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Preparation of PLA/starch foams by an extrusion process

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► **To cite this version:**

Margot Chauvet, Martial Sauceau, Jacques Fages. Preparation of PLA/starch foams by an extrusion process. Eurofillers Polymer Blends 2015, Apr 2015, Montpellier, France. . hal-02930915

HAL Id: hal-02930915

<https://imt-mines-albi.hal.science/hal-02930915v1>

Submitted on 4 Sep 2020

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INTRODUCTION

Authors

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Partners

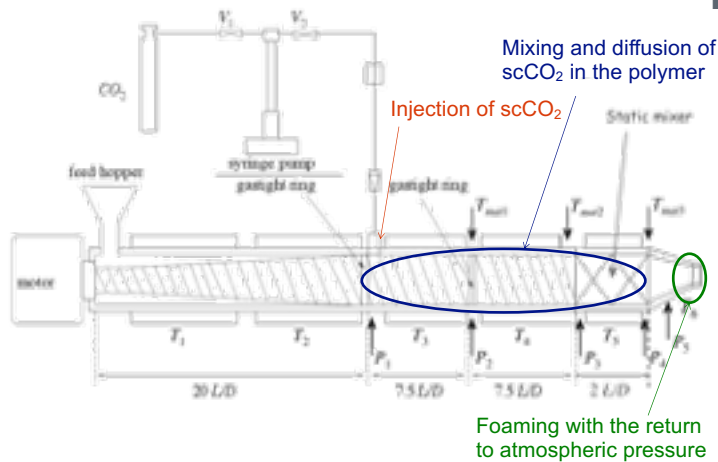


■ Interest of foaming a blend of PLA/starch :

- Biobased, biocompatible and biodegradable polymers
- Reduce the cost and the density
- Improve the barrier properties and the crystallinity

■ Interest of extrusion assisted by supercritical CO₂ :

- Modification of the polymer properties (especially, decrease of the viscosity and the T_g)
- Creation of porosity



MATERIALS AND METHODS

■ scCO₂ assisted extrusion

- Single-screw extruder (Scamex, France)
- D=30 mm and L/D=37
- T₁ to T₄ : 160, 180, 180 and 160°C
- Blend of 95% PLA with 5% starch

■ PLA from NaturePlast (PLE001)

- Semi-crystalline (T_g≈60°C; T_m≈150°C)
- Low D-lactic acid content

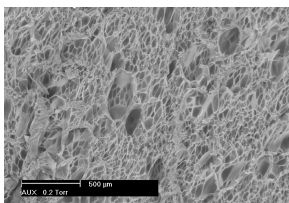
■ Native corn starch from Roquette

- Lost at drying ≈13%

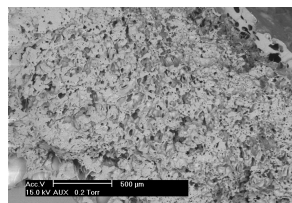
RESULTS

■ Morphology with 3 mL/min scCO₂

- Uniform structure for the PLA
- Coarse structure for the blend (higher T₅ and T₆)



100% PLA



95% PLA + 5% starch

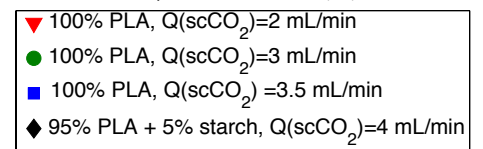
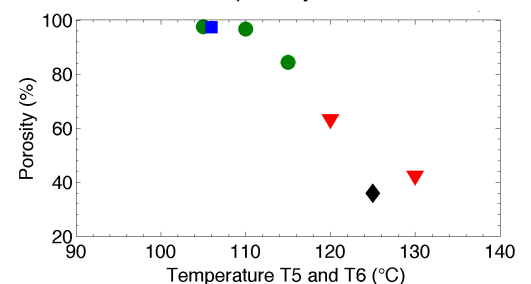
■ Thermal analysis with 3 mL/min scCO₂

- ↗ crystallinity with T₅ and T₆ ↘
- Highest porosity ⇒ highest crystallinity

Sample	T _g (°C)	T _{cc} (°C)	ΔH _{cc} (J/g)	T _m (°C)	ΔH _m (J/g)	X _c (%)
PLA raw	59	104	12.4	146	12.4	0
Foam of PLA (110°C)	59	78	11.5	150	29.4	19
Foam of PLA (105°C)	58	73	5.2	148	31.5	28

■ Porosity

- Up to 95%
- ↗ with T₅ and T₆ ↘
- ↗ with scCO₂ ↗
- Lower porosity for the blend



CONCLUSION

- Production of foams with a porosity up to 95%
- Increased crystallinity with the addition of scCO₂
- Perspectives : more tests for the blend (PLA/starch) with decreasing temperatures T₅ and T₆ and increasing scCO₂