BioRest: Production of Bio-polymers from biogenous feedstock and remnant

Regina Itzinger[a], Christian Paulik[a]

[a]Institute for Chemical Technology of Organic Materials, Johannes Kepler University, Linz, Austria

INTRODUCTION

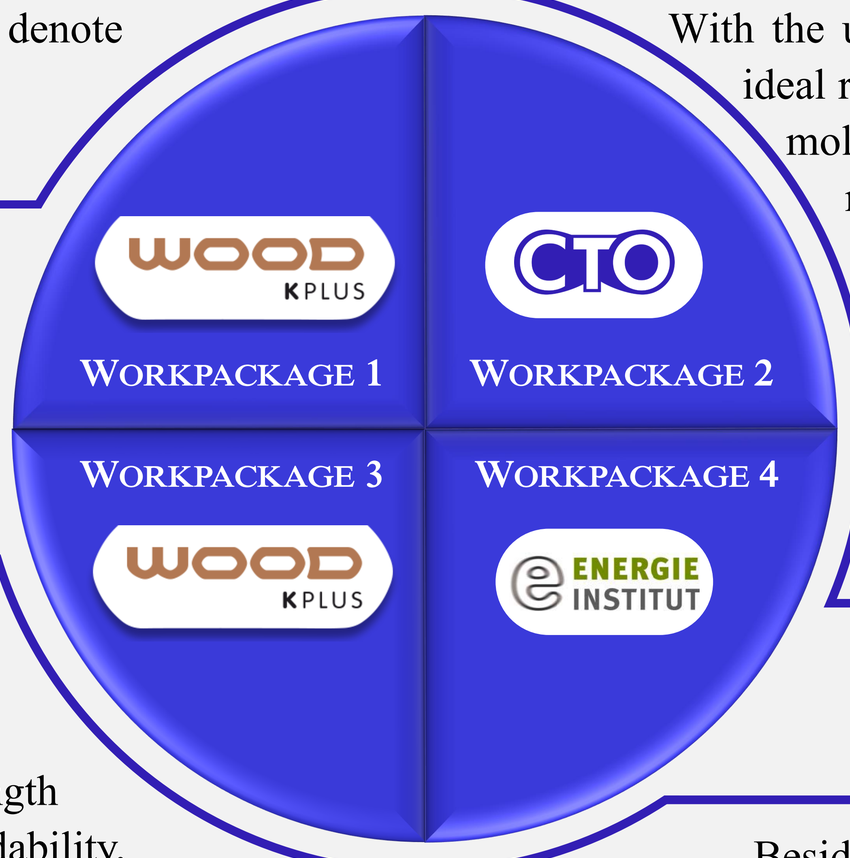
The project BioRest considers the production of new bio-based materials from remnants of the paper and cellulose industry. Various scientific literature denotes, that with the generation of bio-polymers, which are predicted to be able to substitute commodity polymers in a wide range, a reduction of resource input from fossil origin can be achieved [1-3]. The aim of this project is the production of polyhydroxyalkanoates PHAs and lactic acid LA via fermentation processes. The LA is in a further step polymerised to poly lactic acid PLA. Considering the industrial production volume of these polymers – 0.2% based on polyolefin production [4,5] – one can see that the manufacturing rate is not exploited by far. Furthermore, specific property modifications of the bio-polymers (PHA, PLA) and their composites are targeted to adjust the mechanical properties and the machinability.

Conditioning of the feedstock

The miscellaneous feedstock strains, depending on the pulping strategy, are separated into a lignin rich fraction and a carbohydrate rich fraction to enable their utilisation. In the following pathway extremophilic microorganisms are used in a fermentation process. The advantages given by halophilic microorganisms are exploited to generate PHA, whereas thermophilic microorganisms are used to produce L-LA. The wide range of fermentation properties denote these microorganisms as a favourable way in the production.

Polymer production

The lactic acid, obtained from the fermentation process, possesses a great racemic purity and is converted into poly lactic acid by the application of direct polycondensation, azeotropic polycondensation, solid phase polymerisation or ring opening polymerisation ROP. The ROP is carried out with tin (II)-2-ethylhexanoate acting as a catalyst and an alcohol operating as the initiator, which is starting the polymeric chain growth. With the usage of various catalyst-initiator ratios, the ideal reaction conditions for the synthesis of a high molecular weight polymer are determined. The results from the obtained database are then used to adapt the synthesis, depending on the lactide quality received from the fermentation process. Furthermore, with different block co-polymers from L-LA and D-LA, properties similar to commodity polymers should be achieved.



Property Modification

Focusing on the mechanical properties, like rigidity and strength, PLA and PHAs have a great applicability in technical purposes. Nevertheless, the low impact strength of these materials and their minor extrudability, especially of PLA, poses a pushback factor in commercial use. To overcome these disadvantages the polymers are treated by blending with different bio-based polymers. The addition of modified nucleating agents speeds up the crystallization and with the application of additives and bio-based fibre-additives the shrinkage is reduced to a minimum.

Life Cycle Assessment

Besides the laboratory work economic and environmental evaluations have to be made. Therefore it is important to reveal the current market share of bio-based polymers and understand the underlying process chain of the polymer production. Furthermore, the environmental impact, the energy footprint and possible implementation of the processes in a company are investigated.

References

1. Ed.: Umweltbundesamt (UBA), Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit; *Zukunftsmarkt Biokunststoffe;* **Dez. 2007**.
2. Shen L., Worrell E., Patel M.; *Present and future development in plastics from biomass;* Biofuels, Bioprod. Bioref. **2010**, 4, 25-40.
3. Mülhaupt R.; *Green Polymer Chemistry and Bio-based Plastics: Dreams and Reality*; Macromol. Chem. Phys. **2013**, 214, 159-174
4. Carus M.; *Growth in PLA production: a production capacity of over 800,000 tonnes expected by 2020*; bioplastics Magazine.com; **Aug. 2012**, viewed 2017
5. Endres H-J.; *Biopolymere: Markchancen Flächenbedarf und künftige Entwicklungen; Kunststoffe;* **2011**, 105-110

Acknowledgement

This project is funded by the "Europäische Fonds für regionale Entwicklung" and the province of Upper Austria.

Europäische Union Investitionen in Wachstum & Beschäftigung. Österreich.

LAND OBERÖSTERREICH