Chapter 7
Advance Biodegradable Polymer Composite Materials for Biomedical Additive Manufacturing Applications

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ABSTRACT

In the present period there has been an increasing awareness of the utilization of cost-effective greener resources to design biodegradable polymer composite materials in biomedical additive manufacturing (AM) applications owing to their excellent physical and mechanical properties, lightweight, high strength, stiffness, fatigue, and good corrosion resistance compared to the metal and ceramics materials. On the other hand, the production of bioplastic-based products increased to approximately 30% due to their remarkable role to diminish the greenhouse effect and petroleum-based pollution. Nevertheless, biodegradable polymers are renewable substitutes for petroleum-based AM materials with various advantages such as being biocompatible, biodegradable, bioresorbable, non-toxic, recyclable, and exhibiting better mechanical properties. This chapter discusses the design and preparation of biodegradable polymer composites for AM biomedical applications with different techniques.

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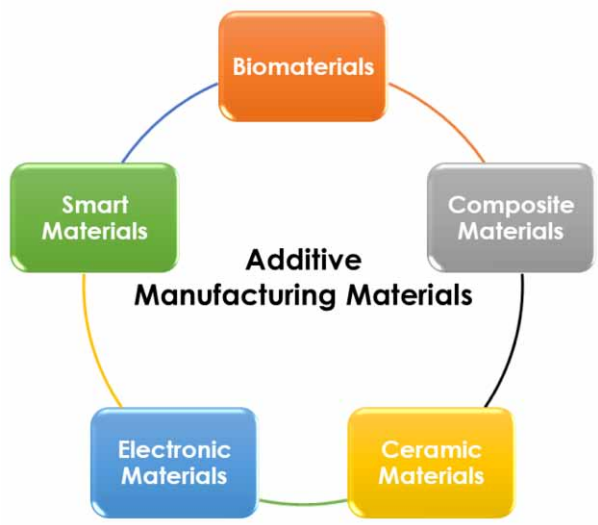
INTRODUCTION

Additive manufacturing (AM) is a novel method for building 3D components with difficult shape layer-by-layer deposition from liquid and powder with the support of a computer-added model. However, there has been rising awareness and growth of biomaterials areas, owing to the rapid enhancement of medical product requirements reasons by population growth and aging (Madhavadas et al., 2022; Sheoran et al., 2020; Singh et al., 2019). As per the universal industry investigation report, the biomaterials market is projected to touch approximately $ 94 billion in 2018 and is predicted to be over $ 256 billion by 2025, for instance, an enhancement of more than 15% between 2019 and 2025 (Mathew et al., 2022). Figure 1 demonstrated the different materials employed in the AM.

Figure 1. The different materials employed in additive manufacturing



On the other hand, renewable resources were utilized to prepare bio-based 3D printing polymer composite materials in biomedical applications (Durfee & Iaizzo, 2019; Yan et al., 2018). As the annual bioplastic manufacture is increased by 30% estimated (Jamróz et al., 2018), and these bioplastics show a crucial role to diminish petroleum-based plastic pollution and greenhouse emissions effect (Lim et al., 2016). Bio-based polymers are sustainable substitutes for petrochemical-based materials with frequently mentioned benefits instance less dependence on fossil fuel reserves as well as inferior CO_2 footprint, and biodegradability (Gross & Kalra, 2002; Reddy et al., 2012). Consequently, researchers planned an energy-saving system developed for greener 3D printing AM materials, and manufacturing techniques are of a huge reputation around the globe, since of the steady improvement in 3D printing materials utilization.

This chapter aims to endow an updated overview of the development of advanced biodegradable polymer composite materials for AM in biomedical fields. Further, also gives information about the variety of types of biodegradable polymers in assessment for AM initiated by their main points such as physical, chemical, and processing properties in connection to AM processing for medical applications.