and sustainable polymer materials for science and society. In a truly unique funding outcome, a multidisciplinary project involving only a number of TU/e researchers led by Jan van Hest and Patricia Dankers has been awarded more than 15 million euros in the latest NWO Gravitation awards. The Gravitation funding program aims to provide scientific consortia with the funding needed to become world leaders in their research field. The TU/e researchers will use the funding to establish the Interactive Polymeric Materials Research Center in Eindhoven.

You'll find polymers in plastic packaging, mobile phones, and medical devices. While polymers have helped society over the past century, current polymeric materials face challenges. And it's these problems that TU/e researchers in the new Interactive Polymeric Materials (IPM) Research Center, which has just received significant funding as part of NWO's Gravitation program, plan to solve.

## INTERACTIVE AND SUSTAINABLE POLYMERS

"Current polymer materials are great for one application, but they can't change their properties 'on-the-fly' for another application, which would be useful in healthcare," notes Jan van Hest, scientific director of



the Institute for Complex Molecular Systems (ICMS) and coordinating researcher for the IPM Research Center. "Besides that, traditional polymers are not recycled very well, due to the fixed nature of bonds within the polymers. The new center seeks to address these issues."

"We want to develop polymers that can easily interact with the environment around them and then change their properties in response to the environment," adds Patricia Dankers, professor in Biomedical Materials & Chemistry in ICMS. "This can be materials that use certain signals to move, as well as engineered living materials that can send and receive signals like those in biological cells. And of course, we will be thinking sustainably when it comes to the design and production of these materials. In effect, we need materials that can break apart on demand, and then use their building blocks to make new materials."

### IDEALLY PLACED

Along with a multidisciplinary team of TU/e researchers, Van Hest and Dankers are seeking to develop fully interactive polymer materials. These materials could then be applied in many different ways such as in actuating materials for soft robots, in materials that enable improved communication between living cells and new drugs or regeneration treatments, and in materials that can recycle upon command.

"In Eindhoven, we have a lively research community in the field of polymer science, which means that we have established expertise to help tackle the challenges of creating interactive and circular polymer materials. We are ideally placed to innovate and create the next generation of polymer materials," says Dankers. "I am very excited to bring the team together and make

polymer innovation happen." Besides revolutionizing polymer materials, the new center also wants to make an impact on training the next generation of researchers. "We want to deliver resilient scientists who can work seamlessly between disciplines, perform great science, and have a mindset for sustainability," adds Monique Bruining, Managing Director of ICMS.

### GREAT HONOR

Receiving the NWO Gravitation fund is a significant achievement for any researcher, something that Van Hest, who was awarded the Spinoza Prize in 2020, recognizes. "It is a great honor, and a great opportunity to showcase the strength and breadth of Eindhoven polymer science. The grant provides us with the means to innovate polymer materials with circularity as a basic philosophy."

And for Bruining, the funding means also a lot. "Not only do we get the trust and funds to do great science, but also the endorsement to train and equip young talent to address academic, industrial, and societal challenges in an unprecedented way. We invite industry to team up with us to translate scientific concepts to interactive and circular polymer products, and to interact with our talent who will have a 21st century mindset geared toward next generation polymer materials."

Funding for the new IPM Research Center will be used to hire new personnel to strengthen the research team. "We also aim to invest some of the funding in analytical tools that will allow us to study in unprecedented detail the materials that we create at the center," says Van Hest.

### ABOUT THE NWO GRAVITATION AWARDS 2022

The Gravitation program is implemented by NWO on behalf of the Ministry of Education, Culture and Science. NWO is responsible for the selection of the research groups. NWO received 40 applications for funding within the Gravitation program in this round. Consortia of research groups could submit their applications through their universities. 15 consortia were invited for an interview, and in the end, seven consortia were selected. The assessment, mutual comparison, and selection were carried out by external referees and an international independent committee of scientists with experience of working on major scientific research projects.



Jan van Hest



A 3D perspective view of a complex maze. The maze is constructed from green, rectangular blocks that form walls. The paths are defined by orange and blue lines. A blue path starts from the top left, near an 'EXIT' sign, and winds through the maze. An orange path also winds through the maze, branching off from the blue path at several points. The maze is set against a dark, textured background.

EXIT

○

**"SERVING YOUR  
INNOVATION NEEDS"**