Maastricht University

AMIBM 10th Anniversary Conference "A Decade of Biobased Materials"

Abstracts

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Catalytic Conversion of Renewable Resources into Bulk and Fine Chemicals

Johannes G. de Vries

Bibliography

Leibniz Institut für Katalyse e. V., Albert-Einstein-Strasse 29a, 18058 Rostock, Germany

Johannes G. de Vries obtained his PhD in chemistry from the University of Groningen under the guidance of R. M. Kellogg in 1979. After a postdoc with J. B. Hendrickson at Brandeis University, Waltham, USA, his first job was as a medicinal chemist with Sandoz in Vienna and in London. From 1988-2013 he worked for DSM research in Geleen, The Netherlands, lastly as a Principal Scientist in the area of Homogeneous Catalysis. From 1999 till 2018 he was part-time professor homogeneous catalysis at the University of Groningen. From 2014 till 2021 he was Department Head Catalysis with Renewable Resources at the Leibniz Institute for Catalysis in Rostock, Germany. His research interests are in the areas of homogeneous catalysis and catalytic conversion of renewable resources and platform chemicals. He is the recipient of the 2013 Paul N. Rylander Award from the Organic Reactions Catalysis Society for Outstanding Contributions to the Science of Catalysis in Organic Chemistry.

He retired in 2021, but is still active as consultant and as visiting professor at Shanghai Jiatong University and Tsinghua University.

Abstract

Most countries have signed the Paris Agreement, in which they pledge to do everything in their power to reduce global warming to just 2 degrees by taking measures before 2050. The best way to do this is by a complete ban on the use of fossil fuels, not only for heating, energy and transportation, but also for the production of chemicals. The most important renewable resource for the production of chemicals is lignocellulose as well as its constituents, cellulose, hemicellulose, the carbohydrates they are made from and lignin. Lignocellulose is in abundant supply in the form of wood or agro-waste. Indeed, the first factories for the production of a number of important monomers made from sugars are being built at this very moment.[1] In the lecture a short introduction will be given on methods to convert lignocellulose into chemicals. We will then focus on the most promising venue, the use of platform chemicals, such as levulinic acid and 5-hydroxymethylfurfural (HMF), that can be made via dehydration of sugars. We will show that these platform chemicals can be used for the economic production of nylon

[1] Industrial implementation of chemical biomass conversion. J. G. de Vries, *Curr. Opin. Green Sustain. Chem.* **2023**, *39*,100715.

intermediates, such as caprolactam and adipic acid.[2] More recently, we have focused on the conversion of 1-hydroxy-2,5-hexanedione (HHD), which can be prepared by aqueous hydrogenation of HMF, into aliphatic and aromatic chemicals.[3] Copper-catalyzed oxidation of HHD gave 2,5-dioxo-hexanal in excellent yield.[4] This compound could be cyclized to form dialkylaminophenol, bis-(dialkylamino)benzene as well as hydroquinone.[5] Reaction in the presence of amines gave 3-hydroxy-pyridinium compounds.[6]

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[6] Synthesis of N-Substituted 3-Hydroxypyridinium Salts from Bioderived 5-Hydroxymethylfurfural in Water. S. Zheng, S. Chakrabortty, E. Baráth, S. Tin, and J. G. de Vries, *ACS Sustainable Chem. Eng*. **2022**, *10*, 15642−15647.

Towards Molecular Redesign: On Biobased, Circular (and Safe) Chemicals and Materials

P.C.A. (Pieter) Bruijnincx

Bibliography

Pieter Bruijnincx was appointed Full Professor in 2018 and holds the Chair of Sustainable Chemistry and Catalysis at Utrecht University, where his research focuses on advancing the resource and materials transitions through sustainable chemistry. His group develops new catalysts and chemical conversion pathways for producing circular and biobased materials and chemicals from renewable feedstocks such as biomass, CO_2, or waste streams. We, for example, work on new routes towards biobased/c-circular platform molecules from e.g. (woody) biomass, integrating biorefining efforts with catalytic conversion, as well as on the further valorization of these platform molecules to new and drop-in value-added chemicals. Currently, we are particularly interested in molecular redesign of building blocks and (polymer) materials for circularity, integrating the concepts of intrinsic chemical metastability and safe-and-sustainable-by-design. Bruijnincx got his Ph.D. degree in 2007 (cum laude) in Chemistry, from Utrecht University. He is an NWO Veni, Vidi, and Vici grant laureate and a former member of the Young Academy of the Royal Dutch Academy of Sciences.

Abstract

The energy, materials and resource transitions and the associated move from a linear to a circular economy are all means to same end: a more sustainable society. As chemists, these changes require us to reconsider the molecules and materials we make. Changing feedstock to renewables to make the current slate of products (with clean production processes) is not sufficient for sustainability. We need to incorporate the necessary safe, sustainable and circular design principles into the actual molecular blueprint of our chemical building blocks. This means making new molecules from new feedstock, which requires new chemistry. Some examples from our lab in this direction will be discussed, with an emphasis on catalytic biomass valorization. Examples include the use of Diels-Alder (DA) cycloaddition of bioderived furans as a powerful strategy towards renewable building blocks, both for small molecule as well as circular polymer applications. Other examples involve our work on lignin valorization, either through its use as macromolecule, or, after depolymerization, via small lignin-derived aromatics, again as monomers for new polymers. Synthesis strategies, functional materials properties as well as end-of-life properties such as (chemical) recyclability, biodegradation and toxicity profiling will be discussed. Finally, some of our work on the analytical challenges associated with the efficient conversion of complex biomass feedstock will be highlighted, including chemometrics-based models for rapid analysis of lignin.

How can we balance material properties and chemical recyclability?

Karin Odelius

Bibliography

Karin Odelius received her Ph.D. in 2008 and was appointed Professor in Fibre and Polymer Technology – Biobased functional materials at KTH Royal Institute of Technology, Stockholm, Sweden in 2022. She leads a research group focused on the synthesis of sustainable polymers, their structure-property relationships and chemical recycling. She is the vice Director of first and second cycle studies at the School of Engineering Sciences in Chemistry, Biotechnology and Health at KTH and was elected Teacher of the year at KTH in 2016. She also currently serves as an associate editor for the journal Materials Today Chemistry.

Abstract

Chemical recycling is often considered a farfetched methodology, mainly complementing mechanical recycling when too much of the material properties have been lost. Yet, for a selection of polymeric materials it could also be the best route of action. The aliphatic polyesters and polycarbonates fall into this category and are often highlighted as such, as they are synthesized via equilibrium reactions that can be pushed to form polymer or conversely monomer. This as a consequence of their thermodynamics, yet their thermodynamics depend on their chemical structure and structures that enable facile chemical recycling are not always equivalent to materials with valuable properties. This becomes a narrow space balancing chemical recycling with material properties matching incumbent plastics, and cost- and energy effective chemical recycling to high purity products in high yields is a challenge. In this presentation, examples of strategies to broaden the chemical recycling space and to design for recycling will be– all in the strive for closed-loop materials.

Producing biodegradable plastics using fermentation

Kevin O'Connor

Bibliography

Kevin O Connor is a Full professor of Applied Microbiology and Biotechnology at University College Dublin (UCD) and Director of BiOrbic Research Ireland Bioeconomy Research Centre. His research interests are bioplastics, plastics recycling, sustainable production and consumption, integrated biorefining, and biobased products. Professor O Connor is chairperson of the Irish Bioeconomy foundation, a not for profit, promoting the development and deployment of the bioeconomy in Ireland. He is chairperson of the scientific committee for the European public private partnership Circular Biobased Europe Joint Undertaking (CBE JU) which focuses on the scale up of biobased technologies to accelerate their market uptake.

Abstract

Polyhydroxyalkanoate (PHA) is a family of biodegradable polymers accumulated by bacteria as an intracellular carbon storage material generally in response to inorganic nutrient limitation in the presence of excess carbon. PHAs are biotechnological polymers with applications in both packaging and medicine.

Fossil based plastics are a major source of pollution of water and soil. Plastics such as Polyethylene (PE), Polyethylene terephthalate (PET), and Polystyrene (PS) are all produced on a multi-million-ton scale worldwide. They are used for a wide variety of applications including many disposable products which become wastes in within a year of production. Inadequate waste management strategies means that these plastics become pollutants. While these plastics can be recycled the rate of recycling is low, often due to the lower grade and higher price of recycled plastics compared to virgin plastics. Innovative new polymers and recycling technologies are required to open new value chains and create a circular plastics economy.

We will present data on the production of Polyhydroxyalkanoates (PHA), biodegradable polymers, by bacteria using waste resources. The conversion uses a combination of chemical and biotechnological processes. We will also present on the applications of PHAs and touch on waste management strategies for biodegradable polymers/plastics and the place in the circular economy.

Seven years of biomaterials start-up in a European chemical industry under pressure

Stefaan De Wildeman

Bibliography

Stefaan De Wildeman graduated as a Bio-engineer (KULeuven, 1998) and finished his PhD after discovering a new dehalorespiring bacterial species (Ghent University, 2002). He joined DSM in 2002 and increasingly explored new biobased building blocks (B4) for novel materials. From there, Stefaan co-developed the Master "BioBased Materials" and created the Chair of Building Blocks at Maastricht University. His hunger for social impact made him the Founder of B4Plastics – a polymer architecture company designing and scaling novel polymeric backbones from new BioBased Building Blocks (B4), with highest speed and accuracy. Since 2020, B4Plastics joined the top-2% league of Green Deal Scale-Ups in Europe via the European Innovation Council and became Winner of the Food Planet Prize 2021 – the biggest environmental award in the world today – for its breakthrough development of degradable fishing gear and textiles. Together with a team of about 25 experts and over 100 active partners, Stefaan goes the long way towards The New Plastics Economy. Determined to reach impactful finish lines, he and the team cross borders towards innovative biomaterials almost every day. In his role of CEO, he protects, inspires and serves the team to reach the ultimate goal: introduce novel biomaterials with much more ecology into industry and every life on earth, and maximize their impact and adoption.

Abstract

Since their origin, plastics have been durable lightweight materials for functional articles such as fibers, films, parts and sheets. They have merged with our lives as silent spies that commissioned prosperity without claiming anything back. If time is money, why spend a thought on such a cheap thing as plastics? So, for more than a century, we never checked their resources. We hardly noticed their presence.

Till now – because suddenly they came back. In places they became much more remarkable than before – although much smaller. As microplastics. In our food. In our natural habitats. In our bodies. In our brains. And in our anxious dreams. And now that we woke up from those dreams, people learned to understand that *durability can be too durable*. It is time to give up on our first generation of plastics. Let's thank them for what they brought, but let's welcome their successors.

This new generation of plastics that can be made from local renewables, produced in our own countries, understood and enjoyed by their users, and designed for smart recycling – into industry or into Nature. For their re-design, it requires scientific know-how. For their success, it requires industrial cooperation and human education. And for their glory, it requires innovators that guide us from the Old to the New. B4Plastics is on a mission.

Connecting research and industry: Exploring a career in sustainability

Varun Srinivas

Bibliography

Varun Srinivas is the Global Manager of Technology and Innovation Materials at Orbia Building & Infrastructure (Wavin), where he manages R&D programs focused on circularity. His background includes experience as a Research Physicist at Teijin Aramid, where he primarily worked on ballistic fibres. Academically, he holds a PhD from the Aachen Maastricht Institute of Bio-based Materials and a Master's degree in Aerospace Materials and Structures from TU Delft.

Abstract

The building and infrastructure industry is a dominant global resource user, making it a critical focus area for systemic change that not only advances the circular economy but also delivers essential reductions in carbon emissions. This talk examines how aligning scientific research with industrial innovation accelerates this dual transition, highlighting the contributions of Orbia Building & Infrastructure. The talk will detail several interconnected initiatives: from the successful incorporation of recycled polymers into both new and existing product lines, to the evaluation and deployment of advanced mechanical recycling technologies, and a focus on understanding the long-term behaviour and durability of recycled materials under varied service conditions. Collectively, these integrated strategies illustrate a robust framework for reducing environmental impact and enhancing resource efficiency.

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From Wood to Bio-based Polymers and Back: Building a Research Path in Bio-based Materials

Sophie Koch

Biography

Sophie Marie Koch is a tenure-track assistant professor (Resource-Efficient Wood Utilization) at the Institute of Wood Technology and Renewable Materials, University of Natural Resources and Life Sciences, Vienna (BOKU). She received her PhD in Wood Materials Science from ETH Zurich (2023), after an MSc in Biobased Materials at Maastricht University (2020) and a BSc in Wood Technology at the University of Applied Sciences Rottenburg (2017), with internships at Swiss Wood Solutions AG, Lenzing AG, and Pfleiderer Holzwerkstoffe. She continued at ETH Zurich as a postdoctoral researcher and later lecturer and research stream lead for Enhanced Wood Properties & Resource-Efficient Wood Utilization (2025), before joining BOKU (2026). At BOKU, she teaches engineered wood materials, wood and fiber quality, and industrial wood processes, and supervises MSc and PhD projects. Her research focuses on bio-based, delignified wood-reinforced composites and (aqueous) polymeric matrix systems, advancing resource-efficient processing, chemical and physical wood modification, and structure–property control through processing-informed characterization.

Abstract

Bio-based materials research is inherently interdisciplinary, spanning chemistry, biology, and materials science, and linking processing to structure and properties. My Wood Science background and subsequent Master's studies at Maastricht University formed an educational foundation that now informs my research, bridging wood technology and materials science.

In this talk, I will connect those formative experiences to recent advances in wood composite materials for advanced applications, emphasizing structure–property relationships across scales [1]. Structure-retaining delignification has emerged as a promising route to engineer anisotropic composites by preserving the hierarchical fiber alignment of wood while increasing porosity; when combined with monomer infiltration and *in-situ* polymerization, this enables interpenetrating network [2, 3]. Case studies illustrate how delignified wood scaffolds can be tailored—from high specific stiffness and strength via densification and interface design [2, 4, 5], to soft, compliant hydrogel-based systems with programmable flexibility and actuation [6, 7]. This presentation concludes by outlining current limitations and opportunities in this field, including control of moisture-coupled mechanics and long-term durability, and integration of sustainable chemistries.

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Tough, sticky, fantastic: protein biomaterials designed by evolution

Julia Jansing

Biography

I obtained my Bachelor's and Master's degrees in Molecular Biotechnology from RWTH Aachen University. After a gap year spend working and travelling in New Zealand, I returned to Aachen and completed my PhD research focusing on optimizing plants as production host for the recombinant production of human proteins such as antibodies in a collaboration between RWTH Aachen University and the Fraunhofer Institute for Molecular Biology and Ecology. In 2018 I joined AMIBM as postdoc working on various projects from plant-based silk to genome editing in Stevia. Since 2023, I have been an assistant professor and combine teaching with my research focusing on finding ways to make suckerins, mussel adhesive proteins and silk proteins available at sufficient scale to use them as biomaterials.

Abstract

Highly specialized materials have evolved in living organisms that fulfill important roles, such as wet adhesive proteins from mussels that help them stick to wet surfaces, strong and elastic silk spiders use for hunting, or thermoplastic proteins from squid ring teeth that provide gripping strength. These materials consist of proteins that have highly relevant properties for biomedical applications, but using the natural source for harvesting is no sustainable option and would involve killing large numbers of animals for very small quantities of protein.

Thanks to modern biology, the genetic blueprint of these proteins can be obtained and used to program organisms easily grown in the lab to produce them, a process called recombinant protein expression.

In our group, we work with microorganisms and plants to establish environmentally friendly, scalable bioprocesses to produce these recombinant proteins with relevant material properties. This reduces the reliance on the natural hosts for harvesting, provides control over quality and protein properties, and enables easier scale-up.

However, these proteins get their exceptional properties from their exceptional biosynthesis and composition: they are often repetitive and often poorly soluble at neutral pH. Silk proteins, mussel adhesive proteins and suckerins are all processed under very specific conditions: they are only soluble while in the respective animal's body, and only solidify into the final structure

– silk, adhesive plaque, or sucker ring teeth – on the outside of the body, in a process commonly triggered by certain environmental conditions. This makes them very challenging to produce, purify, and process.

Our research therefore focuses on exploring different production hosts, performing host optimization to adapt the host to the specific demands of the protein in question, or to enable certain modifications required for the full protein functionality. We also develop purification protocols exploiting e.g. poor solubility, work on scaling up production from ng to mg or even g quantities while keeping processes as simple and cost-efficient as possible and perform material testing in collaboration with our AMIBM colleagues.

High-Speed Lab-Scale Melt Spinning with Milligram Precision: Development and Validation of the Microbatch Spinner

Naveen K. Balakrishnan

Biography

Dr. Naveen Kumar Balakrishnan is a materials scientist with expertise in sustainable textiles, biodegradable polymers, and biobased functional materials. He is a Postdoctoral Researcher in the Polymer Engineering Group of Prof. Dr. Gunnar Seide, where he contributes to the daily supervision of PhD candidates and supports the acquisition of public and industrial research funding. To strengthen cross-border collaboration, he is currently working at AME-Biotex, RWTH Uniklinik Aachen, helping to connect and align activities between both universities. In addition, he supports the management of AMIBM e.V., overseeing organizational operations, finances, hiring processes, and industry partnerships.

He completed his B.Tech in Rubber and Plastics Technology from Anna University and M.Tech in Materials Science and Engineering from the Indian Institutes of Technology (IIT) and later pursued a DAAD-funded Master's thesis at RWTH Aachen University. He earned his PhD in Polymer Engineering at the Aachen-Maastricht Institute for Biobased Materials (AMIBM), focusing on advanced biobased fiber systems, electrospinning, and polymer technologies.

Dr. Balakrishnan's research spans biobased fibers, melt and electrospinning, wet spinning, polymer characterization. His work supports innovation in sustainable materials, circular polymer systems, and advanced textile technologies, with strong integration into the German, Dutch, EU research and industrial landscape.

Abstract

One of the unique strengths of AMIBM is its value-chain approach to material development. Through knowledge exchange with our colleagues, we identified a common challenge: while new materials are often synthesized at the milligram to gram scale, testing their spinnability typically requires several kilograms of polymer. A critical property of filament yarns—strain-induced crystallization—only occurs at winding speeds exceeding 2000 m/min. However, existing lab-scale melt spinning devices are limited in winding speed and drawing capabilities, making them poorly comparable to industrial-scale systems.

To bridge this gap, the Polymer Engineering group at AMIBM, in collaboration with AME-Biotex RWTH Aachen and Textechno GmbH, has developed the Microbatch Spinner (MBS) a first-of-its-kind, cutting-edge lab-scale melt spinning device. The MBS (shown in figure below) achieves winding speeds of up to 3500 m/min, significantly outperforming conventional laboratory machines. This enables the production of filament yarns with properties closely resembling those of industrially spun fibers, while requiring only minimal material input.

We benchmarked the filaments produced on the MBS against those from a pilot-scale melt spinning line. Our results demonstrate that the MBS yields comparable mechanical properties, even when using batch sizes as small as 150 mg. This presentation will detail the approach taken to scale down the industrial melt spinning process and provide an evaluation using a commercially available polymer.

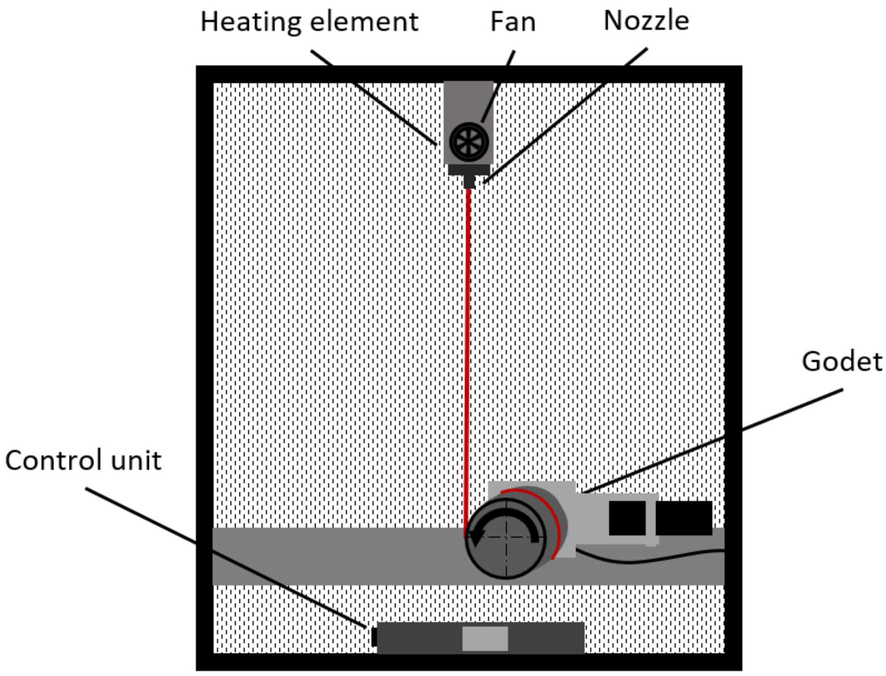

Figure 1: Schematic representation of the MBS

Advances in Functional Biomaterials: Biomimicry and Controlled Drug Delivery for Biomedical Applications

Samaneh Ghazanfari

Biography

Samaneh Ghazanfari is an Associate Professor at Maastricht University with a background in mechanical and biomedical engineering. She obtained her PhD from Eindhoven University of Technology and conducted postdoctoral research at VU University of Amsterdam, Harvard Medical School, and the MIT. With experience in interdisciplinary research at the interface of engineering, materials science, biology, and clinical translation, her work focuses on fiber-based biomaterial technologies for functional biomedical products and medical devices. Her research interests include novel biomaterials, cell–material interactions, biomechanics, and structure–function characterization, with a strong emphasis on translating innovation from lab to clinic to improve patient outcomes. She has published extensively in peer-reviewed journals (h-index 22), contributed book chapter, and delivered invited talks internationally. She is a recipient of several awards, including YERUN and COST Action recognitions, and has served on executive and supervisory boards of European, national, and industry projects.

Abstract

Functional biomaterials have significantly advanced the field of biomedical engineering by providing innovative approaches to complex medical challenges. This presentation outlines the main research lines of our group, focusing on two core areas: biomimetic materials designed to replicate key properties of biological tissues, and engineered systems for controlled drug delivery. The first part of the talk will cover the development of functional materials that mimic various characteristics of native tissues. These biomaterials show great promise in tissue engineering and regenerative medicine, both for constructing functional tissues and for developing in vitro disease models. The second part will highlight our work on advanced drug delivery systems, emphasizing their role in applications such as wound healing and oral drug formulations. These systems are designed to enable precise, sustained, and targeted release of therapeutic agents, thereby improving treatment efficacy and patient outcomes. By integrating biobased design principles with biomedical functionality, our research not only supports the development of effective clinical therapies but also aligns with the growing need for sustainable, environmentally responsible materials in healthcare. The use of renewable sources and eco-friendly processing methods further enhances the translational potential of these biomaterials, bridging the gap between lab-scale innovation and real-world impact.

C-Terminal Modification of Peptides via the Passerini Reaction

Jordy M. Saya

Biography

Jordy obtained his Ph.D. in organic chemistry from the Vrije Universiteit Amsterdam in 2019. He subsequently pursued a postdoctoral stay with Prof. Grossmann at the Vrije Universiteit Amsterdam (2019–2020). Following this, he joined the Aachen-Maastricht Institute for Biobased Materials at Maastricht University, where he initially worked as a postdoctoral researcher before being appointed assistant professor in 2023. His research interests include multicomponent reactions, natural product synthesis, and the synthesis and functionalization of peptides and proteins.

Abstract

Peptides and proteins are key components in medicine, catalysis, and materials. As demand for these molecules increases, there is a growing need for more efficient and sustainable production methods. Although solid-phase peptide synthesis (SPPS) remains the standard, it is resource-intensive and limited to the synthesis of short peptide sequences. To overcome these limitations, we developed a strategy for site-specific modification at the peptide C-terminus using the Passerini reaction (Figure 1). This approach operates under aqueous conditions and enables the ligation of smaller peptide fragments through native chemical ligation and biocatalysis.[1] We successfully applied this method to a broad range of short peptides and amino acids, establishing a versatile platform for constructing longer, functional peptides. This strategy opens new avenues for the development of sustainable, protein-based therapeutics and biomaterials.

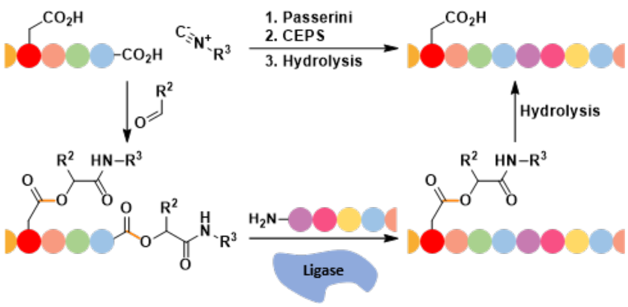

Figure 1. Novel Passerini-CEPS-hydrolysis strategy for the functionalization of peptide C-termini.

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Reading Nature's chemistry for the design of biobased, new and valued materials structure – function relationships

Jules A.W. Harings

Biography

Jules Harings is principle investigator and associate professor Macromolecular Physics & Technology at the Aachen Maastricht Institute for Biobased Materials of Maastricht University (UM). He received his PhD in Polymer Technology from Eindhoven Technical University under supervision of Prof. S. Rastogi and Prof. P.J. Lemstra (2009). After a four year's period as research scientist fiber physics and new product development at Teijin Aramid, where he received the Teijin global best R&D award in 2011, he returned to academia at Maastricht University (2013). He coordinates a multitude of educational activities, o.a. the BioBased Materials master courses Introduction to Materials Science and Engineering, Polymer Physics, and Bio-inspired nano-structure induced material function. His research in the Laboratory of Macromolecular Physics and Technology (LaMP) focuses on the identification, study and control of bio-induced conformational behavior and secondary interactions of biobased macromolecules using optical and mechanical spectroscopy techniques during material fabrication and function. Topics include: (i) additive manufacturing and fiber spinning in (biomedical) engineering, and (ii) water actuated structural refinement, functionalization and biodegradability in timed polyamide performance.

Abstract

The earth has been dynamic since its origin. Driven by solar and inner heat, stability of "system earth" relies on delicate chemical reactions and equilibria involving eg carbon, which are perturbed progressively. Materials scientists focus on closing carbon cycles of polymeric materials timely, and in a green/sustainable way. Bio(macro)molecules possess unique physicochemical functionalities that are - to our opinion – underexplored in the processing, structure formation and function of polymeric engineering materials. "Only if one understands polymeric materials function from product down to morphological, structural and ultimately molecular length-scale, it is the reversed thinking that truly values functionality, "the reading", and function of bio(macro)molecules".

By means of complementary spectroscopy techniques like time- and spatially resolved small- and wide angle scattering/diffraction, FTIR microscopy, solid-state NMR-spectroscopy and rheology, we reveal a fundamental understanding of polarity, chirality and aromaticity induced uncovered degrees of freedom during processing, structure formation, and in operando.

Beyond the Fossil Fuel Age: Developing the Next Generation of Polymers

Katrien Bernaerts

Biography

Assoc. Prof. Katrien Bernaerts earned her PhD in Polymer Chemistry at Ghent University (2005, Belgium) under Prof. F. Du Prez. After seven years in industry doing R&D on coatings and fibres, she became an Associate Professor at Maastricht University in 2012, leading the Sustainable Polymer Synthesis group. Her main research focus is on the design and synthesis of sustainable polymer materials with tuneable properties for the circular economy. Sustainability entails biobased building blocks (but no biorefinery) instead of fossil raw materials, green routes for polymer synthesis/processing, as well as (chemical) recycling methods to make the end-of-life of polymers more sustainable. Structure-property relationships of the resulting polymers are evaluated in several fields of application e.g. stimuli-responsive polymers, coatings, fibres, engineering plastics and biomedical materials. Katrien has a growing focus on the use of artificial intelligence techniques to support and accelerate the experimental work, e.g. data interpretation and prediction of structure-property relationships.

Abstract

The Sustainable Polymer Synthesis group focuses on the design and synthesis of polymer materials with tunable properties for a circular economy. Sustainability in this context encompasses the use of biobased building blocks (excluding biorefinery approaches), the development of green synthesis and processing routes, and the implementation of chemical recycling and reprocessing strategies. These include design for biodegradability, depolymerization, and the incorporation of dynamic bonds to improve polymer end-of-life options.

In the first part of this presentation, we will discuss the design and application of rigid biobased building blocks for thermoplastic polymer synthesis. The second part will highlight the development of thermoset polymers based on biobased building blocks, with a particular emphasis on strategies to enable recyclability. In addition, chemical recycling approaches for thermoset polymers will be presented.

Maximizing impact, minimizing footprint: pathways toward Sustainability in Chemistry and Materials

Yvonne van der Meer

Biography

Prof. Dr. Ir. Yvonne van der Meer holds the Chair of Sustainability of Chemicals and Materials at the Faculty of Science and Engineering, Maastricht University, and serves as scientific vice-director of the Aachen-Maastricht Institute for Biobased Materials (AMIBM), which she co-founded. She also co-founded the Master's programme in biobased materials and has established and led the Sustainability of Chemicals and Materials (SusCheM) research group since 2016. Her research advances life cycle sustainability assessment methodologies for emerging biobased and circular value chains. She serves as research lead of Maastricht University's SUM2030 sustainability strategy, vice-president of the Royal Netherlands Chemical Society (KNCV), and is a long-standing member of the scientific committee of the Circular Bio-based Europe Joint Undertaking (CBE JU).

Abstract

The development of biobased and circular chemicals and materials increasingly relies on sustainability assessments to demonstrate environmental performance and inform innovation decisions. This contribution presents recent work from the Sustainability of Chemicals and Materials (SusCheM) group at the Aachen-Maastricht Institute for Biobased Materials, which has developed and applied life cycle-based sustainability assessment methods for chemicals and materials over the past ten years.

The research advances dynamic, prospective, and ex-ante life cycle assessment (LCA) in the chemistry domain. Case studies cover biobased chemicals and materials, circular plastics and textiles, and novel (bio)chemical technologies, examining pathways based on a wide range of renewable carbon feedstocks, circularity strategies, and regional biomass supply chains. Methodological developments focus on biogenic carbon accounting and end-of-life modeling.

Economic and social impacts are included through targeted methodological developments and trade-off analyses. Overall, the work shows how LCA-based and circularity-informed metrics can support the transition toward future chemical and material pathways aligned with Safe and Sustainable by Design requirements.

Dual Nickel/Photoredox Catalysis Enables Isocyanide Insertion Chemistry

Diego Meneses

Bibliography

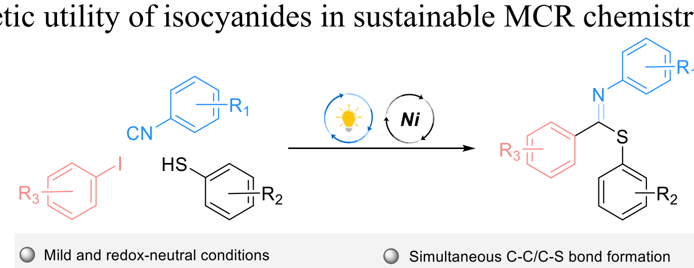
Diego Meneses obtained his BSc in Chemistry at the University of Barcelona (UB) in 2022. He then pursued an MSc in Synthesis, Catalysis, and Molecular Design at the Universitat Rovira i Virgili (URV) and the Institute of Chemical Research of Catalonia (ICIQ). Since 2023, he has been conducting his PhD in the group of Romano Orru, focusing on small molecule activation with dual transition metals/photocatalysis. His research interests include radicals, organometallic catalysis, and photocatalysis.

Abstract

Isocyanides are versatile C1 building-blocks that play a central role in multicomponent reactions (MCRs), often serving as safer surrogates for toxic CO. While their combination with palladium catalysis is well established, strategies involving the use of earth-abundant base metals remains underexplored.[1] This is due to their lack of redox flexibility or their strong reactivity in low valent oxidation states, which has been solved by external driving forces like photocatalysis.

Inspired by the recent nickel/photoredox dual catalytic strategies for cross-coupling reactions[2], we developed the unprecedented direct synthesis of thioimidates from readily available isocyanides, aryl Iodides and thiols. This is particulary challenging, since the isocyanide insertion needs to compete with other cross-coupling pathways (thermally driven charge transfer, EDA complexes, radical coupling)

This work establishes a new platform that merges photoredox and nickel catalysis, thereby expanding the synthetic utility of isocyanides in sustainable MCR chemistry.



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The dimensions of dried gels: A deep dive into aerogels, cryogels and xerogels, their processing and applications

Konrad Beukenberg

Biography

As a business engineer, with a focus on mechanical engineering, Konrad has a Bachelor and Master of Science from the University of Applied Science in Aachen, working on the crystallization of poly-lactic acid during the pilot scale melt spinning process and on the melt electro spinning of biobased filter materials. He has been working at the AMIBM since the end of 2018 as a research assistant, doing his Bachelor and Master thesis with the AMIBM and the group of Polymer Engineering and finally started his PhD in the very same group in 2024 on the topic of aerogel fibers.

Abstract

Over the last five years an increasing number of publications researching dried gel (aerogels, cryogels and xerogels) have been published. Especially publications with a focus on dried gel fibers have increased. Even though the field has had its fair share of advancements since its inception in 1931, a commercialization of such materials into products in different areas has yet to take place. Therefore, it is important to review all the materials, processes, and applications, to be able to make informed decisions on what materials and drying techniques can be used for what specific application. Without this knowledge finding the best way to further develop dried gels, no matter for what application, becomes difficult due to the widespread nature of all the information available. To provide this information in an organized manner and review all the findings from the 250 publications about and pertaining to the topic of aero-, cryo- und xerogels this publication is presented. The field of dried gels is reviewed along six dimensions: Location of the research, form of the dried gel, material, drying, post-process.

Unlocking Tomorrow's Green Electronics: Designing Biobased Semi-Aromatic Polymers for High Energy-Density Applications

Joshua Verstappen

Biography

Joshua Verstappen is a third-year PhD candidate at the Aachen Maastricht Institute for Biobased Materials. His work focuses on the development of novel biobased polymers for high-temperature electrical applications, under the supervision of Professor Jules Harings and Associate Professor Katrien Bernaerts

Abstract

High-performance electrostatic dielectrics are essential for the advancement of energy-storage technologies. Polymers are widely used for this due to their ease of processing, high breakdown strength, and low dielectric losses; however, achieving high energy densities and thermal stabilities remains a persistent challenge. We describe a design of novel biobased polyesters and polyamides to introduce unique combinations of aromatic and polar structural motifs, contributing to enhanced polarizability on various length scales.

In this work, density-functional theory is used to predict dipole moments, polarizability, and conformational stability of polymer crystals, providing guidance for monomer selection toward improved dielectric and thermal performance. An important focus lies on extensive thermal and structural characterization of these polymers. Through understanding how thermal treatment affects the formation of different crystallographic phases, insight is gained in what processing parameters enable the formation of favorable polarizable structures. The dielectric performance of these films, produced following these processing conditions, is subsequently evaluated as a function of temperature. Overall, this work highlights the value of a combined computational and experimental approach for advancing polymer dielectrics.