



## Review

# Processing and characterization of natural cellulose fibers/thermoset polymer composites



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## ABSTRACT

Recently natural cellulose fibers from different biorenewable resources have attracted the considerable attraction of research community all around the globe owing to their unique intrinsic properties such as biodegradability, easy availability, environmental friendliness, flexibility, easy processing and impressive physico-mechanical properties. Natural cellulose fibers based materials are finding their applications in a number of fields ranging from automotive to biomedical. Natural cellulose fibers have been frequently used as the reinforcement component in polymers to add the specific properties in the final product. A variety of cellulose fibers based polymer composite materials have been developed using various synthetic strategies. Seeing the immense advantages of cellulose fibers, in this article we discuss the processing of biorenewable natural cellulose fibers; chemical functionalization of cellulose fibers; synthesis of polymer resins; different strategies to prepare cellulose based green polymer composites, and diverse applications of natural cellulose fibers/polymer composite materials. The article provides an in depth analysis and comprehensive knowledge to the beginners in the field of natural cellulose fibers/polymer composites. The prime aim of this review article is to demonstrate the recent development and emerging applications of natural cellulose fibers and their polymer materials.

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## 1. Introduction

Polymers are playing an important role in the contemporary world for a number of applications starting from daily needs to biomedical and defense fields (Thakur & Singha, 2013; Thakur,

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2013; Yang, Yee, et al., 2012). Recently the field of polymer science has attracted greater attraction of the research community due to the enormous advantages offered by the polymer based materials and several polymers are appearing from the laboratories of scientist with unique and imperative properties for advanced applications (Banerjee et al., 2013; Thakur & Singha, 2013; Thakur, 2013; Yang, Kong, et al., 2012). Polymer based composite materials are playing an important role in niche applications since the last few decades ever since the discovery of Bakelite resin (Azwa, Yousif, Manalo, & Karunasena, 2013; Bharti, Mishra, & Sen, 2013; Bogoeva-Gaceva et al., 2007; Eichhorn et al., 2010; George, Sreekala, & Thomas, 2001; Guilbert-Garcia et al., 2012). These materials are emerging rapidly as the potential substitute to the metal or ceramic based materials in a number of applications including automotive, aerospace, marine, sporting goods and electronic industries to name a few (Abd-El-Messieh, Basta, & El-Saied, 2001). Among

various composites materials, natural fibers reinforced polymer composites are dwindling under increasing scrutiny due to their easy process and enormous eco-friendly advantages (Bogoeva-Gaceva et al., 2007; Dhakal, Zhang, & Bennett, 2012; Eichhorn et al., 2010; George et al., 2001). Indeed the depletion of petro-chemical based materials have paved the way to switch toward biorenewable resources based materials (Banerjee et al., 2013). Biorenewable polymers such as natural cellulosic fibers have been the subject of study in both native and modified form for a variety of applications starting from biomedical to defense (Banerjee et al., 2013; Rangel-Vazquez & Leal-Garcia, 2010; Thakur, Thakur, & Gupta, 2013a). The increased environmental awareness appears to be reaching a new level with the emphasis on the usage of natural polymer based materials in place of commonly used synthetic materials (Bogoeva-Gaceva et al., 2007; Eichhorn et al., 2010; George et al., 2001; Mishra, Rani, & Sen, 2012). Natural polymers belong to the special

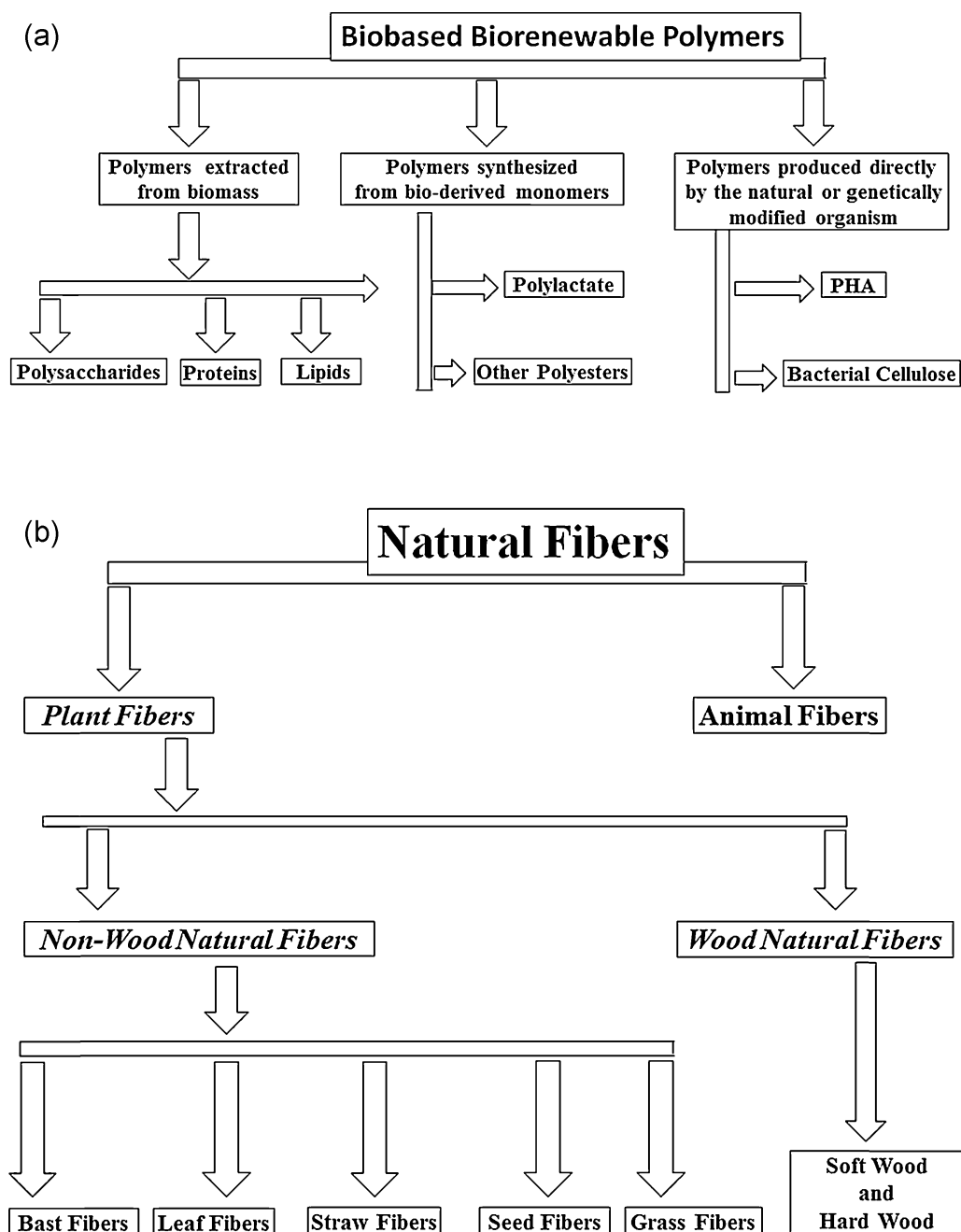


Fig. 1. (a) Classification of biobased polymers (Thakur & Singha, 2013; Thakur, 2013). (b) Classification of natural fibers (Thakur & Singha, 2013; Thakur, 2013).

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