

Recycling and purification of polymer materials from food packaging by supercritical fluid-assisted extrusion

Nathan Razes ^{*a}, Yvan Chalamet ^a

^aUniversité Jean Monnet Saint-Étienne, CNRS, Laboratoire Ingénierie des Matériaux Polymères UMR 5223, F-42023, Saint-Etienne, France

[*nathan.razes@univ-st-etienne.fr](mailto:nathan.razes@univ-st-etienne.fr)

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Resume :

The management of post-use plastics from food packaging represents a major environmental challenge. To answer this issue, it is essential to purify and recycle the polymer materials used in packaging. Pollution in these materials often involves a wide range of non-intentionally added substances (NIAS) [1,2], which exhibit diverse chemical properties and high molar masses. These characteristics render traditional purification methods, such as solvent extraction or vacuum extraction, largely ineffective [3].

A promising solution lies in the continuous depollution of polymers using twin-screw extrusion coupled with supercritical carbon dioxide (SCO₂) [4]. This method allows for the simultaneous plasticizing and purification of polymer materials. However, successful integration of twin-screw extrusion with SCO₂ requires a deep understanding and careful optimization of mass transfer phenomena including diffusion, solubility, and the renewal of the surface at the material-fluid interface.

To identify and quantify key parameters for this coupling, an initial study was conducted in an autoclave equipped with an agitation system designed to simulate the flow dynamics of a twin-screw extruder. The experiments were performed on an artificially polluted system with a set of representative target molecules. Additionally, some trials were also carried out directly using twin-screw extrusion.

References :

- [1] O. Horodytska ; A. Cabanes ; A. Fullana ; *Chemosphere*, 2020, **251**, 126373.
- [2] M.K. Eriksen ; T. F. Astrup ; *Waste management*, 2019, **87**, 161-172.
- [3] S. Nunez ; J.A. Conesa ; J. Molto ; A ; Fullana ; *Resources, conservation and recycling*, 2023, **195**, 107-117.
- [4] A. Ben Said ; C. Guignot ; J-C. Ruiz ; P. Dole ; C. Joly ; Y. Chalamet ; *Chemical Engineering Research and Design*, 2017, **117**, 95-109.