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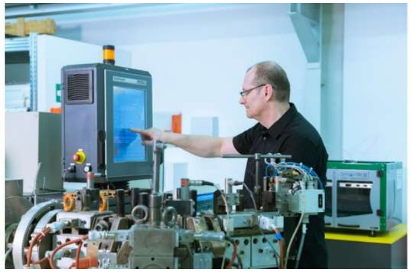


BIOBASED PLASTICS FOR A CIRCULAR ECONOMY

NTE1 PRESENTATION

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ESR 1

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Packaging Applications

- Benefits of Packaging:
  - Protects the product
  - Utility- Effective Product Use, Distribution, Point of sale presentation
  - Brand Content Information

- But Single use packaging is a dire threat to the environment
- Current EU practice - incineration
- Mechanical recycling of the packaging plastics helps to keep it in the loop and not escape out.

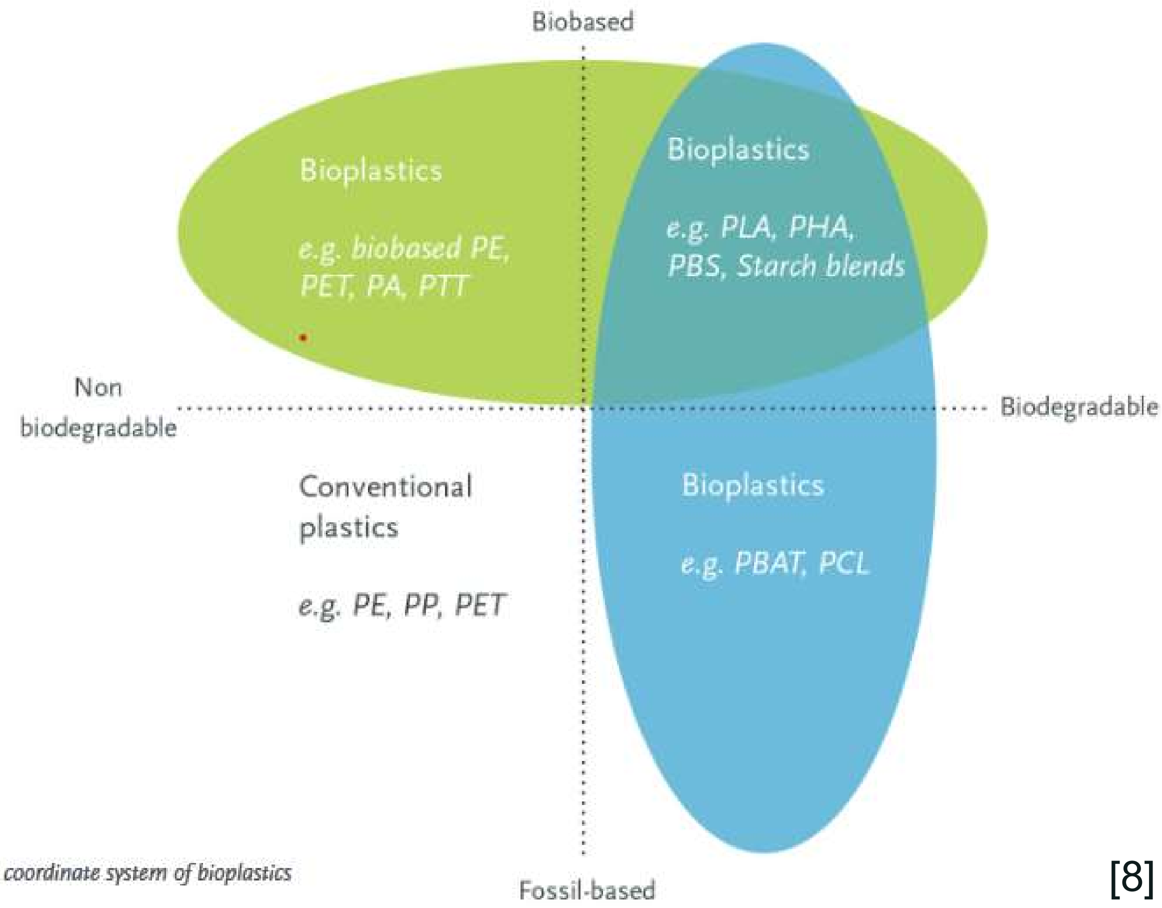
- First Principle of circular economy
  - Maintain resource value in the economic cycle for as long as possible.[1]

Types of Plastics

- Plastics have come to be divided into 2 categories:
- Conventional or petroleum based: from nonrenewable materials
  - Eg: PE, PP etc.
- Bioplastics or Biobased plastics:
  - Eg: PLA, PHA etc.

- The best current general definition for the concept of biopolymers describes a polymer material that fulfills at least one of the following properties:
  - Consists (partly) of bio-based (renewable) raw materials
  - Is in some way biodegradable [2]

BIOPLASTICS



Graph: Material coordinate system of bioplastics

[8]

Why Bioplastics?

- Reduction of carbon footprint
- Independence from Crude Oil
- Perception of the consumer [3]

- Second Principle of circular economy
  - To prevent and decrease the negative effects of obtaining primary resources on the environment and society [1]

End of life options for Bioplastics

- Recycling, Composting, Biodegradation, Energy Recovery, Landfill etc.[2]

- Mechanical Recycling:
  - In contrast to energy recovery, chemical recycling and composting, mechanical recycling allows for preserving the polymer structure and the material value in terms of feedstock and polymerization energy. So it is crucial to ensure the sustainability of biobased plastics in the long term.[7]

- **Objective of Research:**
  - Further development of mechanical recycling of bioplastic packaging products.
  - Improve the current bioplastic packaging products (with focus on PHAs).

PHAs-Polyhydroxyalkanoates

- Polyesters produced by a variety of microorganisms in different conditions.
- They are accumulated as intracellular storage granules.
- Thermoplastic, biodegradable, biocompatible, nontoxic, good barrier properties[4]

- The general structure:
- –O–CHR–$(CH_2)_m$–CO– [5]

- Generally divided into three groups:
  - Short chain length: 3-5 C atoms eg: PHB, PHV
  - Medium chain length: 6–14 C atoms eg: PHHx
  - Long chain length: >14 C atoms in the backbone eg:PHBHHx[4]

PHB- Polyhydroxybutyrates

- –O–CH(CH$_3$)–(CH2)–CO–
- Linear isotactic structure and highly crystalline(60-70%)[2]

- In terms of molecular weight, melting point, crystallinity and tensile strength, PHB is still equivalent in comparison with a conventional plastic of polypropylene (PP).

- It is even better than PP and PET with respect to oxygen, water vapor, fat and odour barrier properties. Therefore, a development of PHB mechanical properties is necessary to fully exploit its useful attributes for packaging applications.[4]

Challenges in using PHB

- Brittle in nature[2]

- Difficult to process:
  - Physical ageing due to secondary crystallization of amorphous phases taking place during storage at room temperature
  - In addition, PHB has a low nucleation density and slow crystallization rate, which promotes the formation of large spherulites that exhibit inter-spherulitic cracks and fractures.

  - Secondly, PHB has a relatively narrow processing window, due to its low resistance to thermal degradation. [6]

Summary

- Packaging is necessary but to be made from bioplastics.
- PHAs are a good choice.
- Mechanical recycling to be developed further.

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“The beginning is the end and the end is the beginning.”- From the Netflix series Dark

Thank You!

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