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BIO-BASED MATERIALS FOR ACTIVE AND INTELLIGENT PACKAGING SOLUTIONS

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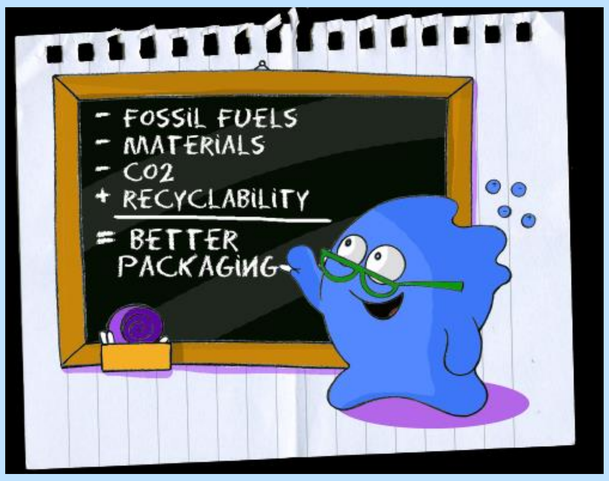
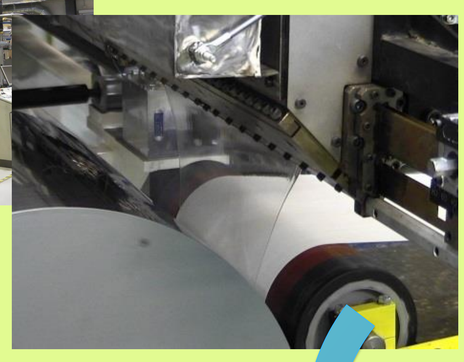
- **Active and intelligent packaging** offers versatile solutions for packaging industry
  - Internet shopping is increasing
  - Supply chains are evolving and need optimization
  - Food losses should be prevented
  - Product safety and authenticity should be ensured
- Most of the current active or intelligent packaging solutions are plastic-based
  - **Bioeconomic development** is based on the shift from fossil to renewable raw materials to respond to the challenges of climate change, ecological scarcity and depletion of natural resources
- The use of **bio-based materials** in packaging decreases the dependence on fossil fuels
  - Wood based biomass that is available in a large scale offers attractive “green” polymers
  - Also biopolymers that are based on agricultural or other waste streams offer interesting alternatives for traditional oil-based polymers



Plant-based polymers



TUT’s versatile Roll-to-Roll pilot line:

- ❑ (co)Extrusion coating and lamination
- ❑ Dispersion coating
- ❑ Cast film (co)extrusion
- ❑ Coatings, treatments and functionalisation of surfaces, *e.g.* corona, flame, atmospheric plasma, IR, UV, LFS
- ❑ Max. line speed ~400 m/min, max. web width 550 mm

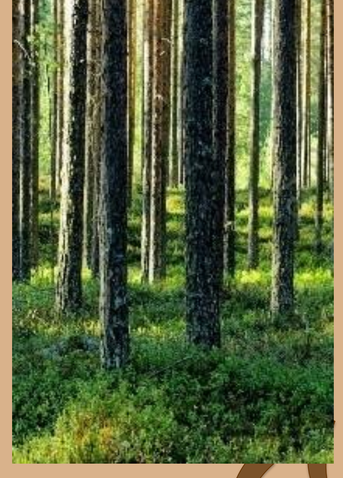
Polyhydroxyalkanoate (PHA) is a linear polyester naturally occurring as a result of bacterial fermentation of sugar.

MINERV-PHA™ is based on renewable raw materials, *i.e.* produced from side streams of sugar production (sugar co-products).

Polymer is biodegradable and degrades also in water.

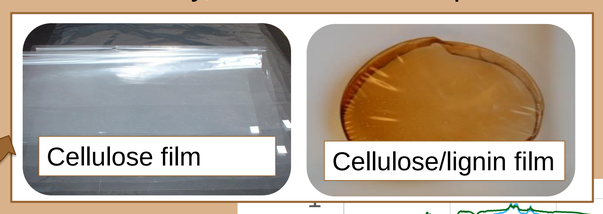
Polymer can be processed with existing extrusion equipment and is suitable for injection and extrusion methods for the production of coatings and objects.

Ref. http://www.bio-on.it; www.tut.fi; www.biobarr.eu

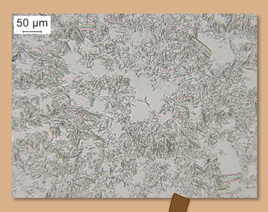


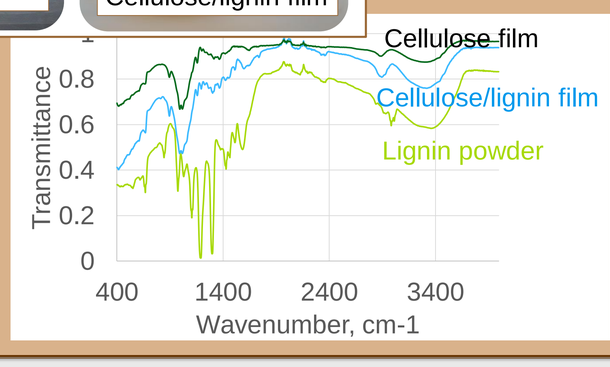
Wood-based polymers, **cellulose and lignin**, have inherent properties that can be utilized in active and intelligent packaging. **Piezoelectricity** is a fundamental property of cellulose. The monoclinic non-centrosymmetric crystal structure of Cellulose II enhances the piezoelectricity and may be used as a sensor and an actuator in intelligent packaging.
The polyphenolic chemical structure of lignin with aromatic rings provides **antibacterial and radical scavenging** functions for it. These properties may be exploited in active packaging.

Transparent films from cellulose can be formed by using the environmentally sound enzyme assisted dissolution method for cellulose. Additionally, it allows the incorporation of lignin into the films.



Microfibrillated cellulose, MFC, can be produced energy efficiently by using specific enzymes and mild mechanical treatment. MFC films were prepared by dehydration.





Oxygen permeability of the different films

Sample	Thickness, µm	OTR, ml m^{-2} day^{-1}	Ref.
Cellulose	32 ± 2	8*	This work
Cellulose	32 ± 2	1**	This work
MFC	58 ± 6	3**	This work
Cellophane	21	3	a
MFC	21	17	b
Polyester	25	50 – 130	c
EVOH	25	3 – 5	c
Polyethylene LD	25	7800	c
Polyethylene HD	25	2600	c

Measurement conditions: *23°C / 50% RH / 10% O_2
** 23°C / 0% RH / 100% O_2

References:
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