

# ICMS

Edition 10  
May 2018

# Highlights

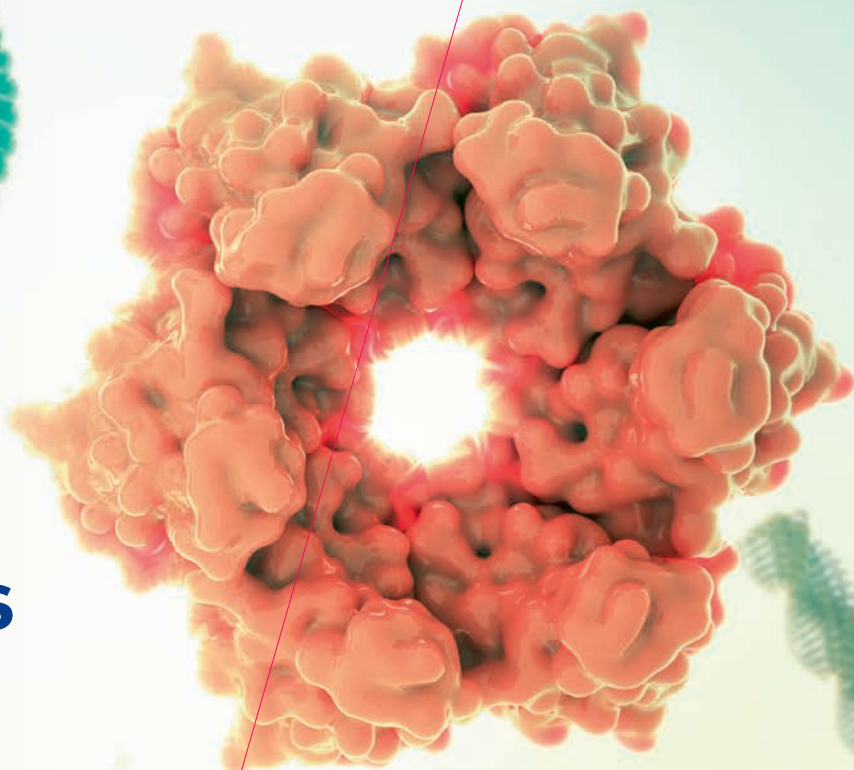
## ICMS: 10 YEARS

Investing in people  
and collaborations

## A picture worth a thousand words

Why is ICMS  
such a good idea?

& more...



**Institute for Complex  
Molecular Systems**

**10  
YEARS  
ICMS**

**TU** e

Technische Universiteit  
Eindhoven  
University of Technology

Where innovation starts

# ICMS Highlights

Ten years ago, the launch of ICMS marked the start of the building of bridges between researchers from different scientific disciplines at Eindhoven University of Technology (TU/e). In 2007, Bert Meijer and Sagitta Peters set out to incorporate basic interdisciplinary science in the field of complex molecular systems into the genome of TU/e research. In the basement of the main TU/e building, they created a home base for scientists with the strong desire to continuously move the frontiers of science.

Over the years, the ICMS approach in facilitating bottom-up and content driven initiatives on the levels of research, infrastructure and education has become a common denominator that unites all ICMS activities. By investing time and effort in attracting and developing research talent, by applying for joint (inter)national grants for exploratory interdisciplinary science, and by building alliances with institutes such as the Max Planck Institute for Polymer Research and Northwestern University, a large and dynamic ICMS community has been created.

Now, ten years down the road, in the beautiful Ceres building, the ICMS legacy of Bert and Sagitta is handed over to us. With the continued support and commitment of Bert, together with other renowned ICMS researchers, the TU/e Executive Board and faculties, and our academic and industrial partners, we will safeguard impact in basic sciences in the field of complex molecular science, for decades to come.

Nourishing curiosity-driven science to advance the field of complex molecular science remains our main future goal. In this special edition of ICMS Highlights we want to take a moment to reflect on the journey behind us and inspire you to engage with us in the journey to come.

Jan van Hest  
*Scientific director*

Monique Bruining  
*Managing director*



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“ICMS brings together **scientists of different disciplines** and stimulates **collaborations** at **scientific interfaces**, where novel insights and new ideas emerge, such as in our Microfab/lab”

Philip de Goeij & Jolanda Snelders (Department of Mechanical Engineering)

### Editorial

This is a special ICMS Highlight edition to celebrate the 10th anniversary of ICMS. ICMS Highlights is the half-yearly magazine of ICMS for ICMS members, colleagues, collaboration partners, policy makers and affiliated companies. ICMS Highlights is published twice a year.

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/ Sagitta Peters and Bert Meijer

**ICMS:**

**10%**

**of investing  
in people and  
collaborations**





**10**  
YEARS  
ICMS

# ears

**Sagitta Peters MSc** was managing director of ICMS from 2008 until 2016 and she created the ICMS community. The realisation of the Ceres building was one of her main achievements, as was the setting up of the educational program of ICMS. She now works as a career coach and interior designer for private and commercial clients.

**Bert Meijer** has been the scientific director of ICMS from 2008 until 2018, and he is responsible for the growing interest in the molecular sciences at the TU/e. He is the driving force behind the Gravitation program Functional Molecular Systems. He will continue his support to ICMS as co-director. He is distinguished university professor and professor in organic chemistry.



“We are *proud* of a decade full of *scientific highlights* achieved by ICMS, TU/e’s multidisciplinary institute. It serves as an international benchmark for frontier research in complex molecular systems”

Laurent Nelissen & Emiel Hensen (Department of Chemical Engineering & Chemistry)

The first ICMS board with Mark Peletier, Jaap Schouten, Rutger van Santen, Bert Meijer and Sagitta Peters. Menno Prins joined the ICMS board at a later stage.

Ten years ago, TU/e rector Hans van Duijn and Chairman Amandus Lundqvist gave us the amazing opportunity to start an institute within TU/e to foster excellence in the basic sciences. With complexity and molecular systems as the initial research topics, we envisaged an institute that would primarily focus on the people involved. We took it as our challenge to bring people together from five different departments and to have them excel in the best possible multidisciplinary research and in the training of young researchers.

We thus decided to follow a slightly unconventional path: not ICMS as an institute is important, but the scientists involved are!

#### Learning each other’s languages

Participation within ICMS is, and has always been, open to everyone with an interest in multidisciplinary research, willing to invest time and energy in looking beyond their own expertise. Since this often requires learning to speak each other’s scientific language, we started 'Friday afternoon sessions' in a living room setting, creating an open atmosphere. First we met in a few rooms in the basement of the main TU/e building, and now we are in our beautiful Ceres building. Topical meetings, summer and winter

schools were facilitated to stimulate multidisciplinary collaborative projects, and some PhD-positions were made available through ICMS. In addition, the ICMS lab facilities – better every year – have been open right from the beginning to all TU/e scientists. With time, collaborations started to flourish and exciting papers were published. Papers that received international attention as a result of unconventional collaborations between scientists from different departments.

#### How to measure success?

Success is in the eye of the beholder and hence is hard to measure. However, the large number of research grants and awards granted to members of





Opening Ceres Building 4 October 2012

**“ICMS has shown that theory, simulation, and experiment together solve problems that can’t be solved by any of these separately. We are proud our department continues to be part of this institute”**

Robert van der Drift & Johan Lukkien (Department of Mathematics and Computer Science)

ICMS is something we are really proud of. To our pleasure, we see that an environment where researchers are inspired by colleagues and students from other disciplines, stimulates creativity and the exploration of novel science.

We like to thank everyone who contributed to ICMS activities. A special word of thanks is for the supporting staff and the animation studio. The ICMS science movies have become known all over the world and add to the reputation of our university and all scientists involved. We wish everyone an even more successful next decade of outstanding science, using the best possible infrastructure in a collegial atmosphere.

**“ICMS will be the center for formulation and screening of intelligent, life-like materials using all the tools *chemistry* and *engineering* have to offer. Using an interdisciplinary approach, the introduction of complex functions will be achieved, such as the potential to regenerate tissue”**

Patricia Dankers



The Institute for  
Complex Molecular Systems

# Creating future technologies by mastering complexity

Advancing the fundamental understanding of complex molecular systems in materials science, energy, mobility, health, and life is the main driver of the Institute for Complex Molecular Systems. It addresses research challenges and pushes the boundaries of science by unifying basic principles of chemistry, biomedical sciences, engineering, physics and mathematics.



**10**  
YEARS  
ICMS



Since 2008, ICMS creates and maintains a versatile and fruitful research environment to:

- Expand and diversify the ICMS expert network
- Identify the underlying academic research questions;
- Enrich the scientific toolbox and infrastructure;
- Educate talented researchers in an interdisciplinary environment; and
- Inspire researchers through industrial research challenges;

The relationship with industry is strengthened via the ICMS Industrial Consortium – where science meets innovation. Furthermore, ICMS hosts the Advanced Study Center that serves as an intellectual home to scientists from all over the world, hosting discussions on the theme of complexity.

The ICMS research highlights the research of TU/e scientists in seven focus areas:

### 1. Polymer Science and Technology

We connect the entire chain of knowledge from theoretical calculations to understanding structure-property relationships, to be able to design improved and novel polymers with desired material properties.

### 2. Chemical Biology

We follow a molecular systems approach to understand and modulate biomolecular networks for the design of new therapies and diagnostics.

### 3. Grip on Complexity

We push forward the foundations and applications of complexity science in its broadest sense.

### 4. Advanced analysis of complex molecular systems

We are building a national characterization centre for the 4D-analysis of complex molecular systems at different length and time scales.

### 5. Molecular Devices

We adopt an integrative approach for the design and synthesis of hierarchically structured functional and responsive materials for functional electronic and adaptive devices.

### 6. Materials and regenerative medicine

We are aiming to regenerate tissue and organ function with intelligent biocompatible materials, using a materials-driven approach.

### 7. Functional Supramolecular Systems

We investigate the construction of functional life-like supramolecular systems to push the frontiers of supramolecular chemistry.



**“Sparkling like a diamond.  
A reputed place with  
open-minded people”** Menno Prins

More information can be found via [www.tue.nl/icms](http://www.tue.nl/icms). Please contact us with specific questions or remarks via [icms@tue.nl](mailto:icms@tue.nl) or +31 40 247 5074.



ICMS HAS BEEN INSTRUMENTAL IN STRENGTHENING THE TIES BETWEEN APPLIED PHYSICS, CHEMISTRY AND BIOMEDICAL ENGINEERING, AND HAS BROUGHT A NEW GENERATION OF TALENT TO EINDHOVEN

Gerrit Kroesen & Jolie van Wevelingen  
(Department of Applied Physics)

**10**  
YEARS  
ICMS

/ Rutger A. van Santen

# Why is ICMS such a good idea?

As a leading institute for interdepartmental research, ICMS is due to the imagination of Bert Meijer, the commitment of its first managing director Sagitta Peters, and the generous support of TU/e. What was a mere concept 10 years ago has matured into a successful institute, connecting science and scientists across disciplines, across universities, and even across countries. The then rector magnificus of TU/e Hans van Duin is pleased to see what has been accomplished: “ICMS has proven to be an interesting model for collaboration. It has become a magnet for talent and a successful multiplier of research funding.”

## FACTS

More than

110 ICMS  
theses.

More than

900 ICMS  
affiliated publications.



### Content-driven management

With its mission to boost internationally leading research in areas of future relevance to the university, the challenge of ICMS was to create an environment where young, talented scientists could start on topics that were not yet established within university departments. Focusing on functional molecular systems, bio-inspired engineering, and complexity, five young tenure track scientists were attracted. They were guided by a small board under scientific directorship of organic chemist Bert Meijer, with as additional members Mark Peletier from mathematics and myself as a computational chemist. That two of the five original tenure trackers now are full professors, and that the others have acquired tenured positions, is a confirmation of the viability of the ICMS concept.

A content-driven management style, aiming at supporting decentralized bottom-up initiatives with a minimum of red tape, created a highly energized and enthusiastic ICMS atmosphere. Joint projects were readily developed, attracting many high-quality students and generating a fantastic output. An additional indicator of the institute's success are a substantial number of additionally funded programs. Among these are four prestigious NWO Gravitation programs and numerous ERC awards for ICMS members, while many groups are participating in European Marie-Curie programs.

### Informal setting

Strongly contributing to the ICMS atmosphere and community feel is its 'home base' the Ceres building. Funded by TU/e, by its design the building enforces a creative environment and strengthens the interaction between its members from very different backgrounds. The 'huiskamer' is the place-to-be for presentations and discussions in an informal setting. Ceres also houses the ICMS Animation Studio that has turned out to be a great contribution to the university, used by many researchers to their benefit.

The ICMS hosts the TU/e Advanced Study Center with great diversity of lectures, workshops and meetings. Examples are the bimonthly meetings of the Multi Scale Center; the ICMS Complexity Science Winter Schools; and the ICMS mini symposia for discussion of specific topics. These and other activities provide ample opportunity to invite national and international scientists as well as students. This contributes significantly to ICMS as a scientific meeting place and

melting pot of new ideas. Adding further to this, a very successful funding program for visiting professorships has been created.

At present ICMS is well-recognized nationally as well as internationally. It is connected to many laboratories such as the Max-Planck Institute for Polymer Research in Mainz. To quote present TU/e rector magnificus Frank Baaijens: "The very nice thing about ICMS is its open atmosphere that stimulates collaboration between scientist with different scientific backgrounds. It is oriented towards top science and has created an environment where new research ideas and the unexplored are valued. I am really looking forward to new exciting science to emerge from ICMS."

### Inspiring TU/e students

ICMS has developed inspiring activities on the levels of master and bachelor education. For instance, the annual Nobel Prize Evening is a unique event, freely accessible to everyone at TU/e, where the unique atmosphere of great science can be experienced. Successful is also the involvement in international student competitions. In SensUs, initiated by ICMS board member Menno Prins, teams of students of five countries compete to develop a biosensor for a particular medical application. ICMS also initiated the participation of TU/e in the iGEM student competition in the field of Synthetic Biology, with Tom de Greef in a leading position. In a field of hundreds of teams from more than 40 countries, TU/e students have performed well each year, winning silver and gold medals.



NWO gravitation awards



# Our industrial *touch*



Complex molecular systems appear in every facet of our daily lives. Often they have sprouted from the brilliant minds of curious researchers, who have put their imagination to the test in many well-designed laboratory experiments. But it comes to industrial parties to make these complex systems available in many day-to-day settings, enhancing the quality of life in all branches of society.

With the ICMS Industrial Consortium, ICMS has created a platform to provide industrial researchers with first-hand expertise and a view onto the newest technologies, to help them address their research challenges. Also our extensive equipment park for characterization purposes is a valuable asset for industrial parties, as an extension of their research capabilities. Through the ICMS Industrial Consortium, industries can boost their innovative power to both support and maintain their businesses, and to secure their edge in an increasingly competitive markets.

The coming years, ICMS seeks to connect with more industrial parties to explore and create fertile grounds, leading to new developments that will impact mankind for the better. A quote of one of our valued industrial partners, DSM Coating Resins in Waalwijk, the Netherlands, says it all: “Nearly all Brighter Solutions developed by DSM involve complex molecular systems. Therefore, we have collaborated with the ICMS since its inception, sharing the ambition to translate understanding of molecular complexity to innovative products in life and materials sciences.”

“The ICMS challenge  
is a *fresh and unique* tool  
for students and companies  
to work  
together  
in an informal yet  
meaningful way”

Jaap den Doelder, Dow Benelux BV





# A picture worth a thousand words

the motto of the ICMS Animation Studio

Where written words failed, an illustration spoke. The story goes that the first sketch of a bicycle was drawn in one of Leonardo da Vinci's notebooks in 1493, almost 400 years before the first real bicycle appeared on the road. While no chain-driven, pedal-powered two-wheeler could have been built with the tools and materials of his time, it is possible Leonardo envisioned and, importantly, sketched such a vehicle. Leonardo was dyslexic and mirrored his writing, which made it hard for others to dig through his notes. However, where written words failed, an accurate illustration spoke.



### A picture worth a thousand words

“When words are combined with illustrations, the viewer immediately gains a better understanding”, says Koen Pieterse, head of the ICMS Animation Studio. Since ten years, the studio has offered the right tools to give shape, color and 'visual power' to the atomic scale and dynamic nature of complex systems. This has allowed ICMS researchers to convey their ideas to fellow researchers and to the

outside world in a convenient, yet appealing way. It has also helped the ICMS research to get noticed among the vast amount of scientific work presented worldwide.

### From the scientific idea to the final animation

The ICMS Animation Studio actively participates in the entire process from the scientific idea to the final animation. Scientists within ICMS have quite different backgrounds and expertise, including chemistry, chemical biology, polymer science, biomedical engineering, biology engineering, physics and mathematics. This melting pot of sciences and scientific languages is seen as an opportunity rather than an obstacle. “Working at the crossroads of different disciplines is what makes the ICMS unique”, says Pieterse, “and this is where the magic happens”.

### Delicate balance between scientific integrity and catchy animations

Pieterse: “Having a chemistry background and being familiar with the scientific language surely helps understanding the needs of the people approaching us”. However, depicting scientific content accurately, while creating visually appealing illustrations, is definitely not an easy task for Pieterse and colleagues. “It is a rather delicate balance between scientific integrity and catchy animations”, explains Pieterse. Scientific illustration is surely about accurately and precisely recording our natural world, from the macroscopic down to the microscopic level. This is obtained through direct observation, by drawing what is seen, and putting it down on paper as color, line, or shape. However, to keep the attention of the viewer alive, accuracy and scientific rigor should

**“ICMS has proven to be a strong magnet for excellent scientific research. As a result it creates tremendously inspiring challenges for many people, including our BME staff”**

Rob Debeij & Peter Hilbers (Department of Biomedical Engineering)



Are you interested in the work performed by the ICMS Animation Studio? Then visit the official page on the TU/e website, the YouTube channel ([www.youtube.com/user/ICMStue](https://www.youtube.com/user/ICMStue)) or send an email to [animationstudio@tue.nl](mailto:animationstudio@tue.nl)



go hand in hand with expressive and captivating elements.

### Fusion of expertise in art, design and science

To succeed in this delicate task, Pieterse can count on the precious support of two excellent and creative co-workers: Marlijn van Nuenen, character animator with a past in large scale productions and animations for educational purposes, and Ricky Cornish, 3D generalist and owner of an animation and design agency for film, TV, projections and other digital media. “When scientists approach us, they sometimes have very clear ideas on what should be represented”, says van Nuenen. “However, others can't really explain in words what they exactly want, perhaps because they have not envisioned it in a visual form yet”. Open communication and constant interaction with the ICMS researchers - “It takes approximately 200 hours to get an animation out”, Pieterse explains

- are then essential to transform scientific ideas into powerful and polished animations.

### An (animated) journey to the unobservable

As art reflects culture, scientific illustration reflects the findings of science and technology. Scientific animations of the ICMS Animation Studio take the viewer to the often unobservable, in a huge variety of scientific fields: from small molecules and protein-protein interactions to the whole and more complex cellular environment; from depiction of the nano-structure of polymeric conduit to their final application as synthetic blood vessels; and from ice-binding proteins to the development of cryoprotective biopolymers for application in biomedicine and materials science. Shapes, anatomy, details, and concepts that cannot be easily conveyed with words form the essence of the Animation Studio's art.

Obviously, animations are not the only visual way to clarify concepts, new scientific methods or interesting results. “Another big part of our work is represented by illustrations”, explains Pieterse. “They can provide added value to scientific presentations, publications and PhD theses, or simply promote the ICMS research with the outside world and the press in a more effective way.”

### Within and for ICMS

Being the only animation studio in the Netherlands working within a university, the Animation Studio has turned its connection with the academic world into a distinctive element and something to stay faithful to. “We have received requests from the outside world in the past”, explains Pieterse, “but our main intent remains to give visibility to the scientific research performed at ICMS.”



“It takes approximately  
**200 hours**  
to get an *animation* out”



# The ICMS *Outreach Symposium* 2018

“ THIS YEAR’S ICMS OUTREACH SYMPOSIUM PROVIDED ONLY A SMALL GLIMPSE OF THE GROUND-BREAKING RESEARCH PERFORMED WITHIN ICMS AND BEYOND





“The mission of the ICMS institute is to become the leading international multidisciplinary institute for research and education in the engineering of complex molecular systems. A hotspot for interdisciplinary science activities of TU/e, performing top research in Complex Molecular Systems”. With these words, Bert Meijer, outgoing scientific director of the ICMS institute, officially opened the 2018 ICMS Outreach Symposium, which was held February 1-2 at Eindhoven University of Technology.

Since its launch in 2008, ICMS has offered academics, researchers and industrial partners a common place to engage in an open exchange of ideas, to create creative collaborations, and to pursue unexplored routes towards new scientific discoveries. Discoveries at the crossroad of polymer science & engineering, materials-driven regeneration, chemical biology, complexity & networks, functional supramolecular systems, molecular devices and 4-D characterization of soft matter. Over the years, the annual ICMS Outreach Symposium has presented the perfect occasion to do so. In this year’s program, much focus was devoted to the design of next generation polymeric materials using multi-material and hierarchical strategies.

**“Cell compartmentalisation is crucial to life”**

Kicking off the first day of the Outreach Symposium was Jan van Hest, who, starting May 8, will succeed Bert Meijer as scientific

director of ICMS. The research of Van Hest revolves around the design and synthesis of bio-inspired peptide-based materials and the development of conjugation methods for the preparation of bio-hybrid systems. The ambitious goal of Van Hest and his research group is to construct smart compartments with cell-like features, working at the “cutting edge of polymer chemistry and biomedicine”. Over the years, the research interests of Jan van Hest have naturally converged towards the development of artificial cells, and, on a smaller scale, organelles. “Cell compartmentalisation is crucial to life”, explains Van Hest, “and due to compartmentalisation a cell can, for example, simultaneously perform many different chemical processes that do not affect each other in an uncontrolled way”. For Van Hest, this phenomenon and the positional assembly strategies found in nature have been two of the biggest sources of inspiration.

Much of his current research is devoted to the development of polymer-based capsules, or so-called “biodegradable polymersomes”. These versatile nanostructures can be tailored by varying the chemical structure of their building blocks, and shaped into specific structures, such as bowl shaped vesicles or nanotubes. By obtaining control over the size, shape, surface chemistry, and membrane permeability of these nanostructures, Van Hest and his team are getting closer to mimicking the complexity of organelles and, ultimately, to the construction of adaptive life-like systems.

**“Nature as a constant source of inspiration”**

The leitmotif of the first day of the Outreach symposium was “Nature as a constant source of inspiration”,

perfectly exemplified by the lecture of Marina Pilz Da Cunha. She is a PhD candidate working in a collaborative project of the Smart and Functional Material and Devices research group and the Laboratory of Materials and Interface Chemistry at Eindhoven University of Technology. The project focuses on the development of bio-inspired hybrid actuators: artificial “muscles” that can convert electrical or chemical energy into a mechanical force. When looking at nature and the panoply of triggers it can offer, the potential of these responsive materials becomes obvious, having an immediate impact on our daily lives. “Think about the possibility of clothes that are more densely packed and warm in winter”, explains Marina, “or, vice versa, less packed and light in

summertime. How nice would that be? Or what about smart building facades that can adjust depending on the weather conditions?”. These responsive materials may come to life in a relatively short period of time using liquid crystals as actuators, similar to those developed by Marina, responding to changes in temperature, humidity or light.

**Balanced leadership across competencies and gender**

That science and gender equality aren't yet on the best of terms is still beyond dispute. In this respect, the recently awarded 18.8 M EUR Gravitation grant “Materials-Driven Regeneration” is a remarkable change of pace. Spearheaded by Carlijn Bouten, full professor in Cell-Matrix Interactions at the TU/e Biomedical Engineering Department, the “Materials-Driven Regeneration” program brings together six outstanding scientists - three of whom are women - in the field of materials science, stem cell biology and tissue engineering. “This consortium shows balanced leadership across competencies and gender”, says Bouten, while introducing the Gravitation program to the audience of the second day of the ICMS Outreach Symposium.

“It does not always happen to have so many women speakers in a row” remarks prof. Pamela Habibovic, long-time collaborator of Carlijn Bouten and main applicant of the Gravitation program. Prof. Habibovic is full professor of Inorganic Biomaterials



On February 1st, Antonio Albi, Yuyang Wang and Lisa Timmers won the Science Award of the ICMS Industrial Challenge, for a challenge posed by Sabic!



at Maastricht University and founding partner and executive team member of the Institute for Technology-Inspired Regenerative Medicine (MERLN) in Maastricht. For several years, her research focused on the development of smart, instructive biomaterials for regenerative medicine. Her earlier work on synthetic calcium phosphate ceramics with intrinsic osteoinductivity contributed to the development of a product that is now clinically used worldwide for the treatment of large bone defects. “The spin off we created was very successful”, explains prof. Habibovic, “however, we still could not understand which properties of these materials were ultimately responsible for osteoinduction”. To answer this question over the past five years, prof. Habibovic and her research team have focused on understanding the interactions between these materials with their biological environment, with the ultimate goal of discovering new methods for improving the existing synthetic bone graft substitutes. Prof. Habibovic: “We decoupled individual properties of complex functional materials, such as structure and chemistry, to investigate their individual contribution to the overall response of the material.” More recently, prof. Habibovic and her group have also invested in developing high-throughput screening platforms based on microfluidics that are specifically intended for studying cell-biomaterial interactions.



Ghislaine Vantomme and Jody Lugger received two prizes: the Industrial Award and the Public Inspiration Award for their work on edible polymers, together with Sabic.

Within the Gravitation program, prof. Habibovic will offer her expertise for the development of a novel class of intelligent biomaterials that, while exploiting the fascinating capacity of the human body to adapt or renew tissue and organ functions, will cure a number of cardiovascular, bone and cartilage diseases.

Co-applicant of the Gravitation program and also lecturer of the second day of the ICMS Outreach was Patricia Dankers, full professor in Biomedical Materials at ICMS and at the TU/e department of Biomedical Engineering. Over the years, Dankers has developed a strong interest in supramolecular bioactive biomaterials and she has focused her research efforts on the translation of the enormous potential of these versatile materials

into tangible improvements in the fields of cardiovascular and renal regenerative medicine. Some of the highlights of the work of Dankers and her team were presented in her lecture on “Synthetic extracellular matrices as biomedical materials”, which is also one of the appealing materials research focuses within the Gravitation program.

This year’s ICMS Outreach symposium provided only a small glimpse of the groundbreaking research performed within ICMS and beyond. Young research talents and world-renowned speakers took the audience through an inspiring scientific journey which is far from over.

***In fact, the best is yet to come.***



**ICMS**  
serving  
basic sciences

