Chapter 3
Properties and Applications of Natural Fiber-Reinforced 3D-Printed Polymer Composites

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ABSTRACT

There is a huge scope for natural fiber-reinforced composite materials, which can be used in 3D printing technology. Non-degradable materials used in the additive manufacturing field can be replaced by the innovative application of natural fiber-reinforced composite materials. This chapter introduces the advantages of 3D-printed natural fiber composite materials compared to polymer materials. The homogeneity and thermal stability of fiber reinforcement are the critical characteristics of the composite material. Also, the standardization of material testing has considerable space for research. Continuous natural fiber-printed composite and short natural fiber-printed composite are the major focuses for researchers in the field of additive manufacturing. Various fiber materials yield diverse results in the final product manufactured. Various additive manufacturing techniques can be applied and compared for the same reinforcements and matrix material.

INTRODUCTION

Amid growing concerns about the use of non-renewable resources, some sectors have given significant recognition to ecologically responsible methods, goods and recycled or scrap utilization. Minimize, reuse,

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recycle, recover, remodel and reprocess are essential components of sustainable production. A really excellent definition of external regulation that has been put into place in Europe from 2015 to resolve those environmental challenges is the need that end-of-life cars be reused or recycled 90 percent of the time, utilized for regenerative braking 10 percent of the time and balanced in landfill (Paul et al., 2015). Numerous studies are being conducted around the world to address environmental problems by utilizing materials and composite parts made from renewable resources (Faruk et al., 2012). Composites prepared from the polymeric matrix and natural fibers are of particular relevance in this situation because they can offer the required output and qualities at a reasonable price. Though natural fiber reinforced composites (NFRCs) have a bright future, there are still a number of material and manufacturing issues that must be resolved if durability and effectiveness are to be maintained over the long run. The fabrication of natural fiber reinforced composites, which have uses in the automobile, electronics, packing, building and medical industries, presently uses a variety of synthetic polymers as matrices. Organic materials in such composite have ecological and financial advantages over synthetic reinforcement agents like glass fibers because they are widely available, recycled, compostable and most importantly they are relatively affordable (Mohammed et al., 2015). For elevated engineering disciplines, thermoplastic-based natural fiber reinforced composites have lately engrossed increasing attention (Faruk et al., 2012; Mohammed et al., 2015). Comprehensive environmental compliance of natural fiber reinforced composites is still a serious difficulty because these non-biodegradable polymer composites provide considerable disposal issues. The optimum method in this situation is to create natural fiber reinforced composites utilizing recyclable polymer matrix made from renewable or non-renewable materials or existing non-biodegradable polymer materials from renewable natural resources (Mohanty et al., 2000; Shen et al., 2009). However, because of their poor thermal, mechanical and physical qualities, these bio-composite materials are not widely used. Using natural fibers in polymeric composite structures has the primary advantage of obtaining higher stiffness-to-weight ratios, recycled content, good biocompatibility, insulation and carbon dioxide neutralization in comparison to their respective traditional equivalents, which include glass fibers and carbon fibers (Madsen & Lilholt, 2003; Satyanarayana et al., 2009).

These can sometimes be weaker than composite materials built with synthesized reinforcing agents, dependent on the matrix and fiber blend, but they are acquiring a lot of relevance because of the advantages listed previously. Additionally, compared to manufactured fibers like glass fibers (54.70 MJ/kg), the manufacturing of natural fibers including flax (9.50 MJ/kg) always requires lesser energy (Joshi et al., 2004). In addition to the discussion of life cycles of natural and glass fiber reinforcing composite structures, the author of the report found that natural fiber reinforced composites allow the inclusion of significant amounts of fibers, which decreases the total utilization of synthesized polymeric matrix and promotes lightweight design and energy recovering following end-of-life combustion (Merlini et al., 2011; Jawaid et al., 2013; Cao et al., 2012; Majid et al., 2010; Jacob et al., 2006). Thermoplastic materials, as opposed to thermoset plastics and elastomers with complicated cross-linked structures, provide much more design freedom and straightforward methodological approaches. On the other hand, hardly few investigations have been conducted on the usage of agronomic wastes such as hulls of soybean. The majority of natural fibers were unusable around 473 K, hence natural fiber reinforced composites cannot be manufactured with matrices that require a higher processing temperature (Facca et al., 2006).