7th International Conference on Sustainable Solid Waste Management
Crete Island, Greece, 26–29 June 2019

GLOPACK

NEW GENERATION OF BIOBASED & FULLY DEGRADABLE COMPOSITE FOOD PACKAGINGS

Materials optimization for upscaled productive solutions

Horizon 2020
European Union Funding
for Research & Innovation

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UMR iAte Agropolymer engineering & emerging technologies
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IMT Mines Alès École Mines-Télécom
FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

THE CONTEXT

New biomaterials against plastic pollution

- Reduce plastics consumption
- Extend packagings lifetime
- Recycle plastics wastes

The case of food packagings:

LEGISLATIC

Directive EU 2015/720 to limit the consumption of lightweight plastic carrier bags

FRANCE

2016 **forbidden at cashiers**

2017 **forbidden for the packing** of goods & food

Sorry, what 's a « bio -plastic » again ?!

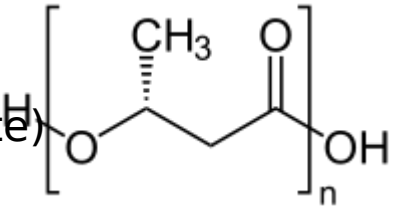
Replace plastic →

DEVELOPMENT OF THE BIO-PLASTICS ECONOMY

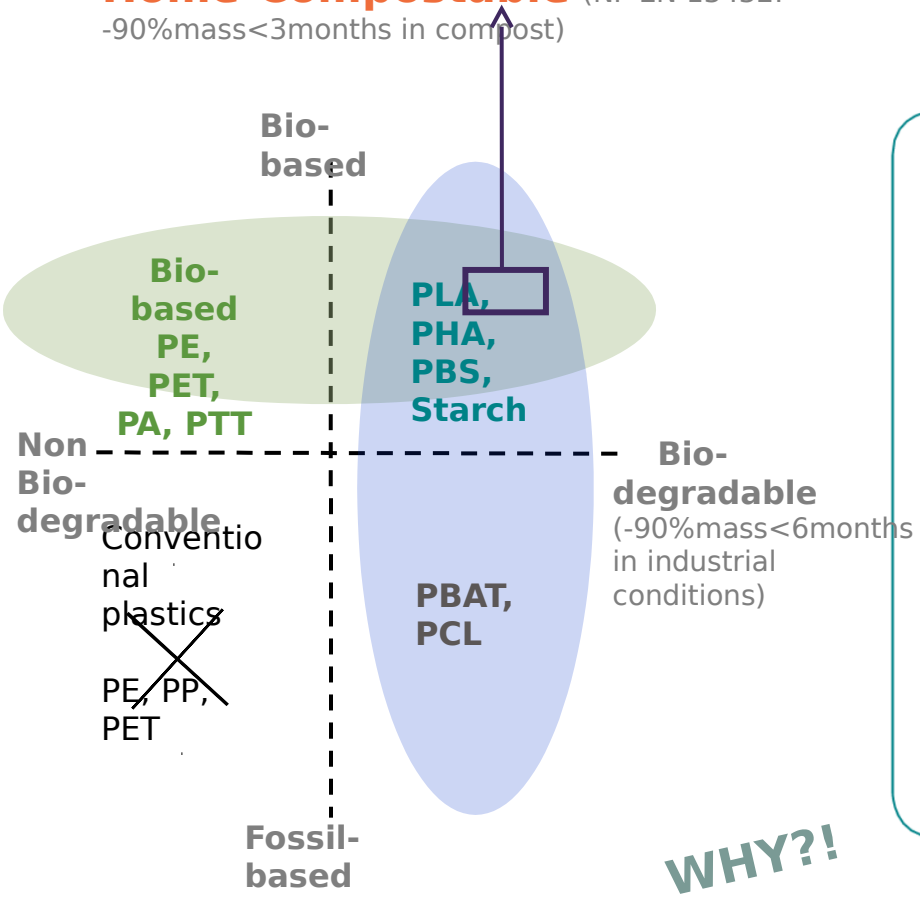
THE CONTEXT

Alternatives to fossil-based non-biodegradable plastics

PHAs (**P**oly **H**ydroxy **A**lkan~~oates~~) **PH3B**
(Poly Hydroxy-3-Butyrate)

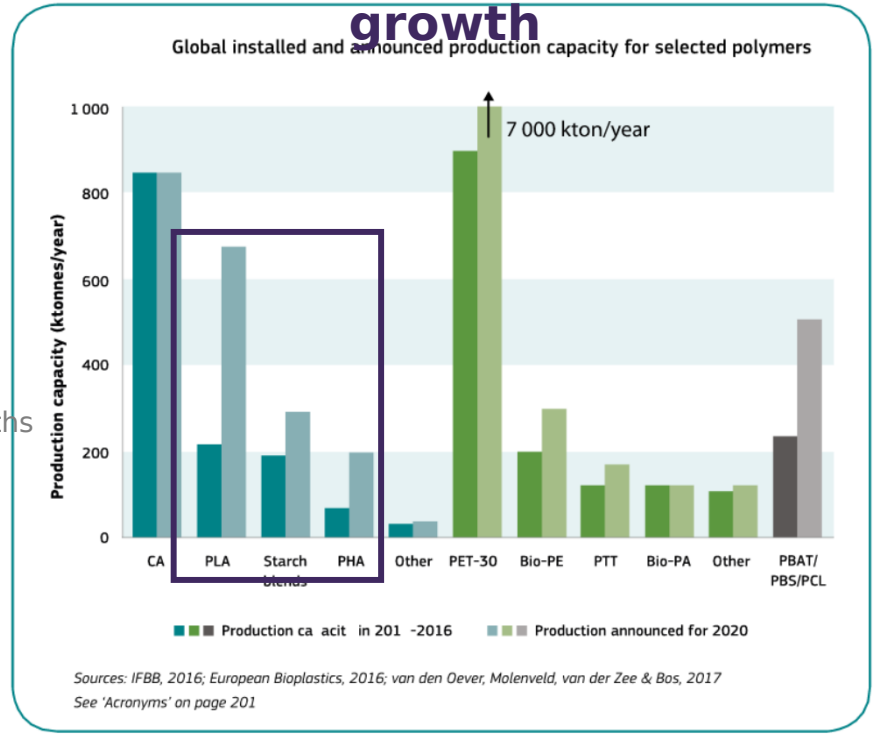


Biopolyesters
Bacterial fermentation of sugars/lipids
Home-Compostable (NF EN 13432: -90%mass<3months in compost)



WHY?!

Relative strong growth



STILL: Bio-plastics = 1% of the current volume of plastics offered annually

THE CONTEXT

Major Bottlenecks

The European Point of view

2019 UE Commission Report

« The added value of opportunities of bioplastics is often not valorized when the only aim is to replace fossil-based plastics »

New overview:
Compostable plastics offer new opportunities such as **functionalities** or **facilitation of wastes management**

KEYS FOR COMPETITIVITY :

Reduce production costs	**Enhance properties**	**Adapt to circular bioeconomy**	**Bring new functionalities**

THE PROJECT

GLOPACK Project

Horizon 2020
European Union Funding
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“ Investigating food packaging with no environmental footprint and the ability to extend the shelf life of food products ”

Consortium

Main objective:

Develop upscaled industrial solutions to produce home-compostable, intelligent and functional food packagings from agriculture wastes.

Today's Topics ?

I. Operational strategy

II. Efforts in material optimization

III. Constraints on

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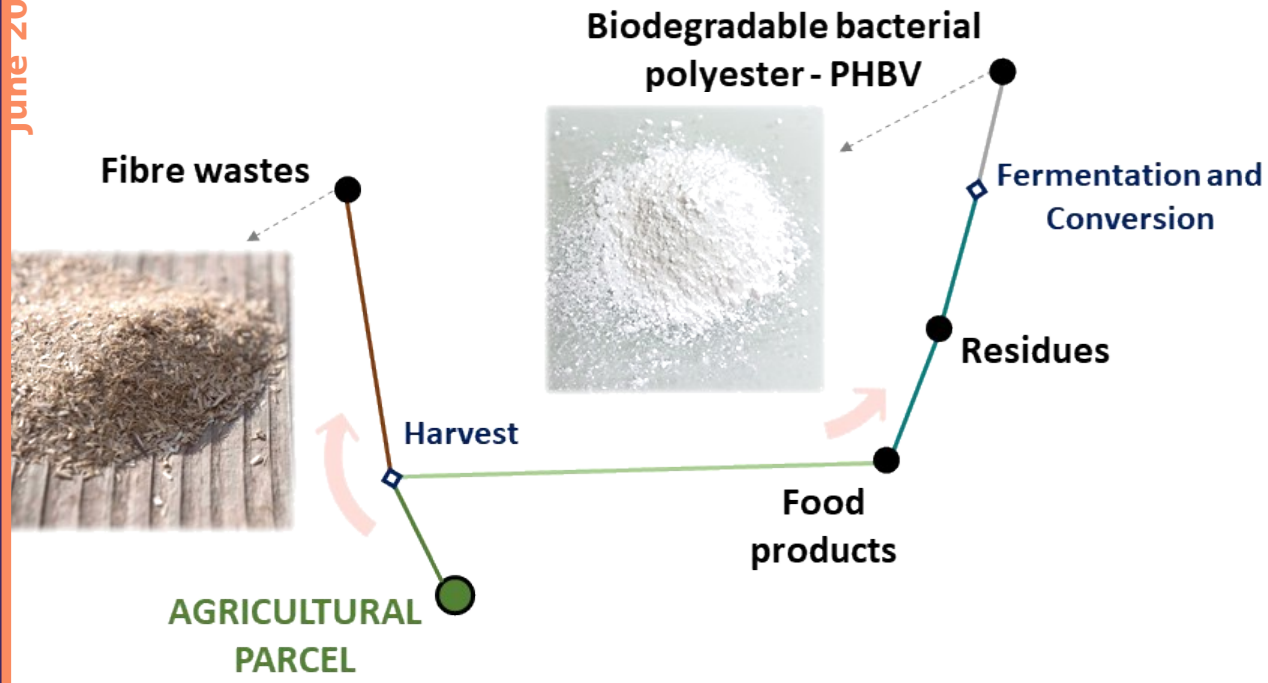
I. OPERATIONAL STRATEGY

I. OPERATIONAL STRATEGY

Reduce production costs



I. OPERATIONAL STRATEGY

Apple fruit pulp waste

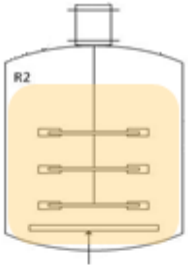
67 kg Fruit pulp
8,5 kg-COD pulp

Acidogenic fermenter

3,0 kg-COD VFA

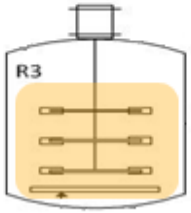
3,4 kg-COD VFA

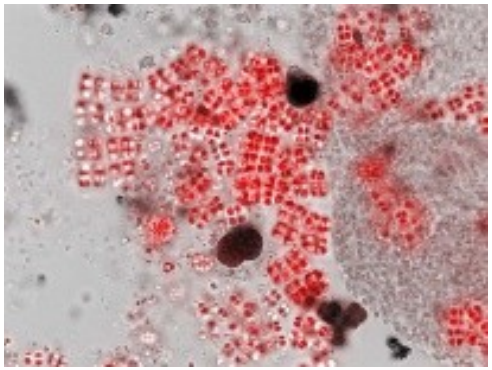
Sequential Batch Reactor



1,0 kg Biomass

Accumulation Reactor





1 kg PHA = 1,7 kg COD

$Y_{PHA/FW}$ = 20 % (COD basis)

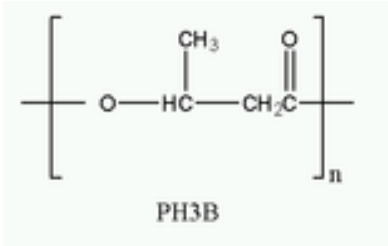
I. OPERATIONAL STRATEGY

Reduce production costs

Enhance properties

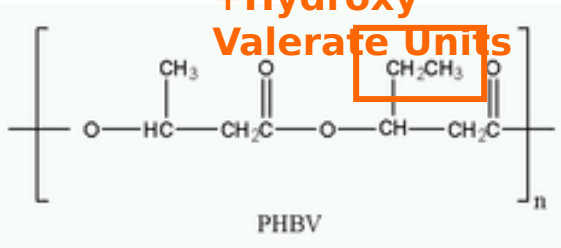
iBET
Instituto de Biologia Experimental e Tecnológica

PHB



PHB**V**s
(Poly Hydroxy Butyrate -co-Valerate)

+Hydroxy Valerate Units



I. OPERATIONAL STRATEGY

Reduce production costs

Enhance properties

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EXTRUSION

FILLERS

MATRIX

Fibers/PHBV composites

Fractionation

Optimization

Biodegradable bacterial polyester - PHBV

Fibre wastes

Fermentation and Conversion

Residues

Harvest

Food products

AGRICULTURAL PARCEL

I. OPERATIONAL STRATEGY

Reduce production costs

Enhance properties

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AGRICULTURAL PARCEL

coopbox group

FÜRSTGROUP

Fraunhofer IVV

I. OPERATIONAL STRATEGY

Reduce production costs

Enhance properties

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Residues

Harvest

Conditioned product

Food products

Distribution

Consumption

AGRICULTURAL PARCEL

Symetris Etudes marketing

Used trays

CONSUMMER

I. OPERATIONAL STRATEGY

Reduce production costs

Enhance properties

Adapt to circular bioeconomy

GHENT UNIVERSITY

I. OPERATIONAL STRATEGY

Reduce production costs | **Enhance properties** | **Adapt to circular bioe** | **Bring new functionalities**

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EXTRUSION
FILLERS
MATRIX
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+functionalization
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Food trays
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Food products
Distribution
Consumption
AGRICULTURAL PARCEL
Spreading
Biodegradation
Compost
Used trays
CONSUMMER

TAGEOS

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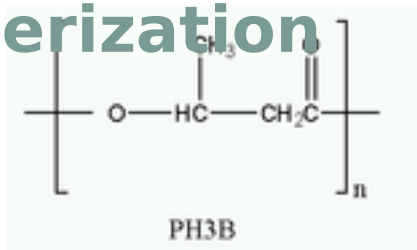
I. OPERATIONAL STRATEGY

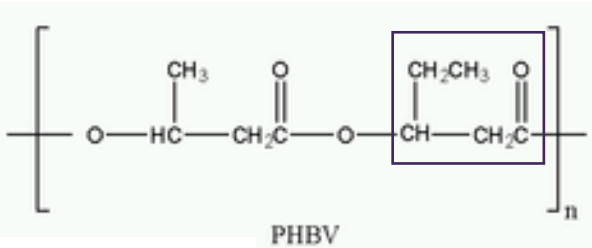
II. EFFORTS IN MATERIAL OPTIMIZATION

I. EFFORTS IN MATERIAL OPTIMIZATION

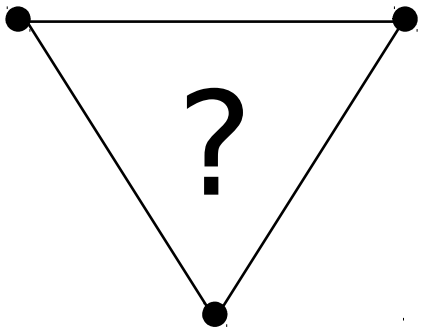
Quality of the co-polymerization



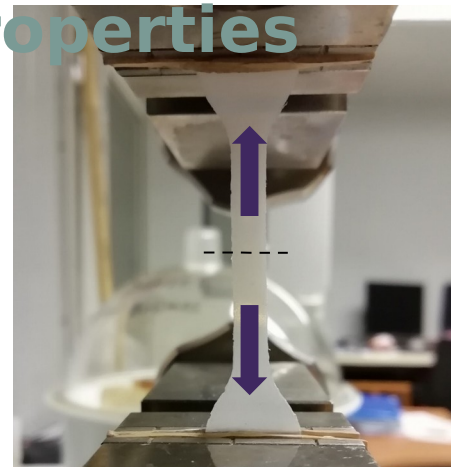
PH3B



PHBV



Visco-elastic properties



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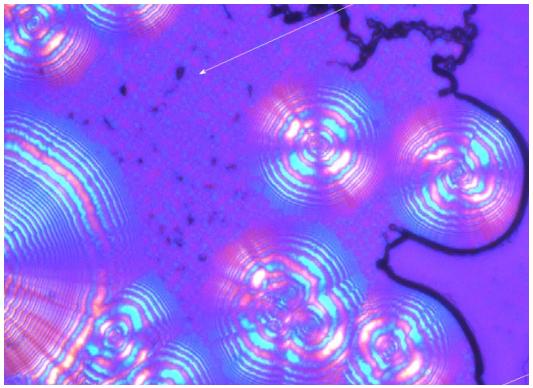
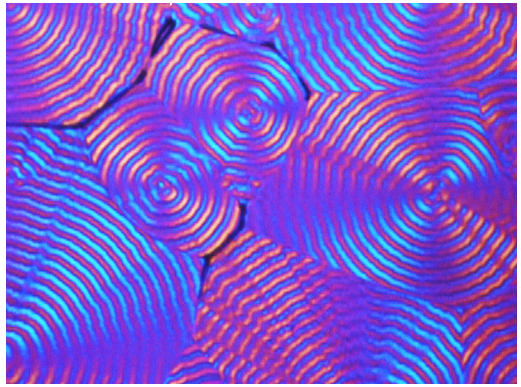
Crystallization





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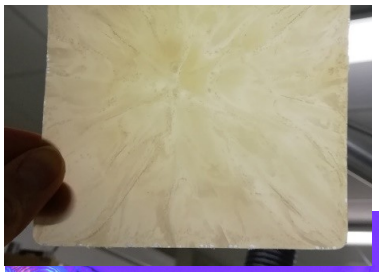
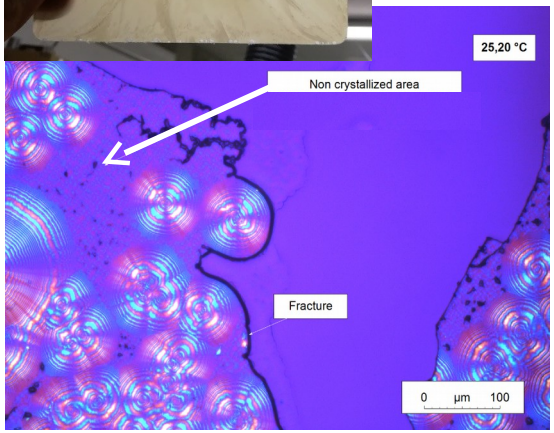
I. EFFORTS IN MATERIAL OPTIMIZATION

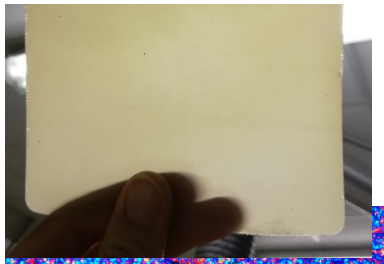


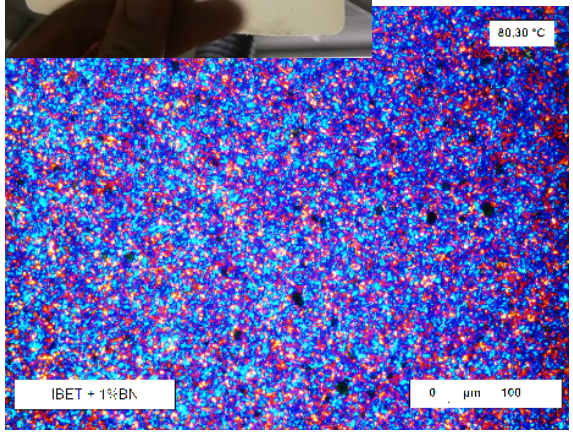


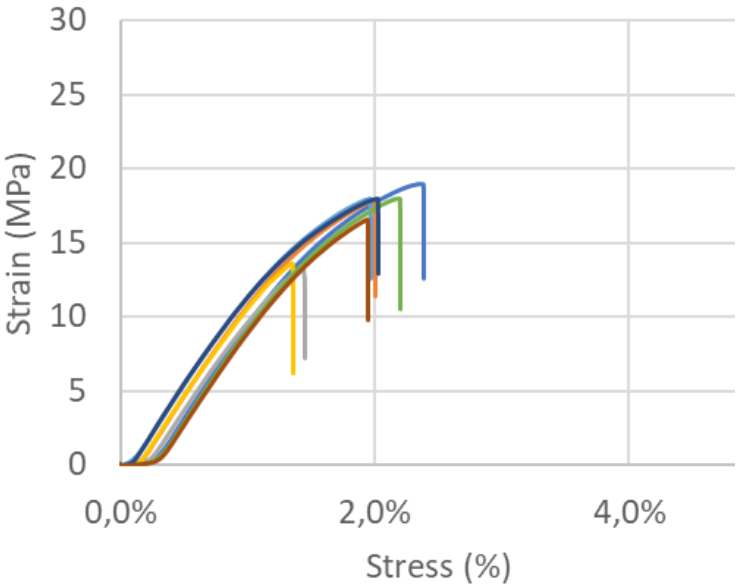
PHBV18%
IBET

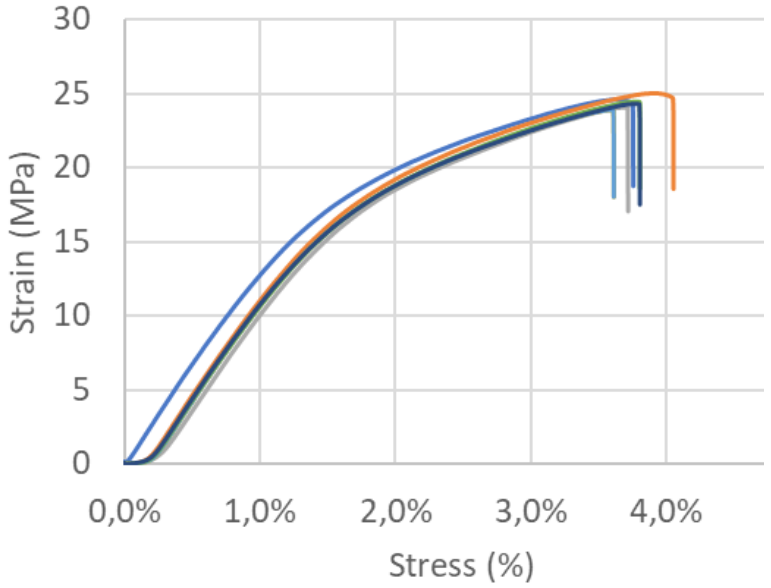
Before purification

After purification + Additives









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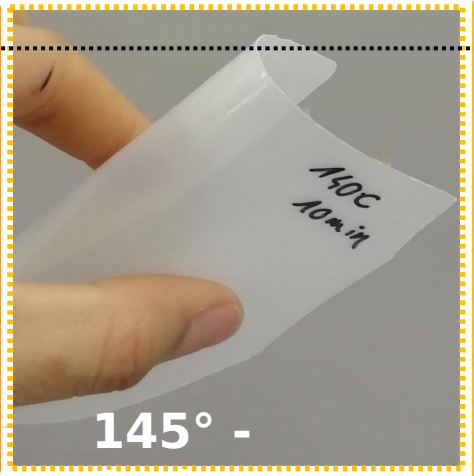
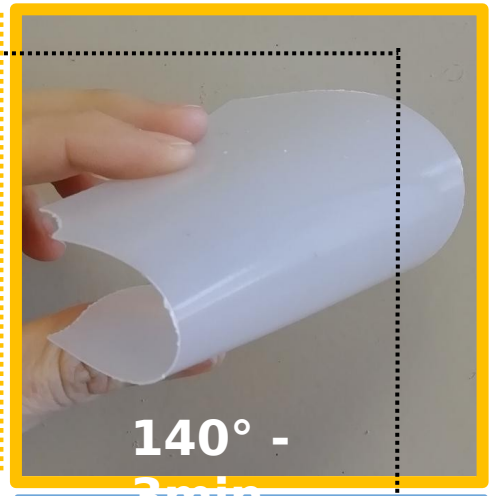
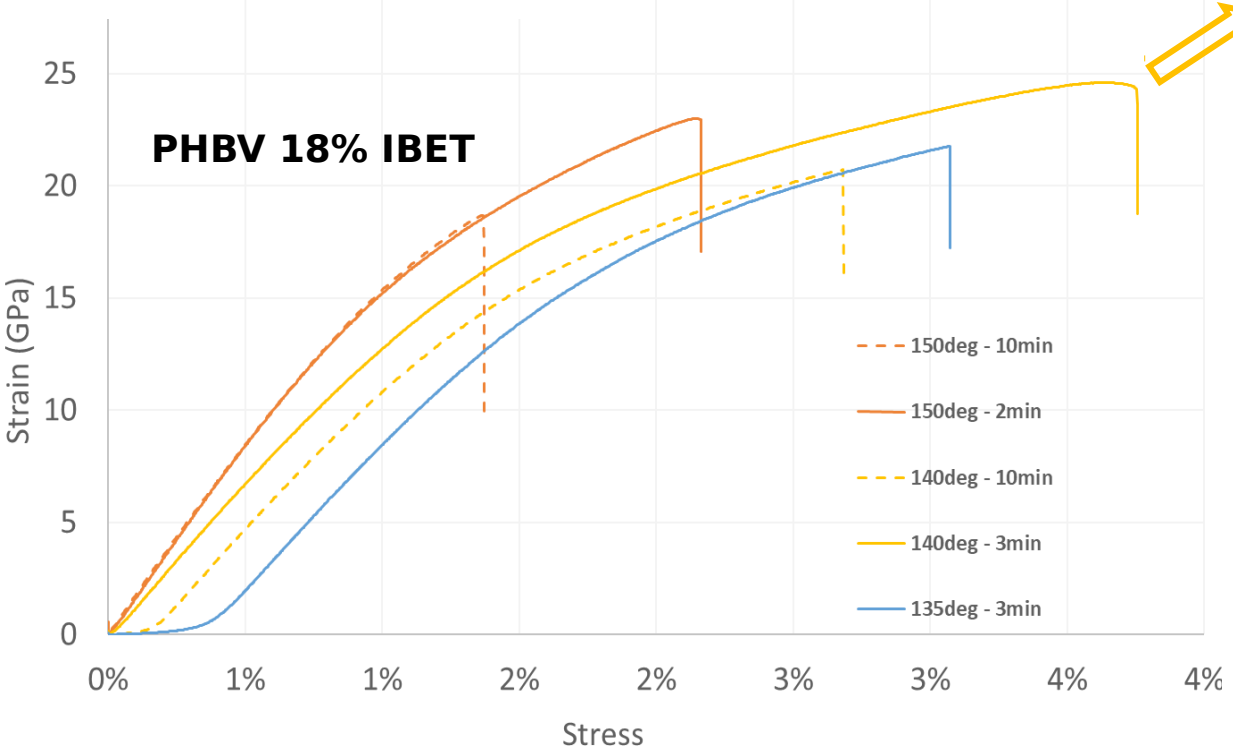
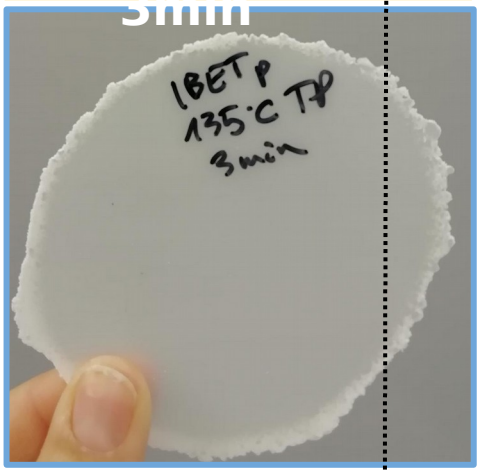






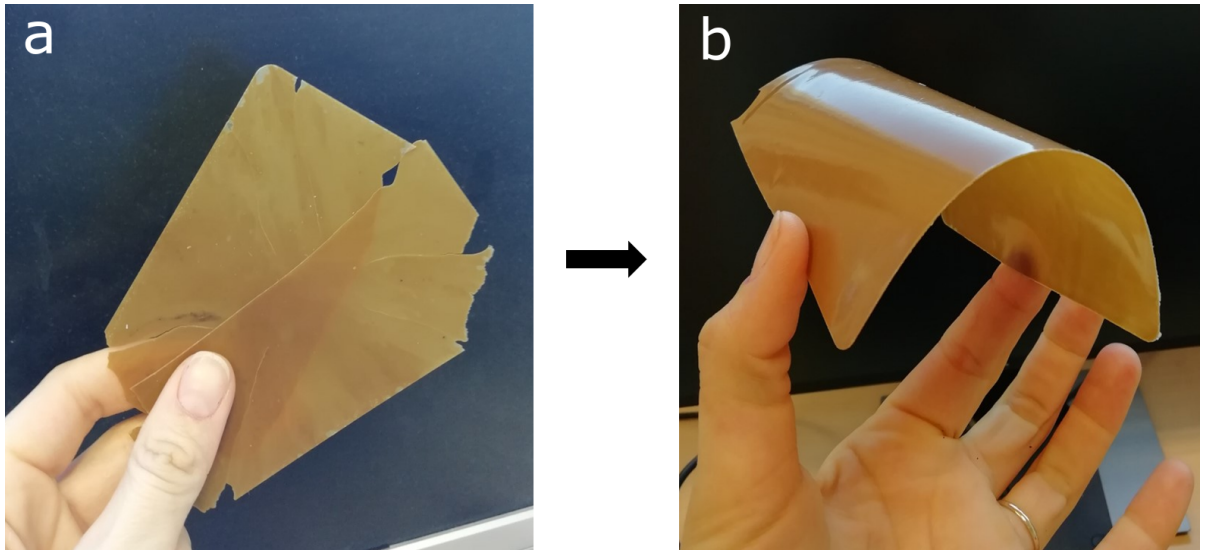


+ Temperature

I. EFFORTS IN MATERIAL OPTIMIZATION

Nucleants	Cellulose	Talc	Ligno-cellulosic Fibres	Boron Nitride
Load (%)	0.2%	0.5%	1%	5%

Temp.	130°C	135°C	140°C	145°C	150°C
Speed	100RPM		150RPM		200RPM



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I. OPERATIONAL STRATEGY

II. EFFORTS IN MATERIAL OPTIMIZATION

III. CONSTRAINTS ON UPSCALING

I. CONSTRAINTS ON UPSCALING

Large scale production of raw components: PHA synthesis

Goal: to optimize large-scale process efficiency for PHA production and recovery

Feedstock: fruit industry waste

Process: 3 stages

iBET

Acidogenic fermentation

60L-UASB reactor

Selection

100L-SBR

Production

60L-Fed Batch Reactor

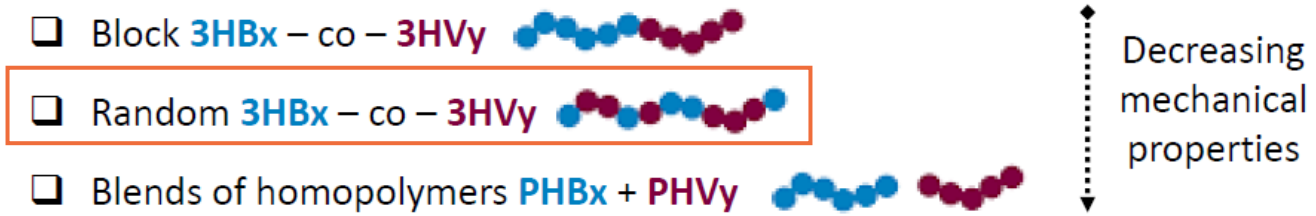
I. CONSTRAINTS ON UPSCALING

INNOVEN
INNOVATION FOR THE ENVIRONMENT

SPIN-OFF DELL'UNIVERSITÀ DEGLI STUDI DI VERONA

I. CONSTRAINTS ON UPSCALING

- Constraints of mixed culture and



- Purification, the costly bottleneck
- Pilot plant productivity

Under study

I. CONSTRAINTS ON UPSCALING

Upscaling of industrial forming processes

Goal: to define technical parameters for optimized processability

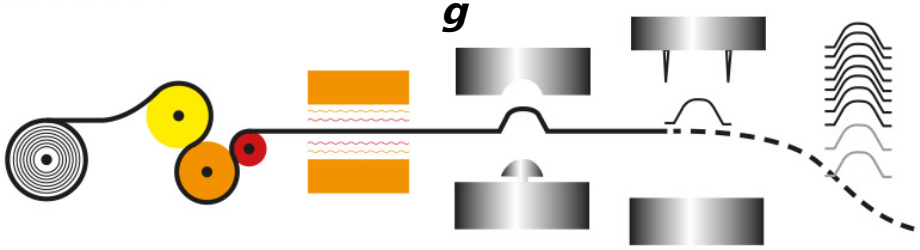
Material: compounded pellets

Process: injection OR thermoforming

Compounded pellets

Injection

Thermoforming



I. CONSTRAINTS ON UPSCALING

- Maximal acceptable load

Size	2mm	0,3mm	15µm

LOAD	10%	20%	30%	40%	50%

- Viscosity VS thermal degradation

- Sealability

Under study

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CONCLUSION AND OVERVIEWS

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data

- Degradability: PHBV degrades into carbon dioxide and water.

50% mass loss after 200days

- Production: yield around 20% (cod base)
- Crystallinity: 55% HV decrease crystallinity improve biodegradability
- Visco properties: around 4% Elongation, 25MPa,

PHI003 3% 30MPa

- Bacterial source: It can be produced from glucose and propionate by the recombinant Escherichia coli strains (also Paracoccus denitrificans and Ralstonia eutropha are also capable of producing it).
- Thermal degradation: PHBV has a low thermal stability and the cleavage occurs at the ester bond by β elimination reaction
- Aging: evolution of properties with time