N°4 - SEPTEMBER 2007

European Polysaccharide Network Of Excellence

“Nature produces polysaccharides, EPNOE turns them into materials”

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editorial

The combination of the words “bio” and “polymer” or “plastics” are now in the forefront of many discussions, and the general public are slowly becoming aware of the possibility of manufacturing plastics from biomass. Most of these polymers are either directly derived from polysaccharides or manufactured by enzymatic or bacterial treatment of polysaccharide residues. We are beginning to see tough competition between biomass-based and oil-based plastics. The outcome of this will depend on the abilities of the scientific and industrial communities to meet scientific and technological challenges on the side of bioplastics, the rate at which fossil fuel feedstocks are exhausted and the extent to which society is prepared to seriously address environmental issues.

To help EPNOE members to tailor their research and also to assist industry in deciding on their future investments, European Bioplastics, the industrial organisation of the bioplastic producers, and EPNOE have decided to join their efforts to commission a large scale prospective study on the techno-economic feasibility of large-scale production of bio-based polymers in Europe by 2020 including starch and cellulose. The objectives of this study are to prepare an overview of existing and emerging bio-based polymers for bulk applications, environmental scenario analysis and policy recommendations. The study will also include all relevant new materials which are currently on the market or emerging. It will include market projections by the type of material and by the product area, and will also provide scenario-based environmental assessments.
The first results of this study should be available in the first quarter of 2008.

Dr. Patrick Navard
Coordinator of EPNOE
Centre for Material Forming
Ecole des Mines de Paris/CNRS
(France)

news

New EPNOE web site

Visit our new web site on:
www.epnoe.eu

Courses and Conferences

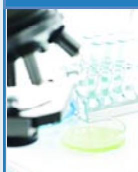
Modern analytical tools for pulp and paper - PhD course organised by the Aabo Akademi University
- Dates: 5-10 November 2007
- Place : Turku (Finland)
- Information : www.abo.fi/instut/pcc

The course has got the status of COST Training School, getting some support from the COST E41 program.

STARCH 2008
- Dates: 17-19 March 2008
- Place : University of Nottingham (UK)
- Information : val.street@nottingham.ac.uk

1st Austrian and Slovanian Polymer meeting with one section about renewable polymers.
- Dates: 26-28 March 2008
- Place : Graz (Austria)
- Information : www.aspm2008.at

Members'info



New staff member:

University of Nottingham (UK)
Dr Tim Foster joined the Division of Food Sciences at Nottingham from Unilever Research Vlaardingen on September 1st.

New students:

University of Graz (Austria)
Mag. Rupert Kargl, PhD thesis in collaboration with Federal research centre of Forestry and Forest Products, Hamburg

Denise Gaal, Master thesis on interaction of functional polysaccharides with cellulosic surfaces for medical application

Barbara Theiler, Bacchelor thesis on Cellulose-Cellulose Interaction

New appointment:

Juergen Puls has been appointed acting head of the Institute for Wood Chemistry and Chemical Technology of the Federal Research Centre for Forestry and Forest Products.

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Education within EPNOE

Education is one of the three main actions of EPNOE, together with research and industrial relations. It is organized by an Education Task Force whose first meeting was held in June 2007 in Vienna. Europe will soon need well-trained scientists able to master all the aspects of biomass-based polymers, i.e. to understand what polysaccharides are and how they can be transformed into valuable goods. EPNOE intends to make a major contribution to polysaccharide education with the current objective being to build an Education Road Map.

Academic education: the main aim with education within EPNOE is to promote the knowledge of the study of polysaccharides. To this end, a procedure to establish an EPNOE PhD will be written. A similar action will be made at the Master level with a plan to provide opportunities for students from several EPNOE and non-EPNOE universities to obtain a European Master degree on Renewable Materials where polysaccharides will be a major item.

Continuous education: A comprehensive series of 30 min-videoed lectures is under creation with the aim of providing students, academic and industrial scientists with a complete in-depth description of polysaccharides and their applications. These videoed lectures will be available on the EPNOE web site (www.epnoe.eu) and will work as an introduction to 1-3 day courses on different themes.

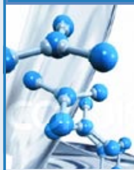
Dissemination: EPNOE is aiming to include scientific sessions in already planned conferences (eg. STARCH 2008 to be held in Nottingham, 17th-19th March 2008 (further details from val.street@nottingham.ac.uk)). More information on this and other conferences will be posted on the EPNOE website. Some conferences have already been translated into English and posted on the website. In the future, EPNOE will organize a conference of its own. Special issues of journals edited by EPNOE scientists are planned.

Many ideas have been brought up regarding education within EPNOE. Now these ideas will be realized for the benefit of EPNOE members and their partners.

Pedro Fardim
EPNOE Vice-President Education
Annika Holmbom
EPNOE Education project Assistant
University of Åbo Akademi - Laboratory of Fibre and Cellulose Technology (Finland)

news

Forthcoming Articles



Applications of ionic liquids in carbohydrate chemistry: A window of opportunities - *El Seoud O. A.,Koschella A.,Fidale L. C., Dorn S., Heinze Th.* - Biomacromolecules

Unconventional Methyl Galactan Synthesized via the Thexyldimethylsilyl Intermediate: Preparation, Characterization, and Properties - *Koschella A., Inngjerdingen K., Paulsen B. S., Morris G. A., Harding S. E., Heinze Th* - Macromolecular Bioscience

The influence of alkali pretreatments in lyocell resin finishing - fiber structure - *A.P. Manian, M. Abu-Rous, M. Lenninger, T. Roeder, K.C. Schuster, T. Bechtold* - Carbohydrate Polymers

Upgrading of paper-grade pulps to dissolving pulps by nitren extraction: properties of nitren extracted xylans in comparison to NaOH and KOH extracted xylans - *R. Janzon, B. Saake, J. Puls* - Cellulose

Physicochemical characterization of spruce galactoglucomannan solutions: Stability, surface activity, and rheology - *Xu, C., Willför, S., Sundberg, K., Pettersson, C., Holmbom, B* - Cellulose Chem. Technol

Norway spruce galactoglucomannans exhibiting immunomodulating and radical-scavenging activities- *Ebringerová, A., Hromádková, Z., Hibalová, V., Xu, C., Holmbom, B., Sundberg, A., Willför, S.* - Int. J. Biol. Macromol

Spruce-derived mannans ? A potential raw material for hydrocolloids and novel advanced natural materials - *Willför, S., Sundberg, K., Tenkanen, M., Holmbom, B.* - Carbohydr. Polym

Topochemical modification of cotton fibres with carboxymethyl cellulose - *L. Fras1, P. Stenius, J. Laine, K. Stana-Kleinschek* - Cellulose

Swelling and dissolution of cellulose, Part III: free floating plant fibres in aqueous systems - *C. Cuissinat, P. Navard* - Cellulose

Swelling and dissolution of cellulose, Part V: free floating cellulose derivatives fibres in aqueous systems and ionic liquid - *C. Cuissinat, P. Navard, Th Heinze* - Cellulose

Description of EPNOE research

Fundamental Theme 3: New Derivatives by Enzymatic and Chemical Methods Applying Ionic Liquids

Homogeneous phase chemistry of polysaccharides is undoubtedly one of the most important paths to design novel products and materials. Based on the recent discovery that ionic liquids (IL) are efficient solvents for various polysaccharides including cellulose, the objective of Fundamental Theme 3 is to study ILs as the reaction medium for homogeneous phase conversion of polysaccharides applying modern organic chemistry and enzymology. ILs are able to dissolve biopolymers of a high degree of polymerization (DP) like bacterial cellulose (BC) with DP up to 6500 (Figure 1).

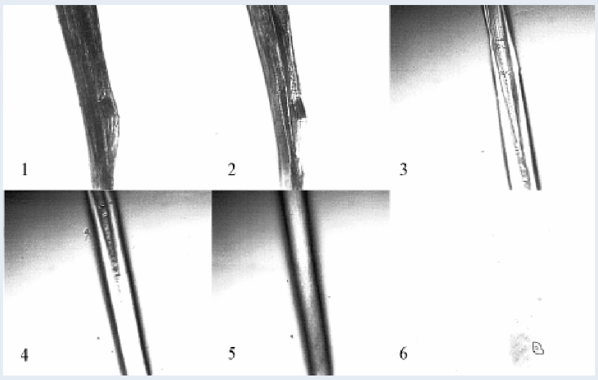


Figure 1. Microscopic images of bacterial cellulose (BC) Native BC (1), after contact with the ionic liquids (2), after 5 min (3), after 10 min (4), and after 15 min (5) and 20 min (6), K. Schlufter et al., Macromol. Rapid Commun. 27 (2006) 1670-1676

The state of dissolution and the polymer-solvent interaction are studied by NMR spectroscopy and rheological measurements. BC dissolved in IL shows a strange behavior depending on polymer concentration and temperature, which may be caused by an entanglement of the polymer chains. The acylation of cellulose in ILs is highly efficient, i.e., conversion of the reagent may even reach 100%.

To take advantage of the unique properties of cellulose, novel derivatives with unconventional functional groups are studied, e.g. dendronized cellulose (Figure 2).

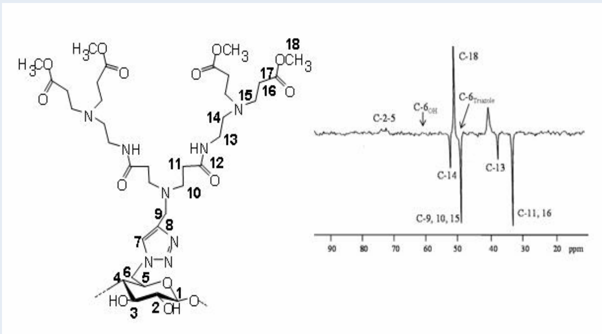


Figure 2. DEPT135 NMR spectrum of second generation PAMAM-triazolo-cellulose (degree of substitution 0.59) prepared in 1-Butyl-3-methyl imidazolium chloride, M. Pohl, J. Schaller, F. Meister, Th. Heinze, Macromol. Rapid Commun., submited

Investigations revealed a distinct influence of the type of IL on the degree of substitution and on the functionalization pattern. Long-chain carboxylic acid esters and phenylisocyanates from different cellulose types could be prepared efficiently as a topic of further studies. Various ILs appear as complementary solvents for different wood components, which are expected to enable a selective solubilization of the wood constituents.

It should be pointed out that the research results of Fundamental Theme 3 are an excellent basis for applied projects with industrial partners in order to develop advanced commercial products and processes; discussions in this regard have already started.

Thomas Heinze
Fundamental Theme 3 leader
University of Jena - Centre of Excellence for Polysaccharide Research (Germany)

Zoom on EPNOE Partners'research

Extrusion Processing of Hydrocolloids for Improved Functionality

Hydrocolloids are water soluble polysaccharides that are extensively used for their gelling and thickening properties. A major application is in food products. Because of the cost of the extensive toxicological testing required it is unlikely that new chemically modified hydrocolloids will be approved for food use. The Food Structure Group at Nottingham has therefore been interested in physical modification. Of particular interest has been the use of extrusion processing to modify xanthan gum. This approach combines ideas on fabrication of polysaccharide structures which is an important component of EPNOE with Nottingham's traditional interests in polysaccharide rheology in water. An example of what can be achieved is shown in Figure 1.

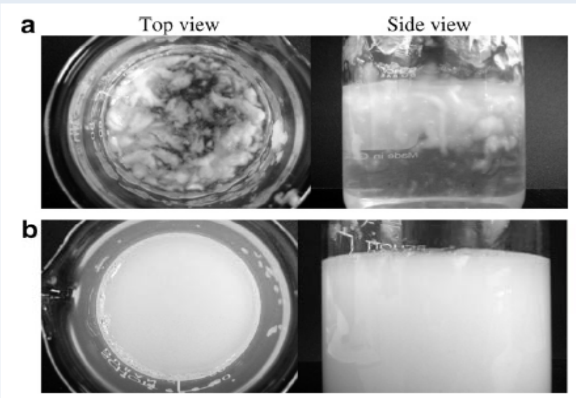


Figure 1. Xanthan gum dispersion in distilled water (0.75% wet weight basis): (a) non-processed xanthan gum and (b) extruded xanthan gum (dispersions prepared by mixing with a spoon for 10 s).

Through extrusion processing the water dispersibility of this important cellulose based hydrocolloid can be dramatically improved. This is because the material is converted to a particulate form.

It is believed that this is because reformation of the xanthan dihelical structure is kinetically trapped leading to a network structure which maintains the particulate structure below the melting temperature of the helix (Figure 2).

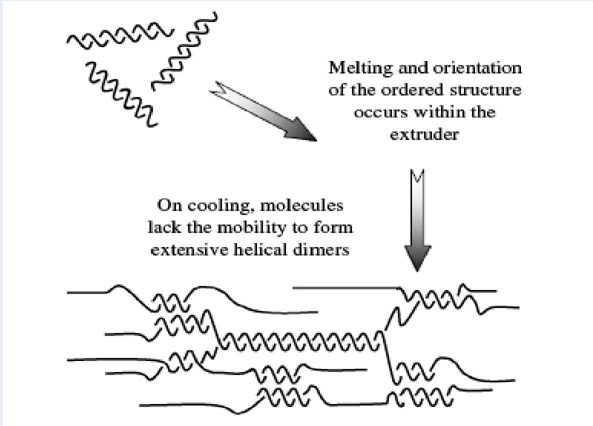


Figure 2. Model of xanthan gum molecular organisation resulting from extrusion and subsequent drying.

In water the particulate form will swell dramatically giving rise to much higher viscosities than can be achieved with non-processed xanthan [1]. This research has been aided by a fundamental study on amorphous low xanthan powders involving the PetruPoni Institute of Macromolecular Chemistry in Romania and the University of Nottingham [2]. This collaboration is part of EPNOE's Fundamental Theme 1 programme aimed at understanding the amorphous phase in cellulose and starch based polysaccharides. We believe these ideas may be applicable to a wide range of hydrocolloids.

1. Nuno M. Sereno, Sandra E. Hill and John R. Mitchell. *Impact of the extrusion process on xanthan gum behaviour.* Carbohydrate Research, Volume 342, Issue 10, 23 July 2007, Pages 1333-1342.

2. Irina E. Raschip, Iryna Yakimets, Christopher P. Martin, Sabrina S. Paes, Cornelia Vasile and John R. Mitchell. *Effect of water content on thermal and dynamic mechanical properties of xanthan powder: A comparison between standard and novel techniques.* Powder Technology, In Press, Accepted Manuscript, Available online 13 July 2007.

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