*Materials Today Communications* • Volume 35 • June 2023 • Article number 106093

**Document type**
Article

**Source type**
Journal

**ISSN**
23524928

**DOI**
10.1016/j.mtcomm.2023.106093

**Publisher**
Elsevier Ltd

**Original language**
English



# Novel soda lignin/PLA/EPO biocomposite: A promising and sustainable material for 3D printing filament

Anuar, Hazleen[a] ; Rahman, Nurul Amirah Abd[a]; Manshor, Mohd Romainor[a, b]; Alli, Yakubu Adekunle[a, c, d] ; Alimi, Oyekunle Azeez[e]; Alif, Fathilah[f]; Suhr, Jonghwan[g]

Save all to author list

[a] Department of Manufacturing and Materials Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia

[b] Food Sciences & Technology Research Center, Malaysian Agricultural Research and Development Institute, Persiaran MARDI-UPM, Selangor, Serdang, 43400, Malaysia

[c] Laboratoire de Chimie de Coordination, UPR8241, Universite´ de Toulouse, UPS, INPT, Toulouse cedex 4, F-31077, France

[d] Department of Chemical Sciences, Faculty of Science and Computing, Ahman Pategi University, Km 3, Patigi-Kpada Road, Kwara State, Patigi, Nigeria

[e] Research Center for Synthesis and Catalysis, Department of Chemical Sciences, University of Johannesburg, PO Box 524, Auckland Park, Johannesburg, 2006, South Africa

[f] Department of Chemical Engineering and Sustainability, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia

[g] Faculty of Mechanical Engineering, College of Engineering, Sungkyunkwan University, Natural Sciences Campus 2066, Seobu-ro, Jangan-gu, Gyeonggi-do, Suwon, 16419, South Korea

Hide additional affiliations

## Abstract

Polylactic acid (PLA) has been extensively used in 3D printing due to its low melting temperature and minimal warping. This study investigated the reinforcement of PLA filament with soda lignin from oil palm empty fruit bunches (OPEFB) in the presence of epoxidised palm oil (EPO) as 3D printable filament. The alkaline extraction method was carried out used sodium hydroxide (NaOH), followed by precipitation with mineral acids utilising one-factor-at-a-time (OFAT). The highest extraction yield was 30 % using 1 M NaOH and 20 % phosphoric acid. Fourier transforms infra-red (FTIR) confirmed the removal of lignin in the absence of 1740 $cm^{-1}$ and 1513 $cm^{-1}$ peaks. Scanning electron microscopy images revealed rough surface and less voids observed at the cross-section of filament. The addition of 1 phr lignin and 5 phr EPO (PLAE1) showed improvement in thermal and mechanical properties, with higher $T_o$ around 5 °C and 10 % crystallinity. Brittleness is reduced by 5 % for PLAE1 compared to unfilled PLA due to increase of elongation at break. Rheology analysis revealed that PLA/lignin filament appeared to be more viscous, shown by lower complex viscosity of roughly 100 Pa compared to 800 Pa for PLA at 1 rad/s. PLAE1 exhibiting decreased in brittleness by 4 %, and high impact strength of 37 %. Dynamic mechanical analysis revealed that PLAE1 had lower rigidity than unfilled PLA with lower damping factor and storage modulus of 1.67 and 1.54 GPa. The findings revealed that the PLAE1 biocomposite has potential as alternative filament for sustainable 3D printing. © 2023 Elsevier Ltd

## Author keywords

3D printing; Lignin; Mechanical properties; Plasticiser; Polylactic acid; Printable filament; Thermal properties



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