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Scientific Tracks & Abstracts

(Day 1)

Ryan W Davis et al., J Material Sci Eng 2018, Volume 7
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Cultivation and utilization of cyanobacterial exopolysaccharide for production of bio-based polymers

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Development of poly-cultures has been identified as a potential means for overcoming several challenges facing scale-up of algae-based commodities which can displace petroleum but do not compete with food production. In this presentation, we describe findings from our recent studies on cultivation of a marine cyanobacterial consortium in open algae raceways and downstream conversion to bio-plastic. In the consortium, three distinct cyanobacterial cultivars were combined to provide nitrogen fixation, photo-protection and high rates of secretion of extracellular polysaccharides in support of a long-term bio-product 'milking' strategy. Following lab-scale investigations of various combinations of the individual cultivars to identify optimal algae raceway inoculation and maintenance strategies, the best performing consortia were successfully cultivated in pilot-scale algae raceways for >120 days. The growth trials indicated bioproduct concentrations >2 g/L consisting primarily of a variety of C^5 and C^6 monosugars which were recovered using a low-cost semi-continuous harvesting strategy. In addition to the remarkable stability of the consortium in open cultivation, measurements of culture density time course indicated insignificantly different log-phase specific growth rates at different levels of nitrate or carbon dioxide addition, which should have significant techno-economic and sustainability impacts for commercialization. Following recovery of the biomass and exopolymer, generation of cyanobacterial-derived bioplastic was demonstrated and performance characteristics were found to be similar to common biobased plastics, such as PLA. Initial techno-economic analysis based on the product yield and corresponding biomass production, harvesting and conversion costs indicate an N^{th}-plant model finished product cost of $ 600/ton.

Biography

Ryan W Davis is the Principal Member of Technical Staff at Sandia National Laboratories. His research has focused on science and technology for production of bio-based commodities from renewable feedstocks using non-arable land and non-freshwater resources. He has obtained his PhD in Physical Chemistry from the University of New Mexico and completed Post-doctoral studies at Sandia Laboratories in New Mexico and California. He has published more than 25 articles in peer-reviewed journals and is Director of the Sandia Algae Raceway Testbed Facility.

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Lignin valorization by making aromatic chemicals and materials

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BTX (Benzene, Toluene, Xylene) represent a massive 120 billion dollars and 14.2 metric tons market of numerous chemicals and products used worldwide. The fight against climate change has convinced many brand-owners to push for more renewables to be incorporated in their product ranges. Furthermore the strong growth of shale gas as energy and feedstock source has demonstrated that the traditional C_3 feedstock for aromatics is reduced at the origin. The need for alternative sources for this multiple of products is driven as well by supply as demand. The purpose of this study is to describe the potential of lignin as feedstock for novel polymers and foams. Starting from the insight in potential lignin sources and the variations in de-polymerization technologies available, a set of functionalized monomers and oligomers are prepared as the starting point for the polymerization process. Additional introduction of epoxide groups or the introduction of lignin as a polyol in the urethane approach led to new structures. The presence of residual functional groups on the lignin segments contribute to variations in the physical mechanical properties of the polymers. Simultaneously with the technical evaluation of the potential innovative materials for different applications, an economic analysis of these material developments is integrated in the study in order to safeguard the potential introduction of the innovative technologies in existing applications of aromatic polymers. The widespread availability of lignin in many different places in the world is creating great opportunity to simultaneously develop new materials without dependency on oil as a feedstock but also as a contribution to fighting climate change. Simultaneously, a complete new value chain is being developed creating great new business opportunities for new actors in the world.

Biography

Walter Eevers is the Director R&D for the Flemish Institute for Technological Research and is the Visiting Professor of Polymer Chemistry at Antwerp University. After obtaining his PhD and MBA he worked for 20 years as Director R&D and Innovation at Nitto. He has over 30 publications and patents on innovations in polymer and material developments. Furthermore, he has been involved in several spinoff companies in innovative technologies derived from VITO's research activities. Recently he had set up a new research group dedicated to incorporation of lignin based monomers and oligomers for materials developments replacing fossil based aromatic building blocks. Furthermore he has been one of the founding fathers of the CO2 Value Europe Association that endeavors the full acceptance of the utilization of CO2 a valuable building block for innovative chemistry.

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Cattaleeya Pattamaprom et al., J Material Sci Eng 2018, Volume 7
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The effect of branching agent on the processability and mechanical properties of polylactic acid/ natural rubber blown film

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Polylactic Acid (PLA) is currently known to be the cheapest and the most prevalent commercial bio-plastic. However, its poor toughness and processability limited its applications in film blowing products. In this study, improvement in the toughness of PLA was investigated by blending with Natural Rubber (NR) with the aid of a plasticizer. The improvement in the bubble stability during film blowing process was investigated by using a peroxide Branching Agent (BA). The compound of PLA, NR and a branching agent (PLA/NR/BA) was prepared by reactive melt blending method. The parameters investigated are the PLA to NR ratio, the content of branching agent on the mechanical properties, processability and morphology of the blend. The results indicated that NR could increase the tensile toughness and elongation at break of PLA blown films and the use of higher amount of branching agent could allow stable processing of PLA/NR blends at higher NR content. The reactions of branching agent with PLA and NR were verified by Fourier-transform infrared spectroscopy.

Biography

Cattaleeya Pattamaprom is currently the Head of Polymer and Rubber Technology Center and an Associate Professor at the Department of Chemical Engineering, Thammasat University, Thailand. She has obtained her Doctoral degree with specialization on theoretical modeling of polymer rheology from the University of Michigan, USA. Her research areas include rheology and theoretical modeling of polymer and rubber, polymer and rubber modification, polymer/rubber processing, composites and blends.

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Zayniddin K Muhidinov et al., J Material Sci Eng 2018, Volume 7
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Characterization of a polysaccharide from *Eremurus hissaricus* roots growing in Tajikistan

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Roots of medical plants are important resources of bioactive compounds including a polysaccharide, many of which have been reported to possess various biological functions. Two types of Water-Soluble Polysaccharides (WSP) and Acid-Soluble Polysaccharides (ASP) with 23% and 8% yields, the molecular weights of 495 kDa and 179 kDa, respectively were obtained from the roots of *Eremurus hissaricus* growing in Tajikistan in dormancy periods. The crude polysaccharides after deproteinization were purified by ion-exchange and gel filtration chromatography to obtain a homogeneous polysaccharide. The monosaccharide composition of WSP and ASP were analyzed by HPAEC-PAD. WSP was composed of D- mannose and D-glucose in 1.7:1 molar ratio. ASP content includes the pectic polysaccharide. IR spectra and analysis of 2D NMR analyses of WSP provide evidence that it has a backbone of (1→4)-linked ß-d-glucopyranosyl and ß-d-mannopyranosyl. The NMR and FTIR spectra of both crude and purified WSP have no differences. This fact probably indicates that WSP has no significant impurity. The carboxyl group of WSP is highly esterified. The NMR analyses of the ASP and deproteinated ASP polysaccharides suggest that the samples are composed of rhamnose, galactose or glucose, xylose and arabinose with partially methyl- and acetylated carboxyl groups which might be consistent with a branched pectic rhamnogalacturonan. Unfortunately, monosaccharide analysis has not yet been performed on these samples. The NMR spectrum of the ASP-S3 sample is similar to the other two but it appears to lack resonances assignable to xylose. It is unclear what this means. The bands at 801 cm-1 in the FTIR of the ASP samples were characteristic of the a-pyranose configuration of sugar unit of the pectin polysaccharide, while the absorption in the region of 880-890 cm-1 confirms the presence of ß-pyranose configuration of another sugar residue in the WSP.

Biography

Zayniddin K Muhidinov has obtained his degree in Chemistry at the Tajik State University and PhD in Chemistry of Natural Compounds and Doctor of Science degree in Polymer Chemistry at Chemistry Institute of Academy of Sciences of the Tajikistan Republic. In the last 14 years, his group has been in collaboration with the USDA scientists in several projects pertaining to development of domestic and agricultural byproducts into Drug Delivery Systems (DDS) for therapeutic purposes. He is also the author of a monograph, four chapters of the book, more than 290 scientific articles and abstracts, including 38 papers in peer reviewed journals and 10 patents.

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PEG-peptide based Doxorubicin delivery systems

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Statement of the Problem: pH responsive Drug Delivery Systems (DDS) have been developed to increase therapeutic activity of the drugs and to overcome multidrug resistance problem of cancer cells. One of the drawbacks of the DDS with pH sensitive moieties where drug molecules are hold via intermolecular interactions is considerable release of the cargo at physiological pH. Although chemically attaching the drug to the carrier molecule can minimize the drug release at neutral pH, these configurations suffer from slow release at acidic conditions as well. In this study, a pH responsive DDS containing both pH responsive functional groups and acid cleavable chemical bond between drug and carrier molecule was proposed.

Methodology & Theoretical Orientation: mPEG-peptide based doxorubicin delivery system (mPEG-AT1-DOX) containing pH responsive histidines and hydrazone bond was developed and its performance was compared with peptide-free DDS, mPEG-DOX having hydrazone bond.

Findings: Hydrodynamic diameters of mPEG-DOX were determined as 9±0.5 and 7±0.5 nm at pH 7.4 and pH 5.0, respectively. The mPEG-AT1-DOX, on the other hand, exhibited a size distribution between 20 and 100 nm centered at about 40 nm at acidic pH much larger than its mean size at neutral pH measured as 12±2 nm. Enhanced pH responsiveness of mPEG-AT1-DOX was also confirmed by the comparison of the percentage of DOX release values of both DDS evaluated at pH 7.4 and pH 5.0. Cytotoxicity of the DDS was assessed using A549 cell line. DOX equivalent absolute IC50 values were obtained as 1.8±0.9, 40.3±10.9 and 10.2±1.4 μM for free DOX, mPEG-DOX and mPEG-AT1-DOX, respectively.

Conclusion & Significance: Superior pH sensitivity and cytotoxicity of mPEG-AT1-DOX indicated utilization of both pH responsive functional groups and acid cleavable chemical bond can be a promising approach in the design of DDS for cancer therapy.

Biography

Beste Balci has graduated from the Department of Chemical Engineering at Izmir Institute of Technology. She had completed her MSc degree at the Biofunctional Materials Laboratory at the same institution under the supervision of Assistant Professor Ayben Top. During her MSc studies she had focused on the development of PEG-peptide based pH responsive drug delivery systems for cancer therapy. Currently, she is pursuing her PhD at Kyoto University, Japan.

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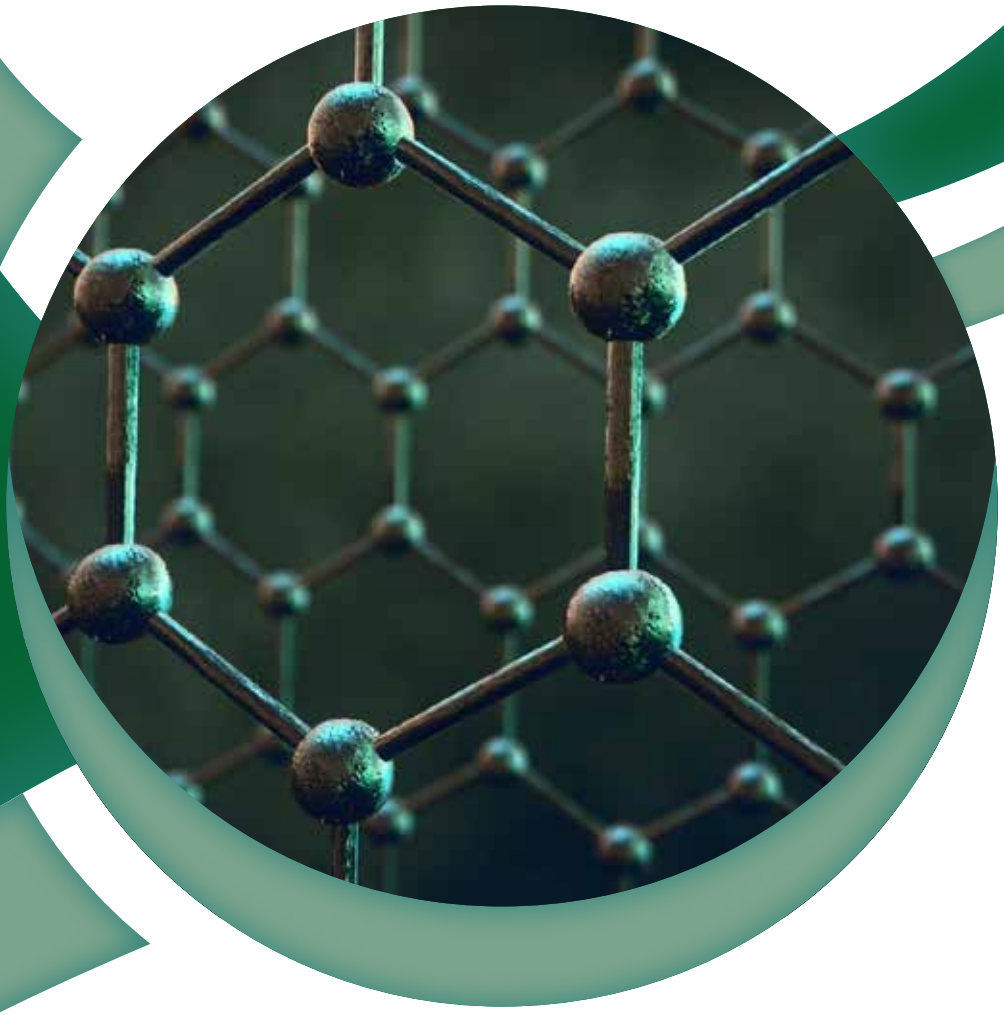

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Scientific Tracks & Abstracts

(Day 2)

Ivan Chodak et al., J Material Sci Eng 2018, Volume 7
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Effect of biodegradation on physical properties of PLA-based blends

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Biodegradable plastics undergo substantial changes due to degradation by enzymes produced by various bacteria. From application point of view, modification of physical properties is important, occurring even when the testing specimens are apparently unchanged. Degradation in compost of Polylactic Acid (PLA), PLA with a plasticizer Triacetin (TAC) and a mixture of PLA/Polyhydroxybutyrate (PHB)/TAC proceeded at temperature 58 °C up to 16 days. Then, the biodegradation degree was determined by measuring the content of evolved carbon. The degradation rate was found to vary a little for the three samples. While the biodegradation tests were performed to almost complete biodegradation of the materials to carbon dioxide and water. Physical properties could be measured only for the first eight days and in some cases up to 16 days when it is possible to separate the material from the compost. At longer periods the materials have been disintegrated to small fragments and separation of the sample from compost was impossible. Numbers of testing methods were applied. Molecular weight and molecular weight distribution was determined by GPC, supported by measuring the viscosity by rheology. Structures of the materials were estimated from changes in Tg and crystallinity. Mechanical properties of samples and the data were compared with information obtained from dynamic mechanical analysis. The conclusions have been made regarding the effect of TAC and PHB presence on the biodegradation of PLA and related changes concerning the structure/mechanical relations.

Acknowledgement: The support from projects VEGA 1/0570/17, APVV 15-0741 is appreciated.

Biography

Ivan Chodak he is currently Full Professor of Macromolecular Science, Slovak Technical University Education. His research focus on Multiphase systems with a modified polymeric matrix, synthesis and properties. Crosslinking of polymers, especially polyolefins and rubbers. Nano composites with polymeric matrices, special experience with matrices of biodegradable plastics and rubbers. Modification of biodegradable plastics, physical, chemical, blending. Electro conductive polymeric composites. A member of Editorial Board of Plasty a kaucuk (Plastics and Rubber), Czech republic, member of Editorial board of Bentham Open Macromolecular Journal. More than 130 papers in peer reviewed international scientific journals (mainly CC),8 chapters in monographies, about 100 lectures in scientific conferences (including about 30 invited key and plenary lectures), 12 slovak patents, 3 European patents. Around 900 citations, Hirsch index 14.

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Plasma surface treatment of recycled polymers for food packaging

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The change of habit and the increase in consumerism in the last decades have led to technological innovations and consequently to the greater production of consumer products, which has generated an increase in the production of packaging. However, its disorderly disposal generates a large volume of solid waste, which is associated with the environmental impact. Concern for this situation, we ought to develop alternative means to reduce such impacts and may highlight the reuse and recycling of packaging. Plastics represent the largest share in the value of Brazilian packaging production, corresponding to 38.85% of the total. The employment level of the packaging industry reached 216973 jobs in June 2017. The plastic industry is the one that most employs, totaling in June 2017, 115307 formal jobs, corresponding to 53.14% of the total jobs in the sector. The plastics sector accounts for 59.58% of total imports. With respect to the results obtained in the last 10 years of research, the reuse of recycled commercial polymers by plasma surface treatment is emphasized. Then, it is possible to change the character of wetting of the polymers, being able to obtain high hydrophobic or high hydrophilic surfaces, maintaining very smoothness, high optical transparency in the visible region (up to 80%) and improving gas barrier (down to 1 g/m^{2}day) mainly for PET and LDPE, which makes the plasma immersion treatment interesting for the food packaging.

Biography

Pericles Lopes Sant'Ana has obtained his Bachelor's degree in Production Engineering from Federal University of Viçosa, Brazil. He has completed his Master's and Doctoral degrees in Materials Science and Technology from the State University of Sao Paulo. He has 10 years of experience in research and development, working with plasma surface treatment and thin films deposition for food packaging and optical devices. Recently he has developed PVC, PET and LDPE polymers using plasma immersion techniques.

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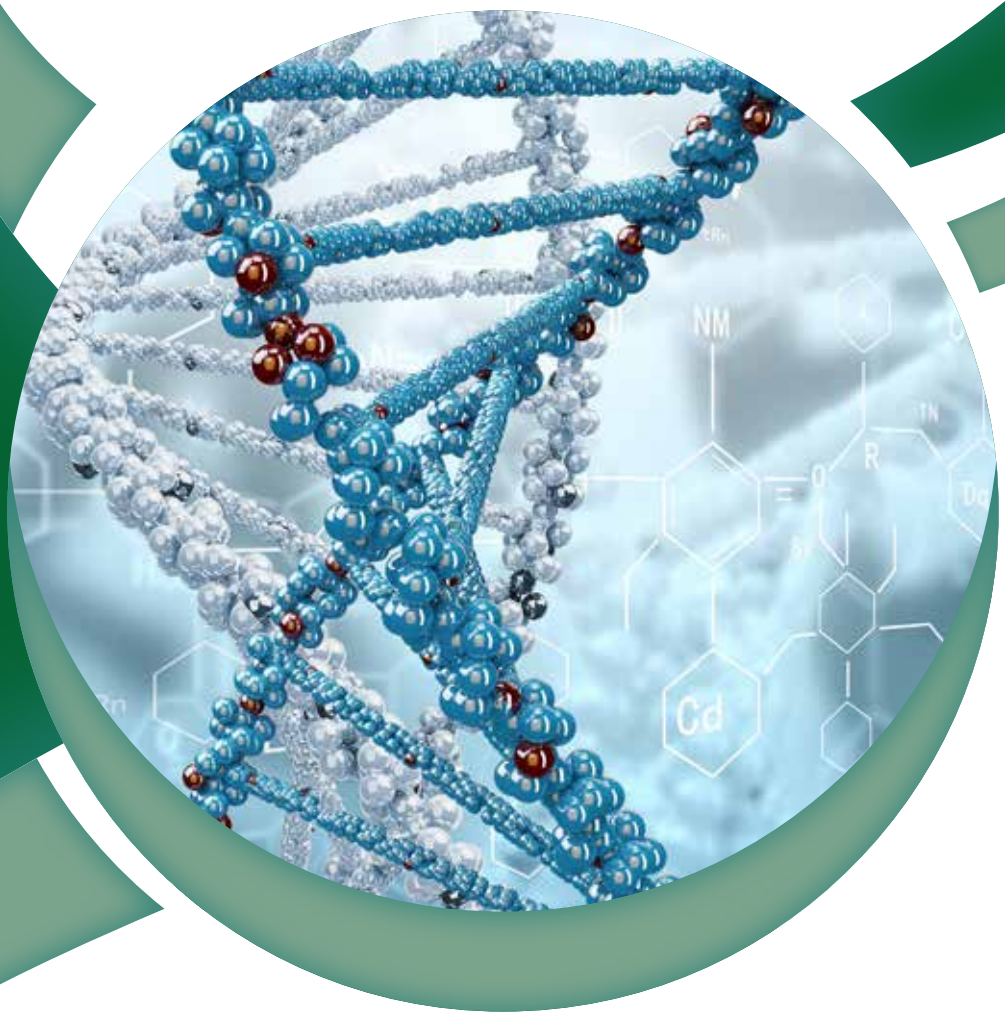

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Scientific Tracks & Abstracts

(Day 3)

Yinghao Fu, J Material Sci Eng 2018, Volume 7
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Facile tailoring the morphology and water-solubility of chitosan

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The solubility of chitosan is depended on its morphology mainly when its chemical structure was fixed. In view of this, we intended to modulate the water-solubility through tuning its morphology. Both the entanglement and crystalline degrees of chitosan could be varied through a common dissolution and precipitation processes, which resulted in the change of the water-solubility of chitosan accordingly. Several possible morphology models were presented for various samples obtained by simply changing the amount of solvents and precipitants. As a result, chitosan was able to be dissolved in water in absence of acid.

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Reinforcing effect of poly-furfuryl alcohol on freeze-dried micro-fibrillated cellulose foams

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Lightweight foams are of general interest in a diversity of applications because of their low density and high specific surface area. Since there is a special interest to replace fossil-based polymers with polymers from renewable and biodegradable resources, cellulose nanofibrils and lignocellulosic nanofibrils were used to prepare bio-based foams, which could be used for insulating materials. For the preparation of the porous materials, lignin-free bleached wood pulp, termed MFC and micro-fibrillated cellulose with 17% lignin content (MFLC) were used in aqueous suspensions. Furfuryl alcohol and maleic anhydride were added to the slurry, resulting in ratios of fibrils to furfuryl alcohol of 0.00, 0.03, 0.06, 0.11, 0.20, 0.33 and 0.50. After mixing with a high-shear blender, the mixtures were placed in an oven at 80 °C for 24 hours in order to polymerize the furfuryl alcohol. Thereafter, foams were prepared by freeze-drying. Characterization of the foams was performed by Scanning Electron Microscopy (SEM), ATR-Fourier Transform Infrared Spectroscopy (FTIR), Thermo-Gravimetric Analysis (TGA) and as well as mechanical testing (e.g. compression tests). Furfuryl alcohol content was found to significantly affect the foam density. Furthermore, mechanical properties were significantly higher for MFLC-based foams.

Biography

Eva-Marieke Lems has obtained her Master's degree in Biomaterials Science and Technology from University of Natural Resources and Life Sciences, Austria in 2017. Presently she is pursuing her PhD with the thesis entitled "Lignocellulosic materials and their application possibilities".

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