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CRITICAL REVIEW

An overview of fused filament fabrication technology and the advancement in PLA-biocomposites

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Abstract

The escalating significance of 3D printing in various industries is underscored by its ability to rapidly and cost-effectively produce distinctive parts. Among the 3D printing methods, fused filament fabrication (FFF) has emerged as a highly productive and cost-effective approach. While extensive efforts have been made to enhance the qualities of FFF products, challenges persist in material availability and quality compared to traditional methods. This study provides a meticulous overview of the FFF process, delving into various 3D printing processes, polymers, and polymer composites. Despite documented efforts to augment mechanical, thermal, and electrical properties, material constraints remain a focal point. Our analysis extends to various PLA/biocomposites, shedding light on achieved improvements and potential applications. Looking forward, the future trend in FFF technology suggests a paradigm shift towards enhanced material diversity and performance. Anticipated applications span beyond traditional use cases, encompassing sustainable manufacturing, medical devices, and eco-friendly construction materials. This comprehensive review not only consolidates the current state of FFF and PLA-biocomposites but also anticipates future trends and potential applications. This research enhances the current knowledge of additive manufacturing and sets a standard for assessing developments in FFF technology by comparing them to previous works.

Keywords 3D printing · Fused filament fabrication · Polylactic acid · Biocomposite · FDM parameters

Highlights
- The additive manufacturing (AM) process and its various techniques are discussed in detail. A get-to-know for newcomers.
- Fused filament fabrication (FFF) materials (polymers and polymer composites) and PLA/biocomposite are discussed in detail.
- Various parameters used in the FFF process are discussed.
- Applications of FDM in the various sectors.
- Research gaps in the PLA/biocomposite are presented for future work.

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1 Introduction

The demand for three-dimensional (3D) printing applications has significantly increased over the past few years, and this trend is anticipated to continue. 3D printing is a method that uses a computer-integrated machining system to construct objects [1]. This technology could potentially heighten the use of raw materials and reduce waste while simultaneously delivering precisely dimensioned end products. Rapid prototyping (RP) was created in 1981 by Hideo Kodama, a Japanese researcher. Later, the stereolithography (SLA) process was instituted by Charles W. Hull. After that, Carl Deckard invented selective laser sintering (SLS) technology that utilises a laser beam to fuse the powder grains [2]. The development of this technology was followed by a batch of inventions such as contour sculpting, inkjet printing, powder bed fusion (PBF), and fused filament fabrication (FFF). The most notable 3D/AM techniques have been classified by ISO and the American Society for Testing and Material Standards (ASTM) [3]. AM technology is divided into seven categories by ASTM. Extrusion of materials is one of the seven