HAL open science

Design and development of co-Extruded PLA/PEG bio-nanocomposite films with enhanced functional properties for food packaging

Mohamed Ait Balla, Abderrahim Maazouz, Khalid Lamnawar, Fatima Ezzahra Arrakhiz

To cite this version:

Mohamed Ait Balla, Abderrahim Maazouz, Khalid Lamnawar, Fatima Ezzahra Arrakhiz. Design and development of co-Extruded PLA/PEG bio-nanocomposite films with enhanced functional properties for food packaging. 53ème colloque national du Groupe Français d'études et d'applications des Polymères – GFP 2025, Nov 2025, Lille (FR), France. ⟨hal-05575087⟩

HAL Id: hal-05575087

https://hal.science/hal-05575087v1

Submitted on 1 Apr 2026

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Distributed under a Creative Commons CC BY 4.0 - Attribution - International License

Design and development of co-Extruded PLA/PEG bio-nanocomposite films with enhanced functional properties for food packaging

Mohamed AIT BALLA 1 [a,b], Abderrahim MAAZOUZ 2 *[a,c], Khalid LAMNAWAR 3 [a] and Fatima Ezzahra Arrakhiz 4 [b]

[a] University of Lyon, UMR 5223, Polymer Materials Engineering (IMP), INSA Lyon, F-69621 Villeurbanne, France 1
[b] Laboratory of Materials, Signals, Systems and Physical Modeling, Faculty of Science, Ibn Zohr University, Dakhla City, B.P.8106, Agadir 80000, Morocco. *2*
[c] Hassan II Academy of Science and Technology, 10 100 Rabat, Morocco. *3*

* abderrahim.maazouz@insa-lyon.fr

Mots-clés : Cellulose nanofibrils, Organomontmorillonite, Hybrid Nanocomposites, Coextrusion process, Rheological, Thermomechanical properties.

Résumé :

Bio-based composite materials are increasingly regarded as sustainable alternatives to conventional plastics, in line with global strategies to reduce reliance on fossil resources and mitigate environmental impacts. Among these materials, polylactic acid (PLA) has gained significant attention for food packaging applications due to its biodegradability and bio-sourced origin [1-3]. However, its intrinsic brittleness, limited thermal stability, and relatively modest processability remain major barriers to its wider industrial adoption [4]. In this study, innovative nanocomposite films were fabricated through a co-extrusion process using plasticized PLA reinforced with lignin-containing cellulose nanofibrils and organo-modified montmorillonite. Polyethylene glycol was employed as a plasticizer to enhance film flexibility and mitigate the inherent brittleness of PLA during melt processing. The addition of LCNFs provided improved mechanical strength, thermal stability, and interfacial compatibility with the polymer matrix, while the incorporation of OMMT platelets promoted better nanofiller dispersion and enhanced barrier performance. The combined effect of these multi-scale reinforcements resulted in a clear synergistic improvement of the final material properties. Morphological observations confirmed a homogeneous dispersion of the nanofillers, whereas thermal, mechanical, and rheological characterizations demonstrated significant enhancements in stability, stiffness, and melt processability. The resulting nanocomposite films were transparent, flexible, and well-suited for the production of thin multilayer structures. These results highlight the strong potential of co-extruded PLA/PEG-based nanocomposites as sustainable and high-performance alternatives for advanced food packaging applications.

Références :

[1] : A. P. Gupta and V. Kumar, "EUROPEAN POLYMER New emerging trends in synthetic biodegradable polymers – Polylactide : A critique," vol. 43, pp. 4053–4074, 2007, doi: 10.1016/j.eurpolymj.2007.06.045.

[2] : B. Chihaoui and Q. Tarr, "Industrial Crops & Products Lignin-containing cellulose fibrils as reinforcement of plasticized PLA biocomposites produced by melt processing using PEG as a carrier," vol. 175, no. June 2021, 2022, doi: 10.1016/j.indcrop.2021.114287.

[3] : N. Berezina, N. Landercy, P. Mariage, and B. Morea, "Separation of the Enantiomers of Lactide , Lactic Acid Dimer , for a Sustainable Bioplastic Management," vol. 1, no. 2, pp. 20–23, 2013, doi: 10.12691/wjoc-1-2-3.

[4] : O. Faruk, A. K. Bledzki, H. Fink, and M. Sain, "Progress in Polymer Science Biocomposites reinforced with natural fibers : 2000 – 2010," *Prog. Polym. Sci.*, vol. 37, no. 11, pp. 1552–1596, 2012, doi: 10.1016/j.progpolymsci.2012.04.003.