MECHANICAL AND PHYSICAL PROPERTIES OF WOOD-PLASTIC COMPOSITES MADE OF POLYPROPYLENE, WOOD FLOUR AND NANOCLAY

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ABSTRACT

The focus of this study was to characterize mechanical and physical properties of experimental composition prepared from nanoclays (Cloisite® 20A), wood flour (WF) and polypropylene (PP). Nanoclays with different concentrations were used as reinforcing filler for wood plastic compositions (WPCs). Maleic anhydride grafted polypropylene (MAPP) was added as a coupling agent to increase the interaction between the components of wood-plastic composites. Nanoclay based wood-plastic composites were made by extrusion process and then injection molding. Mechanical and physical properties of the as-prepared composites were evaluated. The results of strength measurements showed that the flexural modulus of the composite was increased by 56.33 % with increasing of nanoclays contents to 5 wt. %, reaching approximately 3.58 GPa compared to WPC containing 0% of nanoclays. Moreover, the flexural and tensile strengths reached their maximum values when the concentrations of nanoclays was 2.5 wt. %. When maintaining the nanoclays at a low concentration, it was well dispersed in the WPC. However, when more nanoclays (4 –5 wt. %) was introduced, the enhancing effect began to diminish because of the agglomeration of nanoclays which caused poor interfacial adhesion. The addition of nanoclays decreased the average water uptake by 13 %, compared to the control sample (without nanoclays). The improvement of physical and mechanical properties confirmed that nanoclays has good reinforcement and the optimum effect of nanoclays was archived at 2.5 wt. %.

Key words: Wood plastic composites; wood flour; Nanoclay; Mechanical properties; Physical properties

Introduction

The term WPCs relates to any composites that contain plant (including wood and non-wood) fibers and thermosets or thermoplastics. Thermosets are plastics that, once cured, cannot be melted by repeating. These include resins such as epoxies and phenolic, plastics with which the forest products industry is more familiar. Thermoplastics are plastics that can be repeatedly melted. This property permits other materials, such as wood fibers, to be mixed with the plastic to form a composite product. Polypropylene (PP), polyethylene (PE) and polyvinyl chloride (PVC) are the widely used thermoplastics for WPCs (Panthapulakkal et al., 2006). Wood plastic composites (WPCs) are relatively new generation of composite materials and also the most promising sector in the field of both composite and plastic industries. In 1970s, the modern concept of WPC was developed in Italy and gradually got popularity in rest of the world (Pritchard, 2004).

In past ten years, wood-plastic composites (WPCs) have emerged as an important family of engineering materials. They have become prevalent in many building applications, such as decking, docks, landscaping timbers, fencing etc., partially due to the need to replace pressure-treated solid lumber (Pilarski and Matuana, 2005). Wood–plastic composites (WPCs) are obtaining a great attention in industrial sectors and academics due to their favourable properties, which include low density, low cost, renewability and recyclability as well as desirable mechanical properties (Zhang et al., 2012). Better stability and favourable mechanical properties has caused WPCs to become a preferred building material (Adhikary et al., 2008).

Wood flour (WF) is gaining more acceptance as a type of filler for polymers due to its easy availability, low density, biodegradation, renewability, high stiffness, and relatively low cost. Moreover, the renewable and biodegradable features of wood fibers facilitate their fast degradation by composting or incineration. According to the advantages of wood fiber, the production of wood plastic composites (WPCs) and its application in many fields has attracted much attention in the decades (Ashori, 2008). However, when combining thermoplastics with wood fibers by conventional methods, the highly hydrophilic natures of the lignocelluloses materials make them incompatible with the thermoplastics which are highly hydrophobic in nature. The incompatibility leads to weak interfacial adhesion between thermoplastics and wood filler, and poorer of the composite properties. Besides, the hydroxyl groups between wood fibers can form hydrogen bonds which can lead to agglomeration the