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Andreas Künkel, J Adv Chem Eng 2016, 6:3(Suppl)
http://dx.doi.org/10.4172/2090-4568.C1.002

2nd World Congress on

Biopolymers

August 04-05, 2016 Manchester, UK

Biodegradable and renewable polymers: How to contribute to a sustainable future?

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Introduction: In 2050, very probably 9 billion people will live on Earth, resulting in significant challenges. Major tasks will be supply of food, the more efficient use of resources (raw materials, energy), protecting the environment and prevention of further climate changes.

Renewable Raw Materials & Monomers: Use of renewable raw materials for monomer production offers the opportunity to improve sustainability, especially the carbon footprint. Important renewable monomers are lactic acid (for PLA), 1,4-butanediol, succinic acid, mid chain dicarboxylic acids (for biodegradable polyesters), 1,3-propanediol (for PTT) and furandicarboxylic acid (for PEF). Actually only 1st generation biorefineries (e.g. corn to glucose) are in place while 2nd generation biorefineries (cellulose to glucose, xylose) are still in infant status. Technological progress has been significant in the last years, but cost competitiveness to the fossil counterparts is difficult to achieve. 1,3-propanediol and succinic acid are examples where the biobased variants seem to be superior in costs and sustainability.

Polymers & Compounds: ecoflex® F, the aliphatic-aromatic BASF polyester, is made from terephthalic acid, butanediol and adipic acid. ecoflex® is the preferred blend partner for biobased and biodegradable polymers which typically do not exhibit good mechanics and processability for film applications by themselves (e.g. starch, PLA). The BASF brand name for compounds of ecoflex® with PLA is ecovio®. The exchange of monomers (e.g. by succinic acid) gives access to polyesters and compounds with new properties.

Organic Waste Management & Agriculture: Organic waste management and mulch film in agriculture are two application examples where biodegradable and renewable polymers add value. Approximately 40% of the household waste is organic waste, which can be converted to energy and to valuable compost. To enable this organic recycling, biodegradable organic waste bags and coffee capsules have been developed. Mulch film offers the opportunity to increase crop yield by reducing water consumption, improving microclimate and preventing growth of weeds. Biodegradable mulch film is plowed in the soil after harvest thus reducing the number of working steps.

End of Life & Sustainability: The prerequisite for these applications is the biodegradability of the used polymer compounds. Polymer biodegradation commonly begins with the (hydrolytic) breakdown of the main chain – often enzymatically catalyzed – followed by mineralization of the resulting small molecules by microorganisms present in the respective habitat. Therefore elucidation of the interaction of microorganisms and their respective enzymes with polymer substrates in different environments and deducing relevant structure-property relationships is an important task of BASF biopolymer research.

Conclusion: Biodegradable and renewable polymers will not resolve the world's sustainability challenges. But, smartly used, they will contribute to its solution.

Biography

Andreas Künkel is the Head of Biopolymer Research of BASF. After his PhD in Microbiology at the Max Planck Institute for Terrestrial Microbiology in Marburg, he started his BASF career within the Central R&D department, followed by marketing positions within the divisions Fine Chemicals and Performance Polymers. Since starting in BASF in 1999, his focus has been the strategic development and marketing of chemicals and polymers based on renewable resources using the synergies between classical chemistry and biotechnology.

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