



# Evaluation of the parameters of poly(butylene succinate) enzymatic polymerization

C. I. Gkountela, D. N. Markoulakis, D. M. Korres, S. N. Vouyiouka\*  
 Laboratory of Polymer Technology, School of Chemical Engineering,  
 National Technical University of Athens, Greece,  
 (\*mvuyiuka@central.ntua.gr)

## Introduction

Poly(butylene succinate) (PBS) is a **bio-based** and **biodegradable** polyester, that can be used in numerous applications, especially in the biomedical sector [1,2]. Even though green polymerization routes such as **biocatalysis** are being developed [3,4], there is a very limited literature on the enzymatic synthesis of PBS and in most of the works where high-molecular-weight PBS is produced, several drawbacks may impede the process scaling up. On that basis, an **eco-friendly, solvent-free, enzyme-based process for the production of PBS** was applied and the most important process parameters were evaluated.

## Experimental part



Figure 1. Apparatus for the production of PBS oligomers

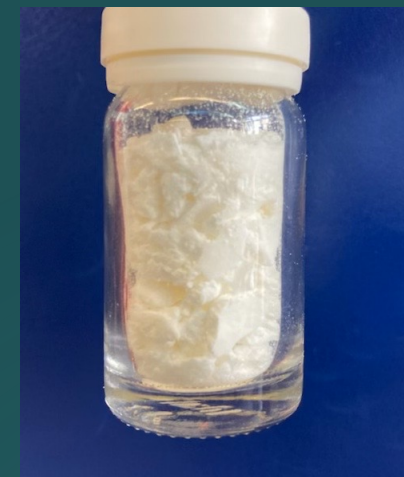
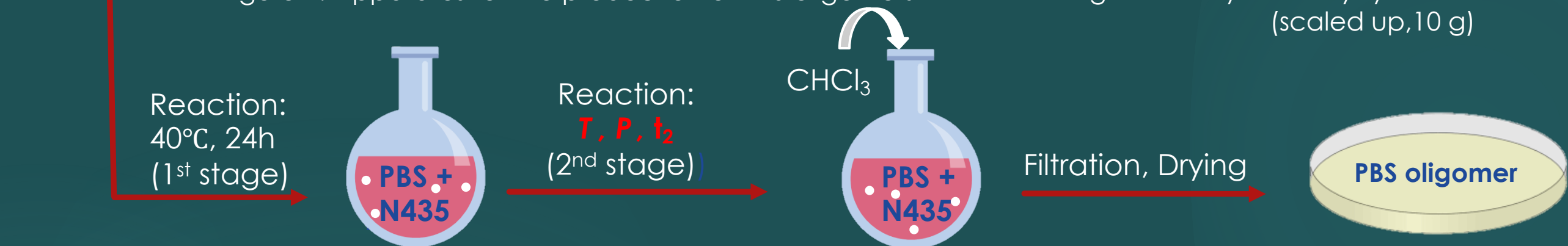


Figure 2. Enzymatically synthesized PBS oligomer (scaled up, 10 g)



## Results and Discussion

- Evaluated process parameters:



Optimum conditions: **90°C, 20 mbar, 2h**

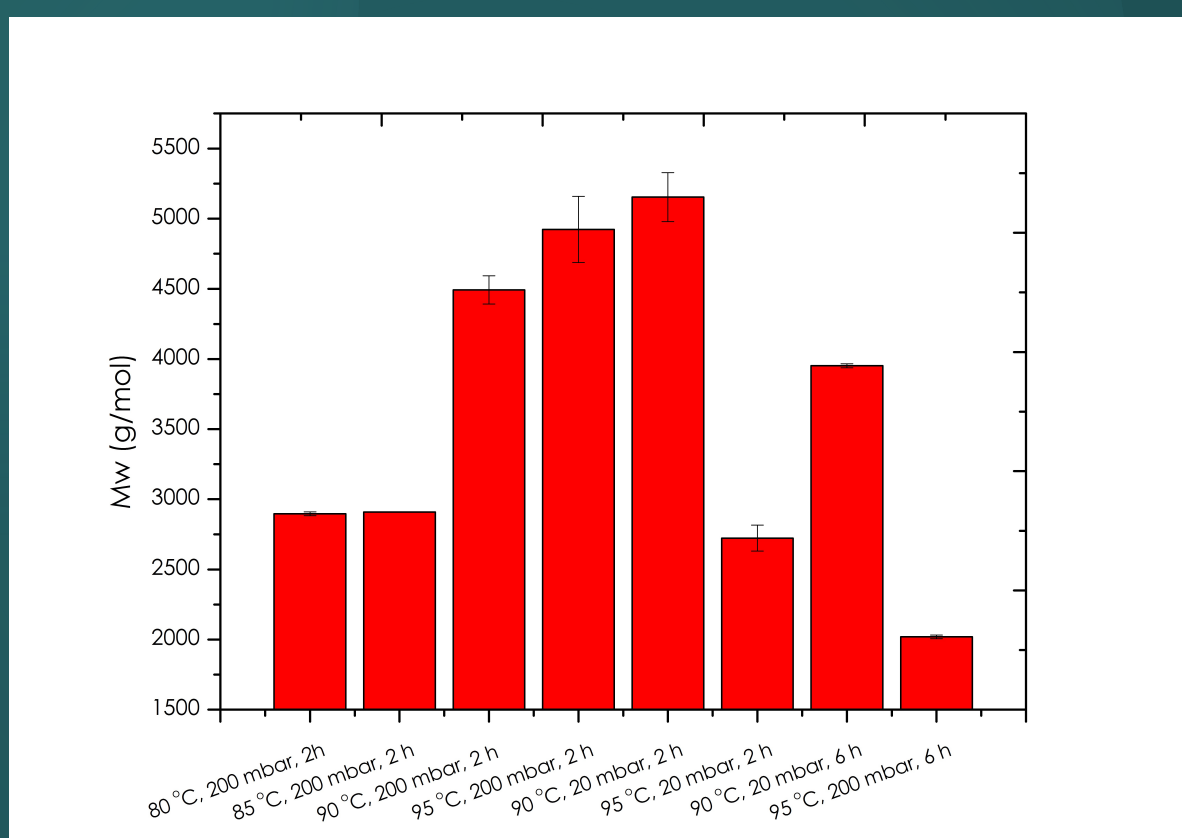


Figure 3.  $\overline{M}_w$  of the enzymatically synthesized oligomers

- The synthesized at 90 °C, 20 mbar, 2h product was successfully **scaled up** (ca. 10 g of product).

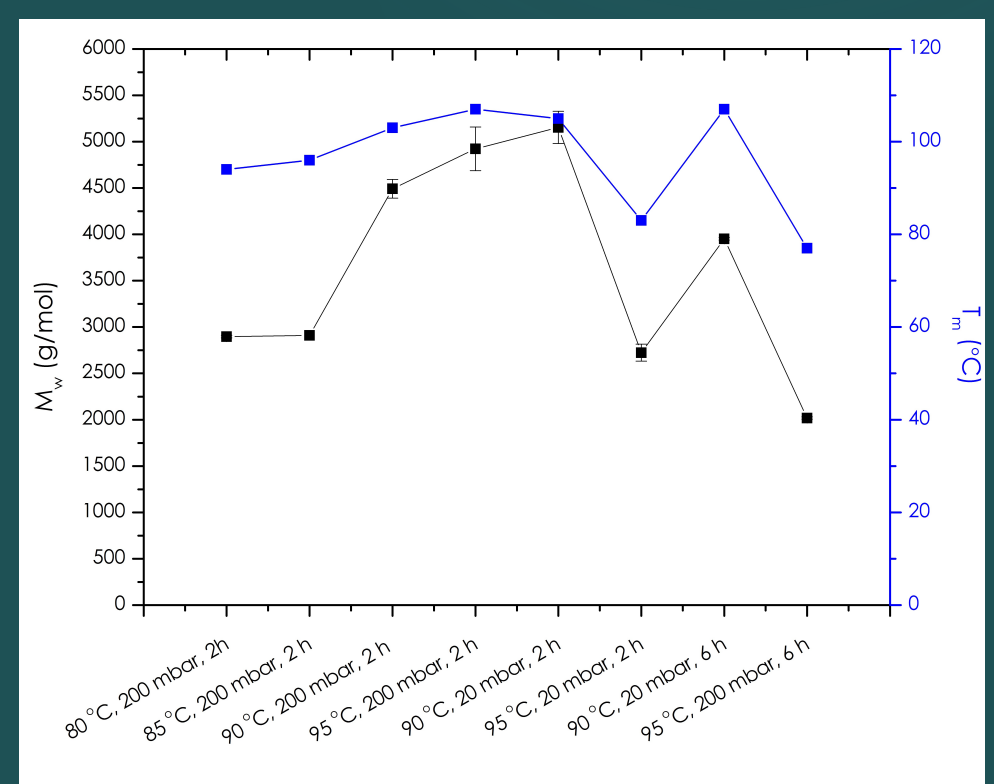


Figure 4.  $\overline{M}_w$  and  $T_m$  of the enzymatically synthesized oligomers

Table 1. Scaled-up PBS oligomer's properties

$\overline{M}_n$ (g/mol)	$\overline{M}_w$ (g/mol)	$T_{m1}$ (°C)	$T_c$ (°C)	$T_{m2}$ (°C)	$T_{d,5\%}$ (°C)	$T_d$ (°C)	Residue (%)
1000	4700	104	57	103	258	387	1,44

## Conclusions

The bulk enzymatic polymerization route resulted in a PBS grade of  $\overline{M}_w$  4700 g/mol, crystallinity ca. 61% and melting points at ca. 104°C. This free of thermal degradation and metal catalyst residues grade is appropriate to be used in biomedicine applications where low controlled molecular weight is usually needed.

## References

- [1] Xu J, Guo B.H, Biotechnology Journal. 2010; 1149–1163.
- [2] Gigli M, Fabbri M, Lotti N, Gamberini R, Rimini B, Munari A. European Polymer Journal. 2016; 75: 431–460.
- [3] Douka A, Vouyiouka S, Papaspyridi L.M, Papaspyrides C.D. Progress in Polymer Science. 2018; 79: 1–25.
- [4] Gkountela C, Rigopoulou M, Barampouti E.M, Vouyiouka S. European Polymer Journal. 2021; 143: 110197