N°44 - MARCH 2018

European Polysaccharide Network Of Excellence



"Nature makes polysaccharides, EPNOE turns them into products"

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editorial

Dear Readers of the EPNOE Newsletter,

The 6th EPNOE Conference will take place in Aveiro, Portugal, October, 7-10, 2019, under the joint patronage of EPNOE, the Cellulose and Renewable Division of the American Chemistry Society, and the Cellulose Society of Japan. Carmen Freire and Manuel Coimbra are the two chair persons.

As a new feature, the 6th EPNOE Conference will be organized by Thematic Workshops which will cover all the fields where polysaccharides are involved, from biosynthesis to applications, in all possible application fields. The objective is to offer to the participants both a broad view and in-depth knowledge of the polysaccharide world.
These Thematic Workshop will be organized by well-recognized and will cover, among others, topics such as:

Structure of plant cell wall polysaccharides; Cellulose-hemicellulose interactions ; Mass spectrometric analysis; Fermentation and immunomodulation of plant polysaccharides; Surface Science and modification of polysaccharides; Chemical modification of polysaccharides; Biosynthesis and biocatalytic routes; Starch biosynthesis; Biomedical applications; Pharmaceutical excipients; Emulsions and thin films; Stimuli responsive polysaccharide hydrogels; Porous materials; Plant-based composites; Cellulose-based man-made fibers; Biomaterials from marine plant cells; Polysaccharides in Smart Materials; Environmental sustainability assessment; Polysaccharides from waste or by-products; Additive manufacturing; Pulp and paper; Building and Construction; Applications in food.

We are expecting you in Aveiro in October 2019 to join what will be an exciting conference.

With my best wishes,

Dr. Patrick Navard
Coordinator of EPNOE
Armines/Mines ParisTech/CNRS
CEMEF - Centre for Material Forming
Sophia-Antipolis (France)

news

Member's info

Masters & PhD defenses:

• At **BOKU University, Austria:**

- **Dr. nat. techn. Slavica Hell,** Resource-saving approaches for oxidation and further processing of man-made cellulose fibers (Supervisors: A. Potthast, T. Rosenau).

New staff:

• At **Jena University, Germany:**

- **Dipl. Chem. Lydia Wöckel** joined the group as scientific coworker. She will work on a projedct dealing with composites from wood and meltable polysaccharide derivatives.

- **M. Sc. Eder Uzziel Pulido Barragan** joined the group as guest scientist supported by the German Academic Exchange Service. He is working in the field of nanocellulose from alternative sources.

- **B. Sc. Maximilian Jacob** joined the group as master student working in the field of reinforced composite materials. He is co-supervised by the TITK and FSU Jena.

• At **Armines-C2MA, Mines Alès, France:**

- **Karen Al Hoyakem** joined the group for six months to carry out "characterizations on natural fibers grafted with phosphorus flame retardants"

- **Elyssa El Kassis** joined the group for six months to develop "new flame retarded PLA-flax fibers composites"

- **Maximilien Gibier** completed his traineeship about the "flame retardancy of woods by radiation-crosslinking of phosphorus-containing resins"

- **Imane Belfadil** will work on "formulation of algae based biosplatics for 3D printing" in collaboration with LUMA (Arles) algae project. supervisors : N. Le Moigne, A. Regazzi

- **Jorge Chaires Vazquez** joined C2MA to work in collaboration with Mines Albi RAPSODEE on "foaming of biocomposites by continuous supercritical CO2 assisted extrusion" Supervisors: M. sauceau, J. Fages, N. Le Moigne

- **Youssef Elmoussi** will work at C2MA on "Interface compatibilization in biocomposites by irradiation processes" Supervisors: A. Taguet, R. Sonnier, B. Otazaghine, N. Le Moigne



Other informations

STAFF CHANGE

- At **Jena University, Germany:**

After many years of service for the Department of Chemistry and extraordinarily productive research at our Division, Assoc. Prof. Dr. Ute Henniges moved to the State Academy of Art and Design Stuttgart, Germany, as of March 2018.

CONFERENCES ORGANIZED BY OUR MEMBERS

Biobased performance materials in the circular economy
14 June 2018, Wageningen
The Biobased Performance Materials (BPM) programme aims to develop high-quality materials based on biomass; materials that are increasingly applied in practice. BPM research focuses on two types of polymer materials: polymers produced by plants and polymers from biobased building blocks produced via biotechnology or chemical catalysis. This edition focuses on the topic 'Biobased performance materials in the circular economy'. The circular economy is developing rapidly. Biobased performance materials - renewable materials - are an important part of this new economy. At our annual symposium, we will look closely at the latest trends and developments. Key industry players from the entire value chain, ranging from agrifood to polymer processing companies, end application producers and users, will reflect on their R&D strategies.
https://biobasedperformancematerials.nl/en/bpm.htm

Summer Course Glycosciences, 15th European Training Course on Carbohydrates, 24–28 June 2018, Wageningen, the Netherlands.
More information: https://www.vlaggraduateschool.nl/en/courses/course/GL18.htm

The 8th Workshop on Cellulose Regenerated Cellulose and Cellulose Derivatives
Karlstad, Sweden, November 13–14, 2018
This 8th semi-annual international workshop will be arranged in cooperation between Umeå University and Karlstad University and is focused on basic and applied studies in the field of cellulose, nanocellulose, regenerated cellulose and cellulose derivatives. The workshop is sponsored by leading suppliers of dissolving pulps and machinery to guarantee that the workshop will have a mix of academic and applied presentations.
Topics of interest for submission include, but are not limited to:
- Cellulose chemistry and derivatives
- Cellulose structures and composites
- Dissolution of cellulose
- Dissolving pulp preparation and properties
- Nanocellulose, Regeneration of cellulose
- Spinning of cellulosic fibres

Deadlines for abstracts
Abstracts of one A4 page are welcome to ola.sundman@chem.umu.se or ulf.germgard@kau.se latest May 31, 2018. If the abstract is accepted extended abstracts of max four A4 pages are welcome until October 31.
Information
For more information visit www.celluloseworkshop.com or contact:
Professor Ulf Germgård, email ulf.germgard@kau.se, Tel +46(0)54 7001780 or Professor Leif Jönsson, e-mail leif.jonssom@umu.se Tel +46(0)90 7866811



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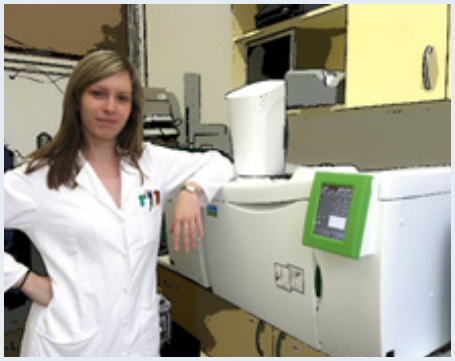
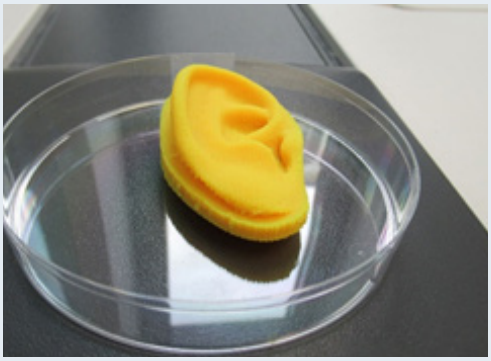
The Laboratory for Characterization and Processing of Polymers (LCPP) has a new Perkin Elmer Clarus 580 **gas chromatograph** (left image) with auto sampler and **MS-detector** for the determination of volatile organic molecules (up to 450 °C). It is mainly used for the analysis of saccharide or amino acid composition of natural products via derivatization GC. LCPP has also extended its know-how on bioprinting and is now able to transfer biomaterials into almost all desired shapes (right image)

Springer Book

Thomas Heinze, Omar A. El Seoud, Andreas Koschella

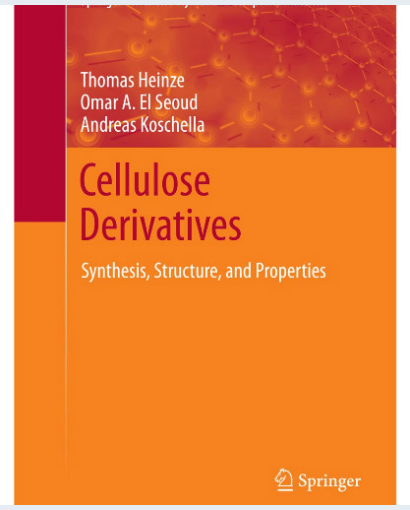
Cellulose Derivatives

Synthesis, Structure, and Properties

Springer Series on Polymer and Composite Materials

- Single source of cellulose production, synthesis, dissolution, derivatization and processing
- Describes different methods to synthesize cellulose derivatives
- Addresses scientists and professionals working on cellulose chemistry, from undergraduate level to expert

This book summarizes recent progress in cellulose chemistry. The last 10 years have witnessed important developments,because sustainability is a major concern.Biodegradable cellulose derivatives, in particular esters and ethers, are employed on a large scale. The recent developments in cellulose chemistry include unconventional methods for the synthesis of derivatives, introduction of novel solvents, e.g. ionic liquids, novel approaches to regioselective derivatization of cellulose, preparation of nano-particles and nano-composites for specific applications. These new developments are discussed comprehensively.This book is aimed at researchers and professionals working on cellulose and its derivatives. It fills an important gap in teaching, because most organic chemistry textbooks concentrate on the relatively simple chemistry of mono- and disaccharides. The chemistry and, more importantly, the applications of cellulose are only concisely mentioned.



More information: Springer.com



Next EPNOE events

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3rd EPNOE Junior Scientists meeting, Maribor (Slovenia)

The 3rd International EPNOE Junior Scientists Meeting ADVANCES IN FUNDAMENTAL AND APPLIED POLYSACCHARIDE RESEARCH organized by the Laboratory for Characterization and Processing of Polymers (LCPP) will be held in Maribor Slovenia from **14th-15th of May 2018.** The organizers are expecting up to 100 junior researchers from many different regions presenting a large variety of research topics. All participants of this event are also granted free access to the lectures of the Paper&Biorefinery conference held in Graz, Austria from **16th-17th of May 2018**. Information can be found at: **https://3rd-epnoe-jun.sciencesconf.org/**

Workshop on Fiber-Reinforced Composites

"A two-day workshop on Fiber-Reinforced Composites, either polysaccharide-based or polysaccharide containing, is scheduled on **11-12 July 2018 in Feldkirch, Austria**. The workshop will focus on challenges, advances, and all questions related to the technology and applications of polysaccharide-based or polysaccharide-containing fiber-reinforced composites, including (but not limited to) the following topics: Sources and raw materials, Manufacture, Structure and property characterization, Performance, Life cycle analysis and End-of-life disposal or recycling."
Information can be found at: **https://fibcomposites.sciencesconf.org**

"Polysaccharide as Sweet Spot for Innovation"

When: September 17th &18th, 2018
Where: University of Leuven, Leuven (Heverlee), Belgium
Place: Thermotechnical Institute, Kasteelpark Arenberg 41, Heverlee
Organizers: Pedro Fardim, Paula Moldenaers, Wim Thielemans

Polysaccharides have a key role for the emerging bioeconomy in Europe. Join this workshop to look at current innovation and future trends for polysaccharides in food, health and materials and to learn about numerous initiatives for collaboration with European Institutes of Technology of Food and Health. Explore lively discussions and networking with company experts, policy makers and top scientists working in the field. The number of participants is limited. Pre-register now using this link: **https://www.surveymonkey.com/r/5YW9YSS**
Cost of registration: 160 euro (To be paid until July 31st)



Opening of Competence Center – Research Institute of Textile Chemistry and Textile Physics, University of Innsbruck

We are pleased to announce the opening of our new competence center the "Textile Competence Center Vorarlberg" (TCCV). The aim is to set new research impulses and intensify cooperation between academia and industry in the fields of smart textiles and high performance materials.

The fields of application are manifold, and range from medical and nursing care, reinforced concrete, energy storage and sports materials. About 1000 square meters of additional space has been acquired for this venture, to house offices, seminar rooms, and testing and prototyping laboratories. New instrumentation has also been acquired, including a high impact tensile tester, a 3D Laser Scanning Confocal Microscope and an Atomic Force Microscope with nanoscale IR spectroscopy.

This article was proposed by Avinash P. Manian, Innsbruck University, Austria

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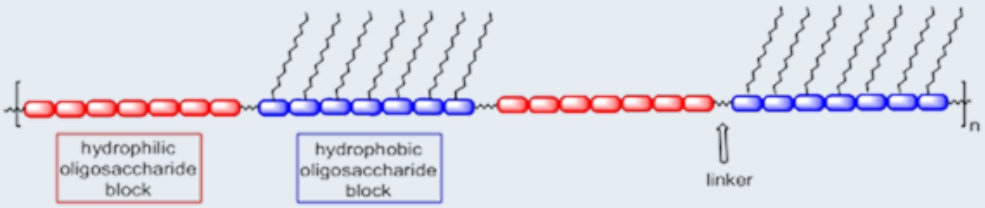
OLIBLOCK: multi oligosaccharide block copolymers

A new collaborative project funded by the French National Research Agency (ANR)

In this four-years project started end 2017, we will prepare and study the properties of a new class of polysaccharides: multiblock copolymers that will be based exclusively on the assembly of oligosaccharides carrying different functionalities and thus varying properties. Structurally defined oligosaccharide monomers will be modified by side-chain functionalization in order to obtain and combine hydrophobic/hydrophilic blocks, and anionic/cationic/neutral blocks especially through the introduction of biobased side-groups.



After preparation and thorough characterization, the most relevant applications will be studied, i.e. formation of nanoparticles, encapsulation/release properties, stabilizers for cosmetics, stabilizers/dispersants of renewable colloids, e.g. nanocellulose, chitin or starch nanoparticles.

After preparation and thorough characterization, the most relevant applications will be studied, i.e. formation of nanoparticles, encapsulation/release properties, stabilizers for cosmetics, stabilizers/dispersants of renewable colloids, e.g. nanocellulose, chitin or starch nanoparticles.

This project is run by three academic laboratories:

Two EPNOE partners:

• Université de Picardie Jules Verne, Laboratoire de Glycochimie, des Antimicrobiens et des Agroressources. José Kovensky (coordinator) and Véronique Bonnet

• Armines-CEMEF (Patrick Navard)

One non-EPNOE partner:

• Université de Lyon 1- Ingénierie des Matériaux Polymères. Eric Drokenmuller

This article was proposed by Université Picardie Jules Verne, France



Development of functionally graded, multi-layered, biopolymer-based membranes for guided periodontal regeneration

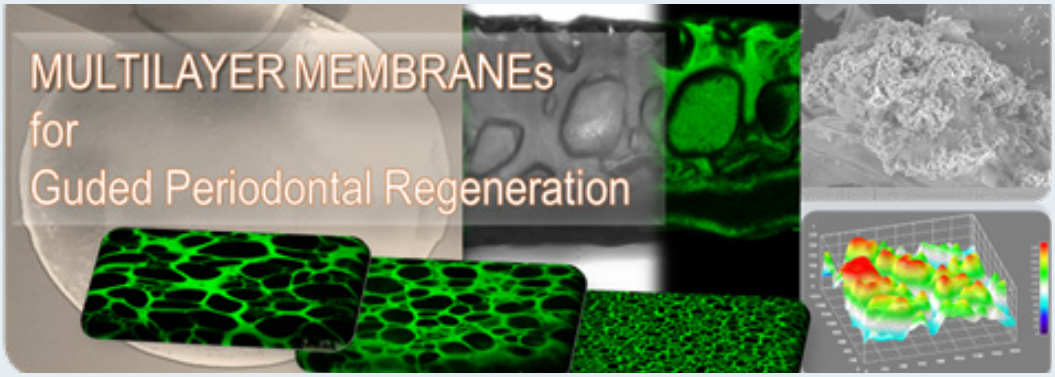
Selestina GORGIEVA

Institute of Engineering Materials and Design, Faculty of Mechanical Engineering, University of Maribor, Slovenia

Periodontitis is a chronic inflammatory disorder that affects ~750M people worldwide, being the 4th highest cost disease with up to 10% consumption of healthcare resources, being close related to diabetes, osteoporosis and other systematic cardio-, cerebrovascular and respiratory diseases. **Guided tissue regeneration (GTR)** is promising therapy, which utilizes the (non) bioresorbable barrier membranes for suppressing the epithelial cells' invasions in alveolar bone defects by providing space for osteoprogenitor cells migration for regeneration process accomplishment.

This project focus on **new GTR membranes development by the systematic engineering of bio-based and functionally graded, multilayer composites.** The leading idea is site specific introduction of the structural, morph-chemical and mechanical triggers within a single material, which would closely meet the periodontal complex tissue´ self-regeneration requirements. Such membranes are envisaged to provide superior performance of their state of the art counterparts, starting from their basic barrier function, up to a) simultaneous regeneration function due to the application of multilayer biopolymer (gelatin, chitosan, bacterial cellulose) layers with specific composition and micro-structure, and b) bacteria infections' management function by incorporation of antimicrobial peptides being active against periodontal pathogens. The multilayers' integration, stabilization and different scale structuring, which are expected to meet the physiologycal stability and degradation aspects, would be potentially achieved by combination of freeze thawing/drying and solvent casting techniques.

The presented innovative concept in GTR membranes' processing might serve in future as a platform for developing cellular scaffolds for different tissue interfaces' regeneration, while gained knowledge for different modification/ stabilization routes of biopolymers as well as their graded 3D structuring may be further exploited within applications such as filtration, separation, sensing, and drug delivery systems.



Acknowledgement

The project (ID Z7-7169) was financially supported by the Slovenian Research Agency

This article was proposed by Maribor University, Slovenia



Innovative composites with addition of feathers

Who does not like the portion of a delicious crispy chicken. It is delicious and quite easy to prepare and very often appears on our tables. Consumption of poultry has systematically grown for over 10 years. Intensification of poultry production on one hand provides to higher profitability, on the other hand generates more and more waste products, such as feathers. According to European Commission, 13.1 million tons of poultry wastes is produced in the European Union every year of which 3.1 million tons feather wastes. Presently the majority of the poultry feathers are disposed in landfills or incinerated. However, such methods are hazardous to the environment, harmful and dangerous to human health.

How to utilize keratin fibers in the form of waste feathers from the poultry industry?

Answer to the question is delivered by scientists from Institute of Biopolymers and Chemical Fibres (IBWCh) as the chicken feathers are an object of their research since many years.

Feathers reveals outstanding barrier properties: they are hydrophobic, characterized by good thermal and acoustic insulation and flame resistant properties. Modern processing technologies combined with the outstanding properties of the raw material open way towards valuable and ecological products. The tragedy of seabirds covered with oily substance due to catastrophic spills from tankers or platforms is a proof that the nano-porous keratin fibers of the feathers effectively bind any kinds of oily contamination from the water surface. This fact has become an inspiration for the development of feathers-based absorbent mats for cleaning water reservoirs from crude-oil pollutants. An **absorption mat** (Photo 1) designed for the removal of crude-oil contamination is composed of an active layer made of milled poultry feathers inserted between two identical layers of a hydrophobic material (e.g. PP fabric) . It is characterized by very high capacity to absorb oily substances and selectivity (sorption of fluids immiscible with water), and it is unsinkable even when fully soaked with the absorbed substance.

1. Absorption mat

2. Polyurethane sponge

3. PVC/keratin fibre composite

4. PP/ keratin fibres nonwoven

(Continued overleaf)



Innovative composites with addition of feathers

(continued)

There are still more possibilities:

Properly disintegrated feathers are excellent filler for various materials. Powdered poultry feathers have one more advantage: when added to plastics they confer fire resistance of the material. Polyurethane sponge used in the production of car seats needs to be fire resistant. Presently, we are engaged in the preparation of ready-made construction elements with the use of **keratin-fibre-modified- PUR sponge** (Photo 2).

What have in common the chicken feathers and PE, PP or PVC? At first glance, nothing. However, combining the organic waste with plastics produces composites which are a great alternative to traditional construction materials in architecture and interior furnishing.

Researchers from IBWCh and University of Science and Technology in Bydgoszcz (Poland) have found an original way of managing keratin wastes for the production of composites. The basic components are waste materials, in the form of poultry feathers and polymers PE, PP or PVC. It has been observed that the linear burning speed is distinctly lower with increasing content of keratin fibers in the composite. Keratin fibers play also the role of enforcing element providing an improved rigidity of the composite. Moreover, the content of keratin fibers causes a fourfold decrease of linear shrinkage of the material, a property much desired in the processing of polymer-based composites (Photo 3). The prepared bio-based composites are suited for processing like moulding, extrusion or pressing to produce elements for uses e.g. in construction and furniture.

How to create a composite nonwoven with addition of feathers?

The production technology of spun bonded nonwoven is known, but the method of introducing the additive in the form of ground poultry feathers so as to obtain a nonwoven composite with good mechanical properties is new. Components of spun bonded process are Polypropylene (PP), Polylactide (PLA) and Chicken feathers (Photo 4). Composite nonwovens are hydrophobic, exhibit flame retardant properties and can be used as a filter material, in construction, agriculture or the automotive industry.

All here presented solutions were awarded with prestigious prizes of fairs and contests of inventiveness (Brussels, Paris, Casablanca, Taipei, London, Istanbul, Osijek, Stockholm, Barcelona).

Presently IBWCh is a Partner of EU Project KaRMA2020 dedicated to "Industrial Feather Waste Valorisation for Sustainable KeRatin-based MAterials" which a main goal is industrial manufacture and exploitation of sustainable raw materials from feather waste to develop innovative green products for high impact cross-sectorial markets.

KARMA2020 project has received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement n° 723268
Website: http://www.karma2020.eu/

This article was proposed by the Institute of Biopolymers and Chemical Fibres, Poland
Authors: Krystyna Wrześniewska-Tosik, Ewa Wesołowska

"Nature makes polysaccharides, EPNOE turns them into products"



Metallisation of Textiles to make Urban living for Older people more Independent and Fashionable

(Call: H2020-NMBP-2016-2017)

maturolife®

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Urban areas are seeing an increasing population of older people and existing approaches to care for them are becoming unsustainable creating a European wide societal challenge. Assistive technology (AT) can provide them with security that will enable them to live independently e.g. wearing alarms and tracking devices around the arm or neck to alert carers to falls or their location if they wander. However such technology is often unsightly and stigmatises the user resulting in high abandonment rates. **The MATUROLIFE project will integrate creative artists and fashion designers into the research team to facilitate design-driven innovation.**

The project will build on existing technological advances in materials which have produced a highly innovative selective metallisation process that utilises nanotechnology, electrochemistry and materials science to encapsulate fibres in textiles with metal and thereby provide conductivity and electronic connectivity. In this way, better integration of electronics and sensors into fabrics and textiles will be possible. This will give the fashion designers and artists the tools to produce AT for older people that is not only functional but is more desirable and appealing as well as being lighter and more comfortable. Developed **3 AT prototypes** (clothes, furniture and footwear) will demonstrate proof of concept, and the industrial scalability of the selective metallisation process will be validated.

This ambitious project started in January 2018 under coordination of Coventry University, United Kingdom (dr. Andrew Cobley). MATUROLIFE brings together 20 partners from 9 countries: 11 SMEs, RTDs, NGOs and academics in a 6 million EUR, 36 month project. **University of Maribor**, as a WP5 leader, will be responsible for activities pertaining to passivation of conductive tracks, which main aim is to ensure the protection of metallised textiles against external factors (e.g. sweat, water). More: http://maturolife.eu/

"This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 760789".

This article was proposed by dr. Alenka Ojstršek, University of Maribor, Slovenia

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"Nature makes polysaccharides, EPNOE turns them into products"

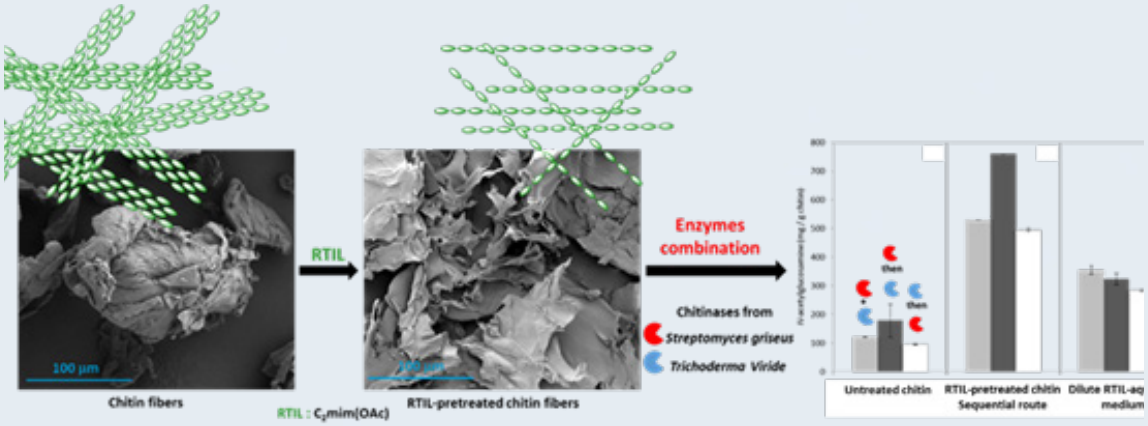
Biorefinery strategies of chitin including room temperature ionic liquids and chitinases

E. Husson,[a] C. Hadad,[b] G. Huet,[b] S. Laclef,[b] D. Lesur,[b] V. Lambertyn,[a] A. Jamali,[c] S. Gottis,[d] C. Sarazina and A. Nguyen Van Nhien[b]

[a]Unité de Génie Enzymatique et Cellulaire UMR7025 ; [b]Laboratoire de Glycochimie, des Antimicrobiens et des Agroressources UMR7378 ; [c]Plateforme de Microscopie Electronique ; [d]Laboratoire de Réactivité et de Chimie des Solides UMR7314.

Université de Picardie Jules Verne, France

The production of mono/oligosaccharides with biological properties from chitin biomass, using cost-effective and sustainable processes, answering to the current environmental requirements, constitutes a promising valorization way within the transition to a future bioeconomy. In opposite to chemical route, the advantages of biocatalytic pathways are the use of mild conditions, high specificity of reactions and thus, a decrease in by-products generation. We developed innovative eco-strategies for the selective production of *N*-acetylglucosamine (DP1) or *N,N'*-diacetylchitobiose (DP2) from crustaceous chitin. The key step consists in pretreatment of chitin by room temperature ionic liquids (RTILs) during a short duration, prior to hydrolysis catalyzed by commercially available chitinases. An efficient production of monomer (185.0 ± 4.0 mg/g chitin) or dimer (667.60 ± 20.71 mg/g chitin) were obtained with the chitinases from *Trichoderma viride* or *Streptomyces griseus* respectively. Alternatively, we investigated the tolerance of chitinases to RTIL and propose simultaneous strategy consisting in a one-pot enzymatic hydrolysis of chitin in RTIL-aqueous medium. This constitutes also a promising route to generate selectively DP1 or DP2, minimizing the required RTIL amount and the number of steps. We also demonstrated that the combination of the two commercially chitinases considerably increased the production of DP1 up to 760.0 ± 0.1 mg/g chitin (Husson et al., Green Chem., 2017, 10.1039/C7GC01471F). These promising strategies are currently applied and adapted to other chitin sources.



SEM images of untreated and RTIL-pretreated chitin fibers; DP1 yields obtained by enzymatic hydrolysis of chitin fibers with or without RTIL-pretreatment and using enzymes combinations.

For more information, please contact albert.nguyen-van-nhien@u-picardie.fr

This article was proposed by Université de Picardie Jules Verne, France

Deep Eutectic Solvents aqueous solutions as efficient media for the solubilisation of hardwood xylans

Eduarda S. Morais[1], Patrícia V. Mendonça[2], Jorge F. J. Coelho[2], Mara G. Freire[1], Carmen S.R. Freire[1], João A. P. Coutinho[1] and Armando J. D. Silvestre[1]*

[1]CICECO – Aveiro Institute of Materials, Chemistry Department, University of Aveiro, Portugal

[2]CEMMPRE, Department of Chemical Engineering, University of Coimbra, Portugal

Deep eutectic solvents (DES), have emerged as one of the most promising technologies for biomass fractionation[1][2]. In this work (E. Morais *et al., ChemSusChem* **2018**,11, 753-762), DES formed by choline chloride, and urea or acetic acid, were initially appraised as solvents for commercial xylan as a model compound. The effect of temperature, the molar ratio and DES aqueous solutions concentration were evaluated and optimized using a response surface methodology.

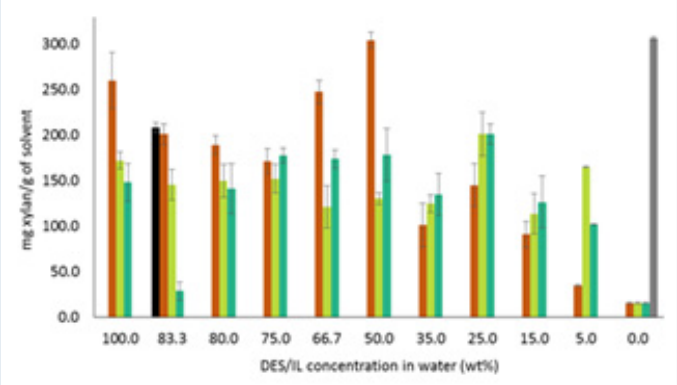


Figure 1 - Solubility of xylan in ChCl:U (1:2 ■, 1:1 ■, 2:1 ■), 1.67M aqueous NaOH ■ and Choline Acetate 83.3 (wt%) ■ at 90 °C .

The screening conducted showcased the potential of the DES (Figure 1) and further optimization showed that a maximum of 328.23 g/L of xylan solubilisation can be obtained using 66.7 wt% DES in water at 80 °C.

Furthermore, xylans can be recovered by precipitation from the DES aqueous media in yields above 90%. The detailed characterization of the xylans recovered after solubilisation in aqueous DES revealed the elimination of 4-*O*-methyl groups from 4-*O*-methylglucuronic acids moieties, as well as cleavage of uronic acids (15%) from the xylan backbone. Similar M_W values of both pristine and recovered xylans confirmed the success of the reported procedure. DES recovery and reutilization in four additional extraction cycles was also shown. Finally, the successful extraction of xylans from *Eucalyptus globulus* wood using aqueous solutions of DES was demonstrated.

[1] A. García *et al., Food Chem.* **2016**, *197*, 554–61.

[2] S. Khandelwal *et al., J. Mol. Liq.* **2016**, *215*, 345–386.

This article was proposed by University of Aveiro, Portugal



European Polysaccharide Network Of Excellence

Hot drink cups: recycle or digest?

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What is the most sustainable end-of-life option for paper cups used for hot beverages? Wageningen Food & Biobased Research and TNO conducted a life cycle assessment study for the Dutch Government to compare two end-of-life routes after separate collection: converting the used cups into toilet paper and tissues in a paper factory (recycling), and digestion of the cups to create bio-gas - and subsequently produce compost of the digestate. Recycled cups were shown to have a better environmental performance, while digestion and composting results in a higher net reduction in CO2 emissions.

'What is the most sustainable disposable cup for hot drinks?' is a question that has been keeping minds busy for decades. Over recent years, various companies and governments have opted for the large-scale purchasing of specific, sustainable types of hot beverage cups. The Dutch government, for instance, decided to purchase paper cups with a polylactic acid (PLA) coating. PLA is a biodegradable and biobased plastic.

At the government's purchasers request, Wageningen Food & Biobased Research and TNO subjected these types of cups to a life cycle assessment study. Until 2017, the cups were being processed in a waste energy plant, but there are now two new end-of-life routes available: recycling and digestion plus composting. No other waste management route than these three are expected to become available in the coming years.

Climate change and other environmental effects

To perform a proper environmental analysis, the scientists used the ReCiPe midpoints method combined with environmental costs. At the request of the client, the results were also presented as a so-called carbon footprint, which only addressed the 'climate change' effect category.

"When evaluating the full environmental profile, the environmental analysis shows that the recycling route performs best by avoiding €1.22 in environmental costs per 1000 cups," says Martien van den Oever, project leader at Wageningen Food & Biobased Research. "One of the reasons for this result is that up to 89% of the collected coffee cups are suitable for recycling, and therefore preventing the use of primary pulp. This avoided use of primary pulp in particular means saving on environmental costs for cultivation of trees and fine particulate matter formation. Although the digestion route takes a second place with €0.45 in avoided environmental costs, it is still a better performance than the €0.28 figure of discarded cups processed in the waste energy plant."

When only looking at the climate change effect (CO_2 emissions), the scientists drew an entirely different conclusion. Van den Oever: "Here the digestion route performs better by saving some 5.4 kg CO_2 eq. per 1000 collected cups. This is followed by the waste energy plant, with recycling in third place. It is surprising to see that recycling performs the poorest in this regard. The reason for this is that when you only consider climate change, the avoided CO_2 from recycling is limited as a result of the limited CO_2 emissions in the production of primary pulp, while digestion and incineration perform well because they avoid the combustion of natural gas and, therefore, CO_2 emissions."

(continued overleaf)



Hot drink cups: recycle or digest?

(continued)

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Government chooses recycling

Based on these results, the Dutch Ministry of Economic Affairs and Climate Policy has now chosen to recycle the discarded hot beverage cups made from paper with a PLA coating. Van den Oever: "It is eventually up to the client which choice best suits their policy goals. It is our responsibility to choose a proper method for the analysis, and indicate the implications of the various options based on the available data."

The research was financed by the Dutch Ministry of Economic Affairs and Climate Policy.

Note for the editor

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- **Tom Ligthart**, expert sustainability assessment TNO, via tom.ligthart@tno.nl

The full report can be downloaded here (please note, in Dutch): https://www.wur.nl/en/news-wur/Show/Hot-drink-cups-recycle-or-digest.htm

This article was proposed by Wageningen University (WUR), The Netherlands

New book in the EPNOE*Springerbriefs in Biobased polymers "Towards Bio-based Flame Retardant Polymers"

Rodolphe Sonnier, Aurélie Taguet, Laurent Ferry, José-Marie Lopez-Cuesta

Centre des matériaux des Mines d'Alès (C2MA), IMT Mines Alès

Sustainable development has become a great concern in modern society. The authors of this brief describe how one strategy to reach this objective is to replace oil-based materials with bio-based materials. They emphasize the great efforts that have been made to synthesize new bio-based polymers or additives or to replace glass fibers by natural fibers in composites. Flame retardancy is one of the most desired properties for many applications in wires and cables, building, transport, electric and electronic devices. The authors of this timely brief summarize this important field in three parts.

The first chapter is devoted to the flame retardancy of biobased polymers and mainly poly(lactic acid) (PLA), surely the main biobased polymer studied at present. In particular, after a short introduction about biobased polymers, this chapter discusses the applicability of usual flame retardant solutions (i.e. already developed for oil-based polymers) to PLA. Mainly nanoparticles and phosphorus-based flame retardants (especially ammonium polyphosphate) are reviewed. Also, innovative flame retardant systems involving new phosphorus-based molecules or macromolecules are detailed. A part of these compounds may act as reactive components.

When looking at all the commercially available polymers, it is obvious that many of them are not used in their pristine state. A great majority of these plastics contains additives that bring additional functionalities to materials: plasticizers, lubricants, antistatics, thermal stabilizers, UV stabilizers, anti-oxidants, dies, reinforcements…In order to have a consistent green chemistry approach, it is convenient to design additives for polymers (including flame retardants) that are based on renewable resources as well. The second chapter reviews how renewable resources have been used for the development of biobased flame retardants. Some of them correspond to mainly academic works, but other ones are available in large quantities and cost-efficient.

Replacing glass or carbon fibers by natural fibers is still in line with the requirements of sustainable development. But ligno-cellulosic fibers are organic and contribute to heat release. Therefore the flame retardancy of biocomposites must be studied with a special emphasis. The third chapter discusses the flame retardancy of composites filled with natural plant-based fibers and compares the influence of ligno-cellulosic fibers on the flame retardancy to that of glass fibers. The strategy of flame retarding the reinforcement rather than the matrix is also assessed.

Sonnier et al. (2018) Towards Bio-based Flame Retardant Polymers. Biobased polymers. Springer International Publishing. pp. 100. DOI 10.1007/978-3-319-67083-6

https://link.springer.com/book/10.1007/978-3-319-67083-6#about

Article proposed by Armines-C2MA, IMT Mines d'Alès, France



European Polysaccharide Network Of Excellence

EPNOE Member's Scientific Publications

At ARMINES-CEMEF, France:

L. DRUEL, R. BARDL, W. VORWERG, T. BUDTOVA, "Starch aerogels: a member of the family of thermal super-insulating materials", *Biomacromolecules* **18** (12), 4232–4239 (2017)

AKIL, R. CASTELLANI, R. LEHNEN, T. BUDTOVA, B. SAAKE, "Hydroxyalkylation of xylan using propylene carbonate: comparison of products from homo- and heterogeneous synthesis by HRMAS NMR and rheology", *Cellulose* **25**(1), 217–231 (2018)

At Friedrich Schiller University of Jena, Germany:

Surprising insensitivity of homogeneous acetylation of cellulose dissolved in triethyl(n-octyl) ammonium chloride/molecular solvent on the solvent polarity
Ch. Achtel, K. Jedvert, M. Kostag, O. A. El Seoud, Th. Heinze
Macromolecular Materials and Engineering (2018) mame.201800032R1

Recent advances in solvents for the dissolution, shaping and derivatization of cellulose: Quaternary ammonium electrolytes and their solutions in water and molecular solvents
M. Kostag, K. Jedvert, Ch. Achtel, Th. Heinze, O. A. El Seoud
Molecules **23** (2018) 511, DOI 10.3390/molecules23030511.

Layer-by-layer decorated nanoparticles with tunable antibacterial and antibiofilm properties against both Gram-positive and Gram-negative bacteria
A. Ivanova, K. Ivanova, J. Hoyo, Th. Heinze, S. Sanchez-Gomez, T. Tzanov
ACS Applied Materials and Interfaces **10** (2018) 3314-3323.

Synthesis and antimicrobial effects of highly dispersed, cellulose-stabilized silver/cellulose nanocomposites
N. S. Alahmadi, J. W. Betts, Th. Heinze, S. M. Kelly, A. Koschella, J. D. Wadhawan
RSC Advances **8** (2018) 3646-3656.

Biocompatibility and antibacterial effects of 6-deoxy-6-aminoethyleneamino cellulose
S. Finger, M. Zieger, C. Wiegand, T. Liebert, Th. Heinze, P. Elsner, U.-C. Hipler
Journal of Biosciences and Medicines **6** (2018) 51-62.

New book on cellulose derivatives:
Cellulose derivatives: Synthesis, structure, and properties
Th. Heinze, O. A. El Seoud, A. Koschella
Springer International Publishing AG, 2018, ISBN 978-3-319-73168-1 (e-Book), ISBN 978-3-319-73167-4 (Harcover)



European Polysaccharide Network Of Excellence

EPNOE Member's Scientific Publications

At University of Natural Resources and Life Sciences Vienna (BOKU), Austria, Division of Chemistry of Renewable Resources:

Oberlerchner, JT, Fuchs, C., Grausgruber, H., Potthast, A., Böhmdorfer, S., A cote calibration - Making optimal use of time and space in quantitative high performance thin layer chromatography. J. Chromatogr. A 1533 (2018) 193-8.

Ghorbani, M., Mahendran, A., van Herwijnen, HWG, Liebner, F., Konnerth, J., Paper-based lami-nates glued with kraft lignin rich phenol formaldehyde resoles meet the standard requirements for outdoor usage, European Journal of Wood and Wood Products 76/2 (2018) 481-7.

Hell, S., Ohkawa, K., Amer, H., Potthast, A., Rosenau, T., "Dialdehyde cellulose" nanofibers by electrospinning as polyvinyl alcohol blends: Manufacture and product characterization. J. Wood Chem. Technol. 2 (2018) 96-110.

Liu, J., Bacher, M., Rosenau, T., Willför, SM, Mihranyan, A., Potentially Immunogenic Contaminants in Wood-based and Bacterial Nanocellulose: Assessment of Endotoxin and (1,3)-β-D-glucan Levels, Biomacromolecules 19/1 (2018) 150-7.

Bazafkan, H., Beier, S., Stappler, E., Böhmdorfer, S., Oberlerchner, J., Sulyok, M., Schmoll, M., SUB1 has photoreceptor dependent and independent functions in sexual development and secondary metabolism in Trichoderma reesei. Mol Microbiol 106/5 (2017) 742-59.

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Ahead of Print

Köhnke, J., Rennhofer, H., Lichtenegger, H. C., Mahendran, A. R., Unterweger, C., Prats-Mateu, B., Gierlinger, N., Schwaiger, E., Mahler, A. K., Potthast, A., Gindl-Altmutter, W., Electrically conducting carbon microparticles by direct carbonization of spent wood pulping liquor. ACS Sustainable Chem. Eng. 2018. DOI: 10.1021/acssuschemeng.7b03582.

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Tisch, D., Pomraning, KR, Collett, JR, Freitag, M., Baker, SE, Chen, CL, Hsu, PW, Chuang, YC, Schuster, A., Dattenböck, C., Stappler, E., Sulyok, M., Böhmdorfer, S., Oberlerchner, J., Wang, TF, Schmoll, M., Omics analyses of Trichoderma reesei CBS999.97 and QM6a indicate a relevance of female fertility for CAZyme and transporter levels. Appl Environ Microbiol 2017. DOI: 10.1128/aem.01578-17.



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EPNOE Member's Scientific Publications

At ARMINES-C2MA, IMT Mines d'alès, France:

Garat, W., Corn, S., Le Moigne, N., Beaugrand, J., & Bergeret, A. (2018). Analysis of the morphometric variations in natural fibres by automated laser scanning: Towards an efficient and reliable assessment of the cross-sectional area. *Composites Part A: Applied Science and Manufacturing*, 108, 114–123. https://doi.org/https://doi.org/10.1016/j.compositesa.2018.02.018

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Aouat, T., Kaci, M., Devaux, E., Campagne, C., Cayla, A., Dumazert, L. and Lopez-Cuesta, J.-M. (2016), Morphological, Mechanical, and Thermal Characterization of Poly(Lactic Acid)/Cellulose Multifilament Fibers Prepared by Melt Spinning. Adv Polym Technol. https://doi:10.1002/adv.21779

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Badji, C., Beigbeder, J., Garay, H., Bergeret, A., Bénézet, J. C., & Desauziers, V. (2018). Under glass weathering of hemp fibers reinforced polypropylene biocomposites: Impact of Volatile Organic Compounds emissions on indoor air quality. *Polymer Degradation and Stability*, 149, 85-95. https://doi.org/10.1016/j.polymdegradstab.2018.01.020

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Other News

First International conference on Chemistry for Beauty and Health

The Department of Chemistry of Biomaterials and Cosmetics, Nicolas Copernicus University in Torun, Poland, announces the first International conference on Chemistry for Beauty and Health. The conference will be held on 13-16 June 2018 in the city of Toruń at Nicolaus Copernicus University.

The conference will be held under the auspices of European Polymer Federation and Polish Society for Biomaterials.

More details at: https://beauty-torun.umk.pl/pages/main_page/

15th International Conference of the European Industrial Hemp Association

12 – 13 June 2018, Maternushaus, Cologne, Germany

Specialists from all over the world will meet in order to exchange information regarding the latest developments in hemp applications for fibres, shivs, seeds and oil as well as cannabinoids. Applications are biocomposites in automotive and construction, textiles, food, food supplements and pharmaceuticals. We are expecting again more than 300 international participants from more than 40 countries – we are looking forward to the biggest event on industrial hemp ever!

More information at: http://eiha-conference.org/

Annual European Congress on Rheology (AERC 2018)

Sorrento, Italy, from 17-20 April 2018

Session on Food, Pharmaceutics & Cosmetics

More information at : https://rheology-esr.org/aerc2018/welcome

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26th European Biomass Conference and Exhibition - EUBCE 2018

14 – 18 May 2018 | Copenhagen, Denmark

The conference programme will address topics from biomass to bioliquids and biofuels for heat and electricity, transport and biobased products. It will cover all aspects of each value chain, from supply and logistics to conversion technologies, from industrial application of research results to impacts on the environment, from market and trade aspects to policy strategies, not least to the role of biomass as a source in integrated energy systems.

The EUBCE is supported by European and international organizations such as the European Commission, UNESCO – United Nations Educational, Scientific and Cultural Organization – Natural Sciences Sector, WCRE – the World Council for Renewable Energy, EUBIA – the European Biomass Industry Association, The Central European Initiative, The Global Bioenergy Partnership and other organisations.

The Technical Programme is coordinated by European Commission, Joint Research Centre.

More information at: http://www.eubce.com



Other News

21th Microencapsulation Industrial Convention

Montreal, Canada - May 21-24, 2018

Lectures from leading experts will cover a large scope of the encapsulation field. Selection mixes senior scientists with an understanding of encapsulation processes, together with experienced business practitioners of well established practical applications

http://bioencapsulation.net/2018-Montreal-Microencapsulation-Industrial-Convention/

2017 Preliminary Statistics Report of the Confederation of European Paper Industries

Summary of the report

CEPI member countries' paper and board production has increased by 1.5% in 2017 compared to the previous year, according to preliminary figures. Total production in 2017 was around 92.3 million tonnes. New capacities and upgrade of existing ones have more than compensated for closures in 2017, similar to 2016. Divergence in the production trends of graphic grades against packaging grades continues with a decline in the production of graphic grades and additional growth in the output of packaging grades. Based on the cumulative data up to the end of the third quarter of 2017, it is expected that total paper and board deliveries for the year were up by 1.8% compared to 2016 and internal deliveries were up by around 1%. The overall consumption of paper and board in CEPI countries in 2017 increased by around 0.5% compared to 2016, based on the latest data available. This is the fourth year in a row registering growth, thanks to the favourable economic environment in the EU and a stronger global growth and trade. It is estimated that the production of pulp (integrated + market) has increased by 2.2% compared to the previous year, with total output of approximately 38.1 million tonnes. It is estimated that utilisation of paper for recycling by CEPI members, at 48.4 million tonnes, increased by around 1.3% compared to 2016.

For downloading:

http://www.cepi.org/publication/preliminary-statistics-2017

www.cepi.org/topics/statistics

The Cellulose Symposium 2018 will be held in the frame of the Annual Meeting of the Zellcheming Association, June 27-28, 2018, in Frankfurt/Main