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POLY(HYDROXYBUTYRATE-CO-  
HYDROXYVALERATE) AND POLY(BUTYLENE  
SUCCINATE-CO-ADIPATE) BLENDS:  
TOUGHENING EFFECT**

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# DEVELOPMENT OF BIODEGRADABLE POLY(HYDROXYBUTYRATE-CO-HYDROXYVALERATE) AND POLY(BUTYLENE SUCCINATE-CO-ADIPATE) BLENDS



BENJAMIN LE DELLIOU, OLIVIER VITRAC, SANDRA DOMENEK

## Introduction

Fossil-based polymers have a large environmental impact and there is a need for replacing them with bio-based and biodegradable materials. Polyhydroxyalkanoates (PHAs), fully bio-based and biodegradable polymers are obtained from microbial fermentation and are promising candidates [1]. Poly(hydroxybutyrate-co-hydroxyvalerate) (PHBV), show a lack of properties by being **stiff** and **brittle** while showing a **relatively high glass transition temperature** (0-5°C). A means to improve thermomechanical properties of the polymer is **blending with ductile materials**.

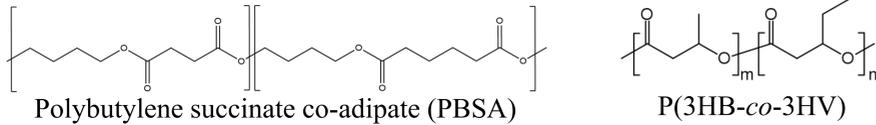
In **this study**, PHBV was melt-blended with PBSA at different PHBV/PBSA weight ratios.

**Objective: Flexible packaging film for fresh, frozen and chilled foods**

## Materials and Methods

### Materials

- Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) with 3HV%, PHBV
- Poly(butylene succinate-co-adipate), PBSA



### Processing

- 1 **Batch Mixer SCAMEX Rheoscam (France)**
  - Temperature: 190°C
  - Screw speed: 90rpm
  - Time: 9'
- 2 **Thermo-compression molding: 180°C at 150 bars**

### Characterization

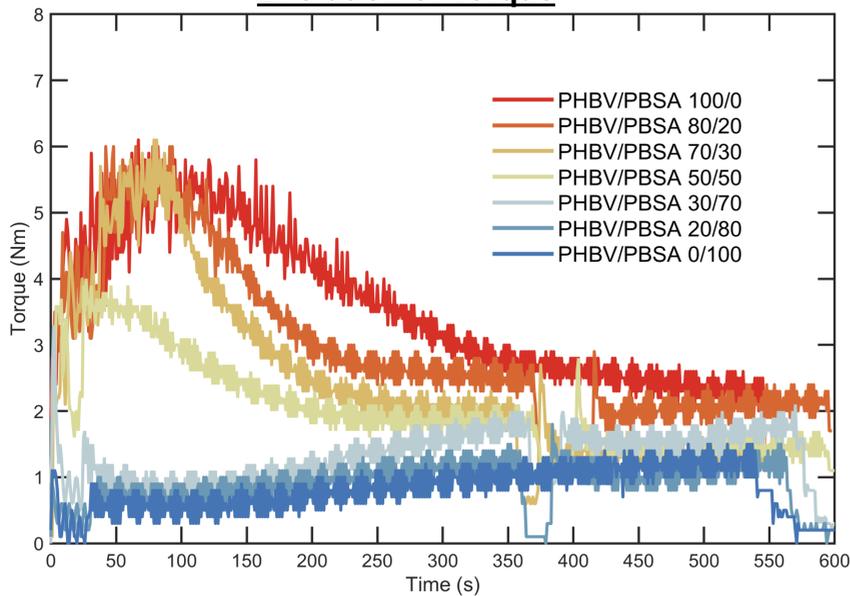
- ❖ **Thermo-Gravimetric Analysis (TGA, Q500, TA Instruments): Hi-Res Mode**
- ❖ **Environmental Scanning Electronic Microscope (ESEM, FEI Quanta 200)**
- ❖ **Dynamic Mechanical Analysis (DMA, TRITEC 2000, Triton Technology Ltd., UK): Temperature scan from -60 °C to 190 °C at  $f=1$ Hz**



PHBV/PBSA 50/50 blend

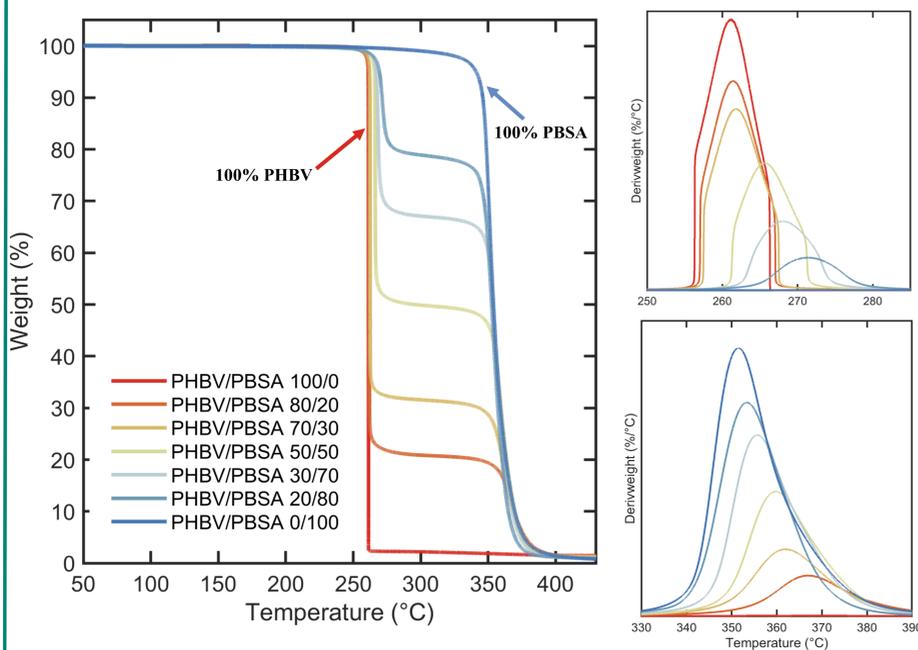
## Results and Discussion

### Evolution of Torque



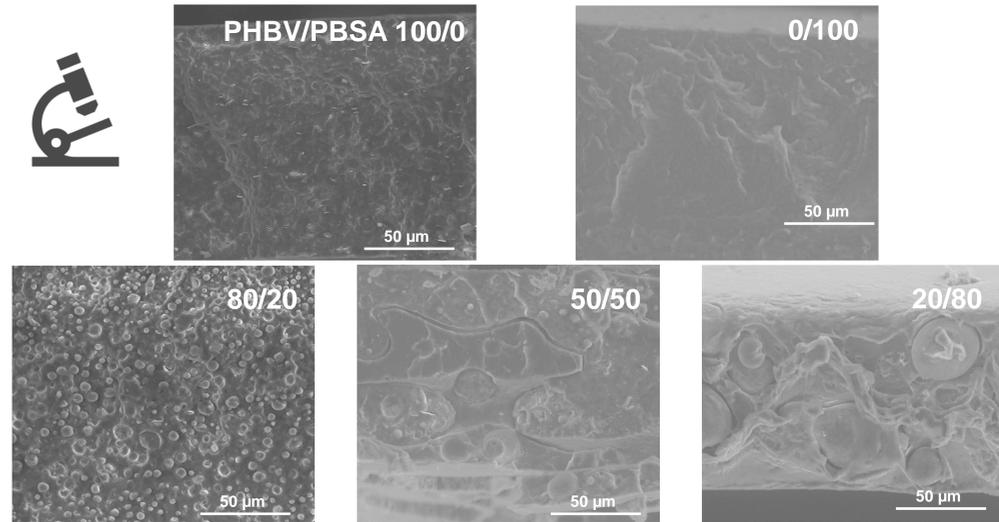
- Threshold between 30% < PBSA < 70%: Large decrease in torque correlated to a decrease in viscosity

### Thermo-Gravimetric Analysis (TGA)



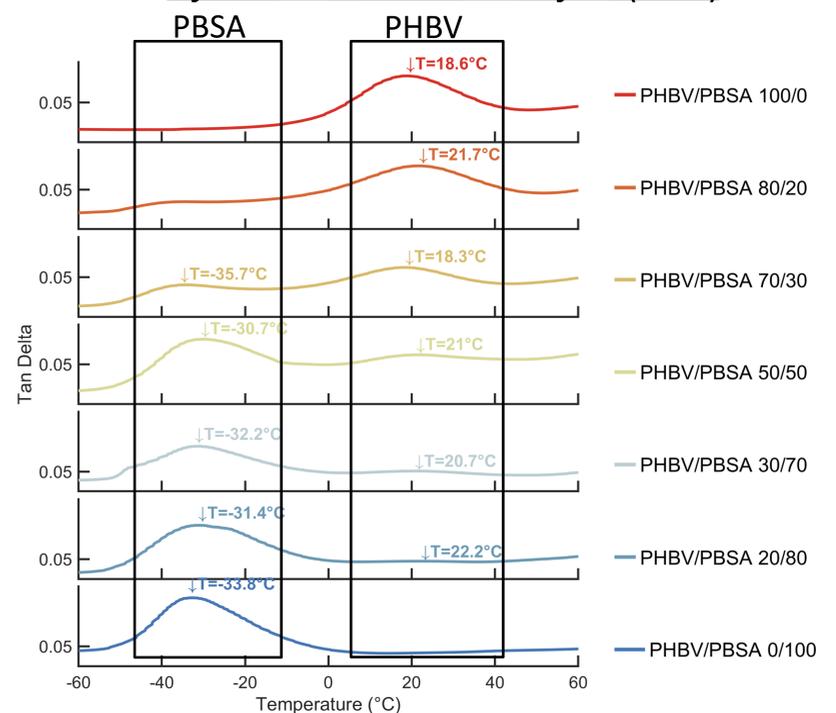
- Post-processing: Validation of PHBV/PBSA blend ratio
- Increase in degradation temperature among blend ratio

### Morphology characterization (SEM)



- Neat PHBV and PBSA: **smooth** surface
- PHBV/PBSA 80/20 & 20/80 : **droplet-in-matrix** phase morphology
- 30% < PBSA < 70%: **Co-continuous** morphology

### Dynamic mechanical analysis (DMA)



- Two distinct glass transition temperature: PBSA and PHBV
- Tg: unchanged notwithstanding blend ratio

## Conclusion

- Design of new PHBV blend *via* melt blending:
  - ❖ Blends with a two phase morphology
  - ❖ No effect of PBSA ratio on PHBV glass transition temperature

**Non miscible!**

## Perspective

- Design of interfacial compatibility: *In-situ* compatibilization

## Reference

[1] Laycock, Bronwyn et al.. 'The Chemomechanical Properties of Microbial Polyhydroxyalkanoates'. *Progress in Polymer Science* 39(2014): 397-442.

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