Documents

Nordin, N.M.[a] , Anuar, H.[a] , Noor, W.N.Q.M.[a] , Buys, Y.F.[b]

Experimental & Simulation of Supercritical Carbon Dioxide PLA Biocomposite Foamed
(2022) *Materials Science Forum*, 1056 MSF, pp. 17-23.

DOI: 10.4028/p-6h2d9j

[a] Department of Materials and Manufacturing Engineering, Kulliyyah of Engineering, International Islamic University, Malaysia
[b] Department of Mechanical Engineering, Faculty of Industrial Technology, Universitas Pertamina, Jalan Teuku Nyak Arief, Simprung, Kebayoran Lama, Jakarta, 12220, Indonesia

Abstract
The use of PolyLactic Acid (PLA) as a green substitute for conventional plastics has increased considerably as a result of increased awareness of the environmental effect of the use of petroleum-based plastics. However, some of the PLA properties including brittleness and sensitivity to high temperature and humidity, greatly restrict its application. The addition of reinforcement of low-cost natural fibers and foaming are considered to overcome the above disadvantages since it can improve some of PLA's processing. This paper reported the effects of supercritical carbon dioxide (SCCO2) on the tensile strength of PLA biocomposite films produced via solution casting method. The biocomposite films underwent supercritical carbon dioxide (SCCO2) treatment at temperature of 40oC and pressure at 200 bar. The tensile strength showed that the PLA biocomposite foamed has improve by 16.18%. This is due to a good adhesion interfacial between fiber and polymer matrix. A simulation on tensile strength of the biocomposite foamed was also conducted using COMSOL Multiphysics software. The tensile strength resulted from this simulation is similar to the experimental value. Therefore, the experimental value is valid and satisfy. This also showed that SCCO2 treatment significantly improved the properties of PLA biocomposite films which could be an alternative in packaging industries.

Author Keywords
Biocomposite Foamed; Cosmol Multiphysics; Polylactic Acid (PLA); Supercritical Carbon dioxide (SCCO2)

Funding details
Ministry of Higher Education, MalaysiaMOHEFRGS/1/2019/TK05/UIAM/02/2
International Islamic University MalaysiaIIUM

The authors wish to thank the Ministry of Higher Education (MOE) for the funding provided through the Fundamental Research Grant Scheme (FRGS/1/2019/TK05/UIAM/02/2). The authors also would like to acknowledge International Islamic University Malaysia (IIUM) for the equipment and facilities provided.

References

- Abu Hassan, N. A., Ahmad, S., Chen, R. S.
  Density measurement, tensile, and morphology properties of polylactic acid biocomposites foam reinforced with different kenaf filler loading
  (2020) *Sains Malaysiana*, 49 (9), pp. 2293-2300.

- **a Review on Natural Fiber and Its Characteristics**
  (2020) *Industrial Engineering Journal*, 13 (3).
  A, M.K., & S,R

- Anuar, H., Apandi, S. N. E. Z. M., Rashid, S. M. S. A., Ali, F., Buys, Y. F., Manshor, M. R., Thomas, S., Nasir, N. A. M.
  The effects of supercritical carbon dioxide on the degradation and antimicrobial properties of PLA biocomposite
  (2020) *IIUM Engineering Journal*, 21 (1), pp. 212-227.

- Baji, A., Mai, Y. W.
  Polymer nanofiber composites
  (2017) *Nanofiber Composites for Biomedical Applications*,
  Elsevier Ltd

- Balaji, V., Senthil Vadivu, K.
  Mechanical Characterization of Coir Fiber and Cotton Fiber Reinforced Unsaturated Polyester Composites for Packaging Applications Mechanical Characterization of Coir

Fiber and Cotton Fiber Reinforced
(2017) *Journal of Applied Packaging Research*, 9 (2), pp. 12-19.

- Bocz, K., Tábi, T., Vadas, D., Sauceau, M., Fages, J., Marosi, G.
Characterisation of natural fibre reinforced PLA foams prepared by supercritical CO2 assisted extrusion
(2016) *Express Polymer Letters*, 10 (9), pp. 771-779.

- Corre, Y., Maazouz, A., Duchet, J., Reignier, J.
The Journal of Supercritical Fluids Batch foaming of chain extended PLA with supercritical CO 2: Influence of the rheological properties and the process parameters on the cellular structure
(2011) *The Journal of Supercritical Fluids*, 58 (1), pp. 177-188.

- Council, A. C.
(2020) *The Basics: Polymer Definition and Properties*, pp. 1-7.

- Kmetty, Á., Litauszki, K.
(2018) *applied sciences Characterization of Different Chemical Blowing Agents and Their Applicability to Produce Poly (Lactic Acid) Foams by Extrusion*,

- Kumar, P., Sairam, C., Dender, V., Rajesh, A.
Modeling and Simulation of Applied Load on Lenin Fiber Composite Materials Using COMSOL
(2020) *IOP Conference Series:Materials Science and Engineering*, 981 (4).

- Li, B., Zhao, G., Wang, G., Zhang, L., Gong, J.
Fabrication of high-expansion microcellular PLA foams based on pre-isothermal cold crystallization and supercritical CO2 foaming
(2018) *Polymer Degradation and Stability*, 156, pp. 75-88.

- Liao, X., Zhang, H., He, T.
Preparation of porous biodegradable polymer and its nanocomposites by supercritical CO 2 foaming for tissue engineering
(2012) *Journal of Nanomaterials*, 2012.

- Lozowski, D.
Supercritical CO2: A green solvent
(2010) *Chemical Engineering*, 117 (2), pp. 15-18.

- Manshor, R. M., Anuar, H., Wan Nazri, W. B., Ahmad Fitrie, M. I.
Preparation and characterization of physical properties of durian skin fibers biocomposite
(2012) *Advanced Materials Research*, 576, pp. 212-215.
(October 2012)

- Mohd Nordin, N., Anuar, H., Buys, Y. F., Ali, F., Thomas, S., Mohd Nasir, N. A.
Effect of freeze-dried durian skin nanofiber on the physical properties of poly(lactic acid) biocomposites
(2020) *Polymer Composites*, pp. 1-7.
September

- Murariu, M., Dubois, P.
PLA composites: From production to properties
(2016) *Advanced Drug Delivery Reviews*, 107, pp. 17-46.

- Stengel, J.
(2019) *Supercritical Carbon Dioxide (CO2) Extraction Method from Cole-Parmer*,
Cole-Parmer

- Sungsee, P., Tanrattanakul, V., Zafar, M. T., Zarrinbakhsh, N., Mohanty, A. K., Misra, M., Ghosh, A.K.
Biocomposite foams from poly(lactic acid) and rubber wood sawdust: Mechanical properties, cytotoxicity, and in vitro degradation
(2016) *Express Polymer Letters*, 136 (48), pp. 1-11.

- Sydow, Z., Bieńczak, K.
The overview on the use of natural fibers reinforced composites for food packaging
(2019) *Journal of Natural Fibers*, 16 (8), pp. 1189-1200.

- Teymoorzadeh, H.
(2016) *Composites and Foams based on Polylactic Acid (PLA)*,

- Villamil Jiménez, J. A., le Moigne, N., Bénézet, J. C., Sauceau, M., Sescousse, R., Fages, J.
Foaming of PLA composites by supercritical fluid-assisted processes: A review
(2020) *Molecules*, 25 (15).

- Zaaba, N.F., Ismail, H., Campus, E., Pinang, P.
(2019) *Thermoplastic/Natural Filler Composites: A Short Review*, 30, pp. 81-99.

Editors: Sutjipto A.G.E., Salim N., Bakar N.H.A., Kabeb S.M.
Publisher: Trans Tech Publications Ltd

Conference name: 3rd Postgraduate Symposium on Industrial Science and Technology, SISTEC 2021
Conference date: 25 August 2021 through 26 August 2021
Conference code: 275149

ISSN: 02555476
ISBN: 9783035716498
CODEN: MSFOE
Language of Original Document: English
Abbreviated Source Title: Mater. Sci. Forum
2-s2.0-85127107042
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus