

# Plastics and Biocomposites

Wageningen UR Food & Biobased Research

InHolland 4 December 2013, Ben van den Broek



# Bioplastics

- Bioplastics are polymers or processed polymers originating from renewable resources made by humans
  - Often the term bioplastics is used for biological degradable plastics

	Non-degradable	Degradable
Petrochemical	PE, PP PS, PET PVC, PC	PBAT PCL PBS
Biobased	Eco-LDPE Nylon 11	PLA PHA's TPS



# Bioplastics

- Biodegradation: degradation catalyzed by biological activity (micro-organisms) resulting in mineralization of the biomass
  - Depending on:
    - Soil
    - Water, sea water
    - Anaerobic (fermentation)
    - Composting (industrial or at home)



# Bioplastics

## ■ Time line biopolymer

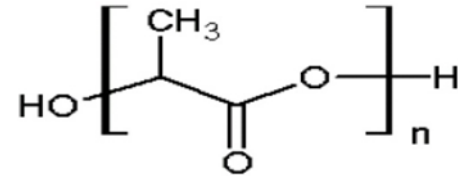
- ~1900 development of first biobased inspired polymers
- After WOII rise of the petrochemical polymers
- Since ~1980 new interest in biopolymers with the focus on biological degradation
- Since ~2000 focus on biobased polymers



# Bioplastics

## ■ Polylactic acid

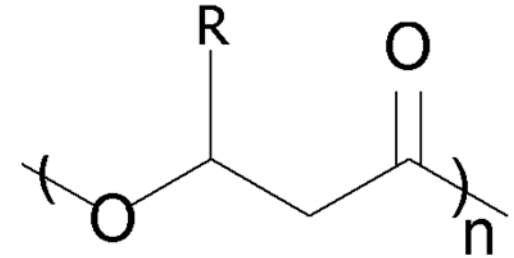
- Biobased and biodegradable
- Several producers, many grades, ~150 kt/year
- Price < 2€/kg
- Good mechanical properties
- Transparent, glossy
- Can be processed using different techniques
- Applications; fibers, foils, thermoform products



# Bioplastics

## ■ PHA's

- Biobased en rapidly biodegradable
- Several producers world wide
- Price > 3.5€/kg
- Good mechanical properties
- Hydrophobic
- High user temperature
- Not transparent



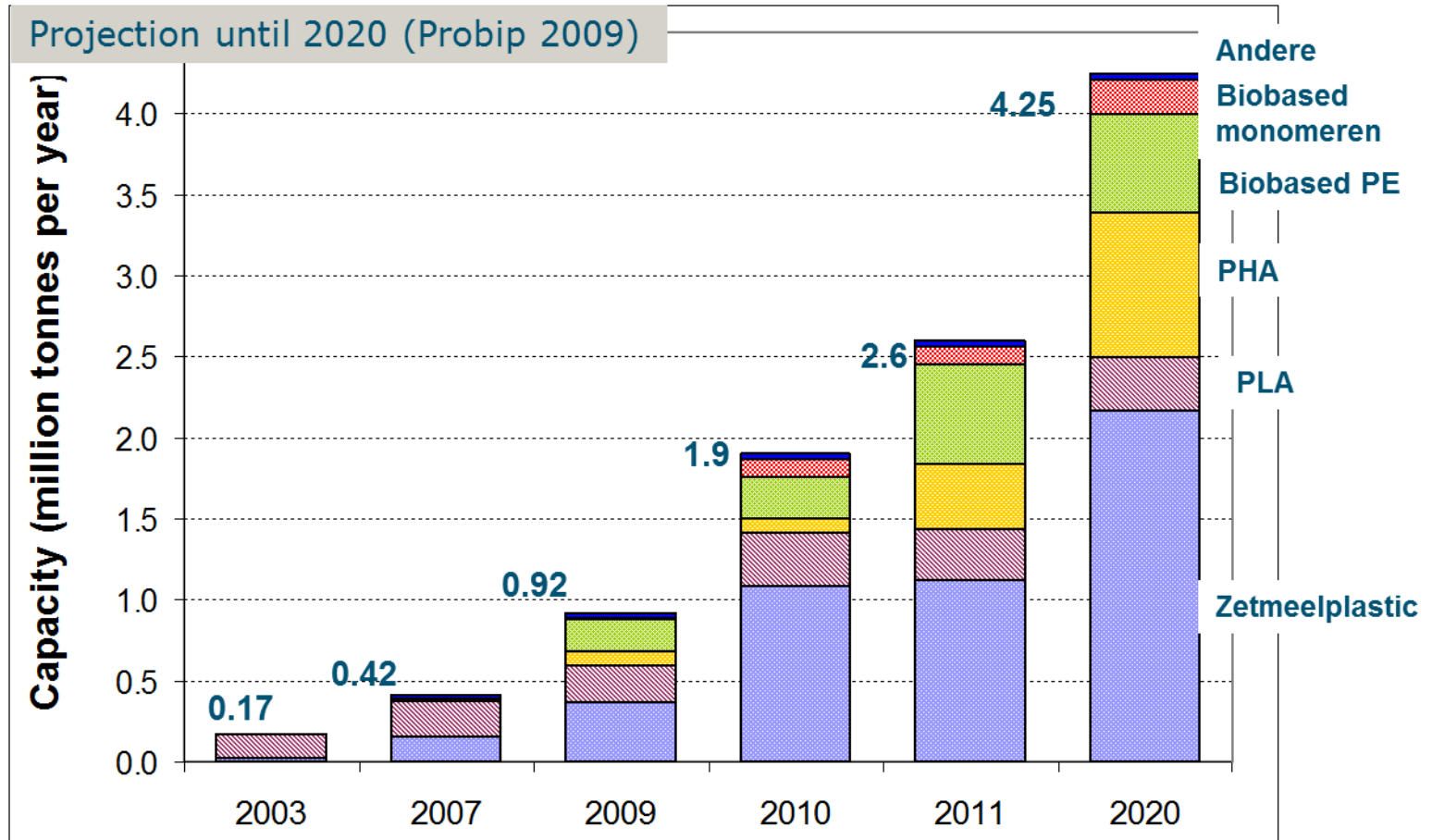
R = CH<sub>3</sub> Polyhydroxybutyrate

R = CH<sub>2</sub>CH<sub>3</sub> Polyhydroxyvalerate



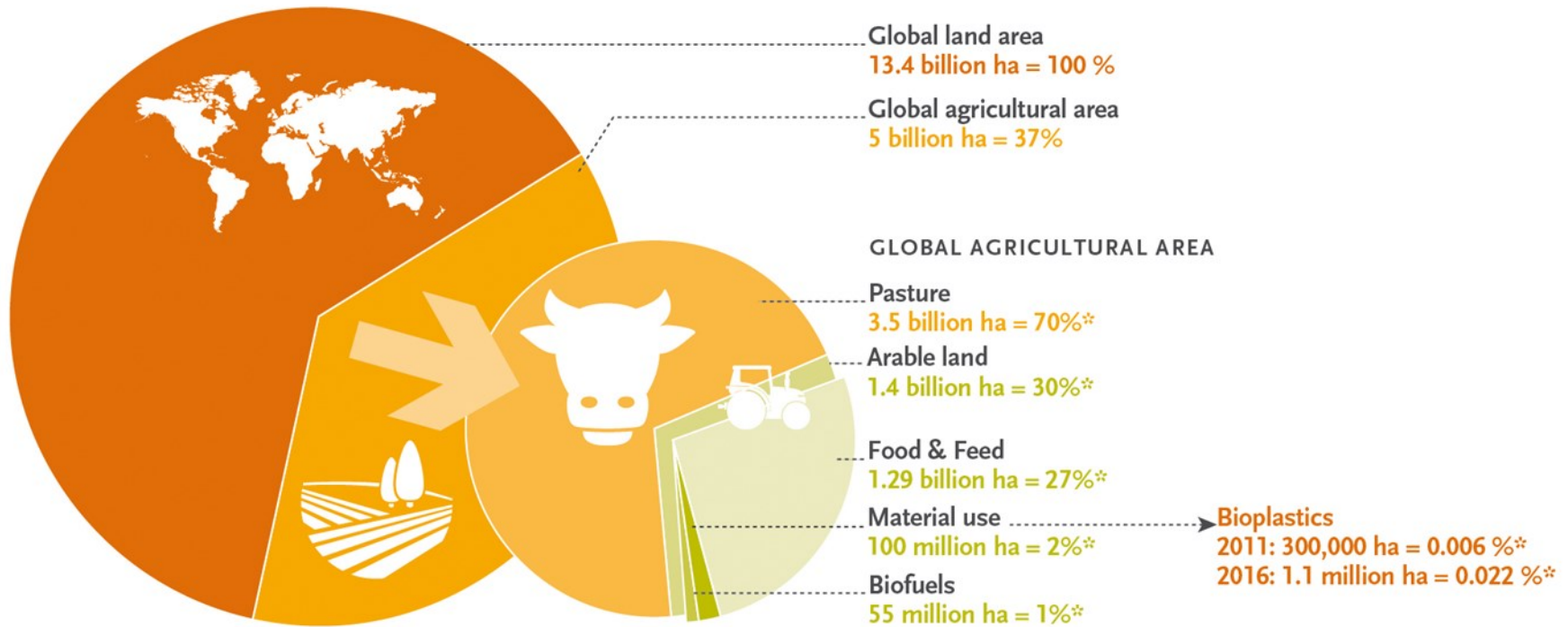
# Bioplastics

## ■ World wide production capacity of bioplastics



# Bioplastics

## Land use for bioplastics 2011 and 2016



Source: European Bioplastics | Institute for Bioplastics and Biocomposites (October 2012) / FAO

\* In relation to global agricultural area.

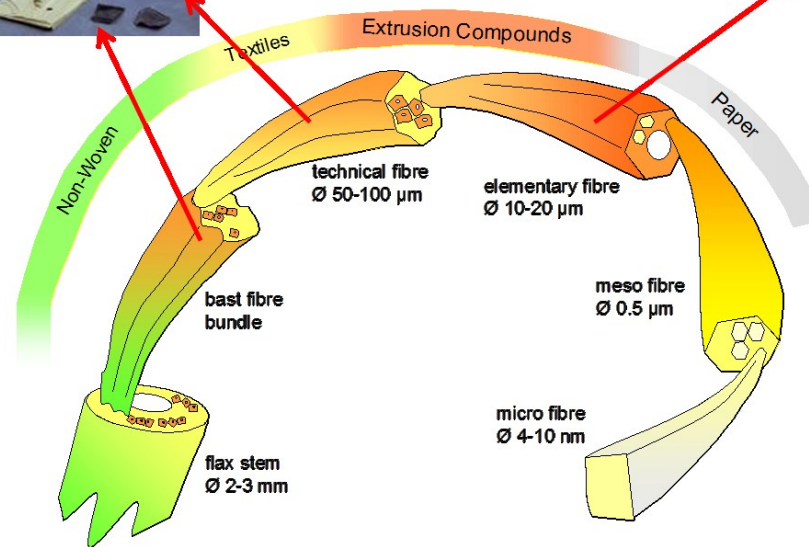


# Biocomposites



# Biocomposites

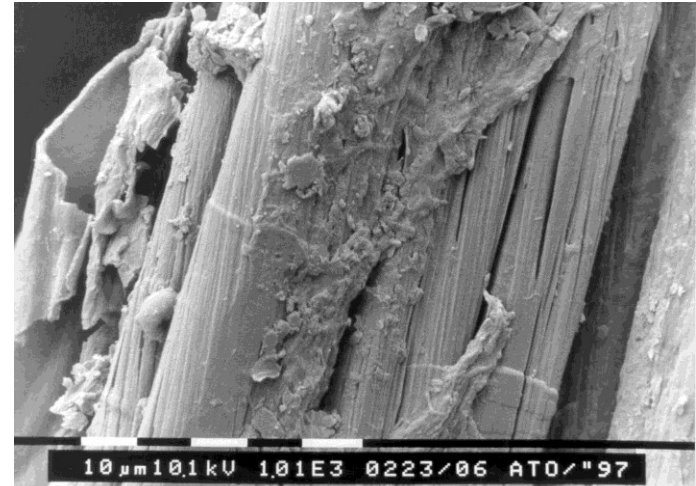
## ■ Application related to fibre structure



# Biocomposites

## ■ Expected benefits

- Strength
- Modulus
- Transparent materials
- Barrier properties/slow release
- Specific surface area
- Suspension stabilization
- Resistance to moisture
- Resistance to high temperature



# Biocomposites

- Potential applications
  - Coating formulations
  - Adhesives
  - Non-calorific food stabilisers
  - Slow release
  - Filtration
  - Reinforcement of paper and board
  - Polymer composites, lightweight sandwich structures



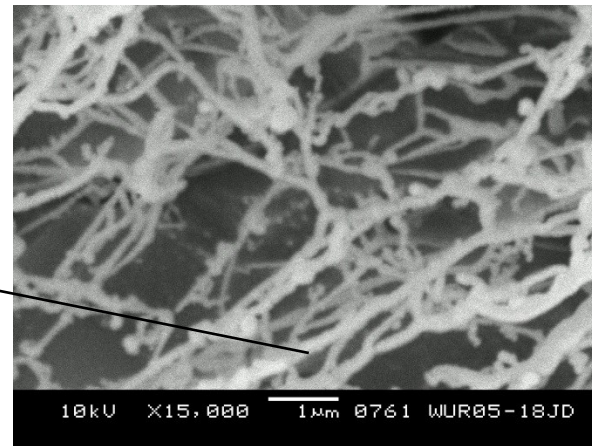
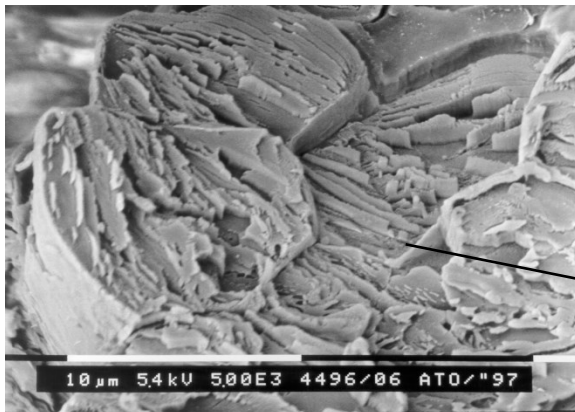
# Biocomposites

- Sources for cellulosic nanofibres
  - Annual fibre crops: e.g. Flax
  - Wood: Paper pulp fibres
  - Basically any lignocellulosic biomass (waste streams)



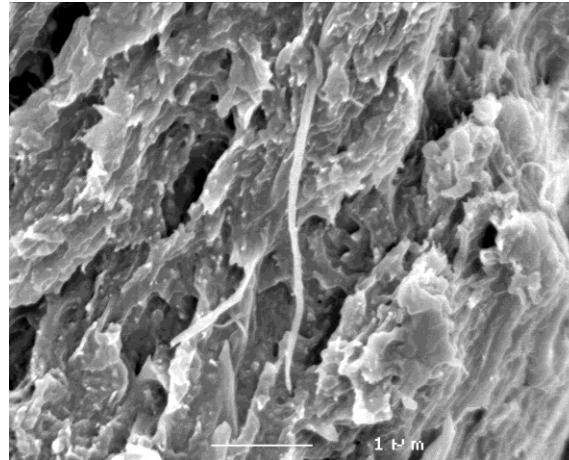
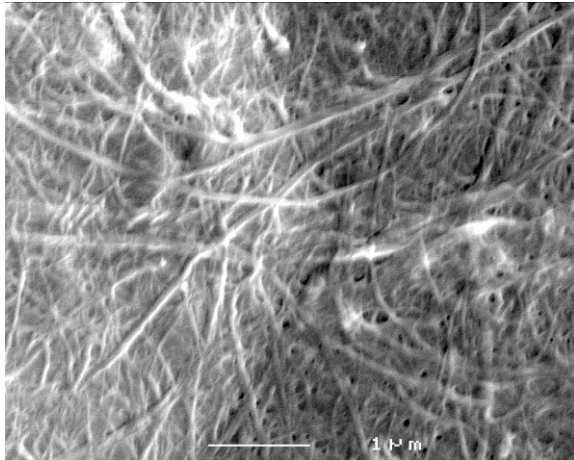
# Biocomposites

- Technologies used in pulp and food industry
  - Refining
  - Homogenisation
- Aqueous environment
  - Fibres tend to agglomerate after being formed
  - Fibres form H-bonds when being dried
- Downstream processing may require fibre modification



# Biocomposites

- Fibre reinforced composites
  - Using water dispersable polymer
  - Higher Strength and Modulus
  - Translucent films



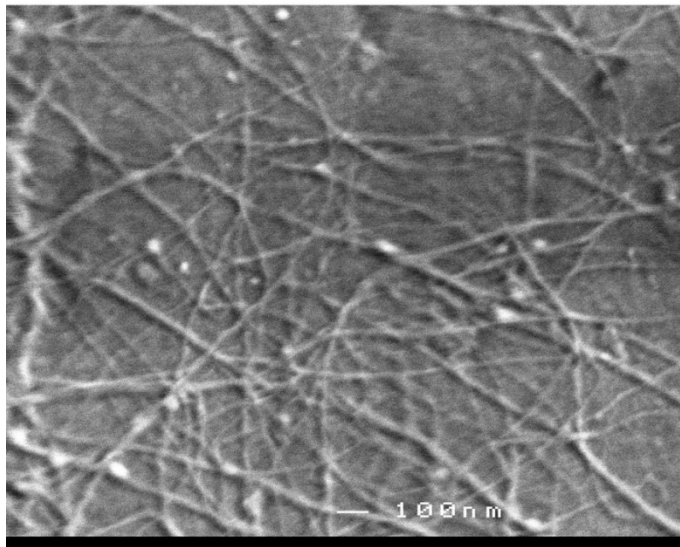
30% Softwood nanofibre-Starch  
Film thickness 110 μm



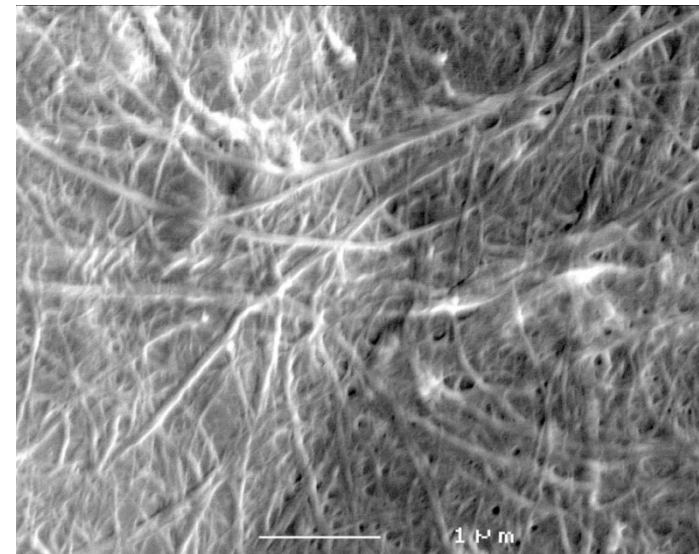
# Biocomposites

- Applications:

Non-calorific food stabiliser



Filtration





# Biocomposites

- Drivers for the use of natural fibers
  - “Bio” and “green”
  - Renewable resource
  - Good price-performance ratio
  - Unique appearance when transparent resin are used
  
- Cradle-to-cradle (recycling)



# Biocomposites



Thank you for  
your attention

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Oever

