



Enhancing Particleboard Panels' Performance Properties by Nanocellulose and Boric Acid Reinforcement

Mert Yildirim¹, Zeki Candan¹

¹Department of Forest Products Engineering, Faculty of Forestry, Istanbul University-Cerrahpasa, 34473, Istanbul, Turkey
yildirimert1993@gmail.com, zekic@istanbul.edu.tr



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Abstract

The major goal of this study was to develop nanocellulose (NC) and boric acid (BA) reinforced particleboard panels with enhanced physical and mechanical properties. Urea-formaldehyde (UF) resin used to produce particleboard panels was reinforced with NC at loading level of 0%, 1%, 3%, BA at loading level of 0%, 1%, 3% and %5. To obtain physical properties density, thickness swelling (TS), and water absorption (WA) tests were performed while modulus of rupture (MOR), modulus of elasticity (MOE), and internal bonding strength (IB) tests were carried out to acquire mechanical performance properties of the particleboard panels. The findings obtained in this scientific study revealed that NC and BA reinforcement significantly affected the physical and mechanical performance properties of the particleboard panels. It was determined that the dimensional stability of the particleboard panels improved by all the NC and BA used in this study. It was determined that using 1% NC and 5% BA in the particleboard panels had the best results in the WA analysis. It was also determined that using 3% NC and 3% BA in the particleboard panels had the best results in the MOR, MOE, and IB tests. It was concluded that the physical and mechanical performance properties of the particleboard panels could be enhanced by using proper NC and BC loading levels. In addition, NC and BA reinforcement technique could be used to develop novel furniture components and interior design materials.

Introduction

There has recently been increased interest in the development of thermosetting resins with enhanced properties.

Nanocellulose could be used to reinforce resins such as urea formaldehyde (UF), phenol formaldehyde (PF) and melamine-urea formaldehyde (MUF).

Previous researchers studied physical and mechanical, properties of nanocellulose, nanocellulose-reinforced resins and wood-based composites (Candan 2012; Candan et al. 2013; Candan 2014; Candan et al. 2014; Candan 2015; Candan et al. 2015; Eichhorn et al. 2010, Jones et al. 2005; Klemm et al. 2011).

Objectives

- ✓ To evaluate influence of nanocellulose and boric acid on the physical and mechanical properties of UF resin.
- ✓ To develop UF resin with enhanced physical and mechanical properties.
- ✓ To widen application of nanocellulose and boric acid by using in manufacture of particleboard panels.

Materials & Methods

Reinforcement of UF Resin with Nanocellulose and Boric Acid

Urea-formaldehyde (UF) adhesive used to produce particleboard panels was reinforced with NC at loading level of 0%, 1%, 3%, BA at loading level of 0%, 1%, 3% and %5. The reinforcement process was carried out in the Nanotechnology Laboratory at IUC.

Physical and Mechanical Properties

Density (TS EN 323, 1999), TS (TS EN 317, 1999), and WA (ASTM D1037, 2012) of the particleboard panels were determined according to national or international standards. MOR (TS EN 310, 1999), MOE (TS EN 310, 1999), and IB (TS EN 319, 1999) tests were performed to evaluate mechanical properties of the particleboard panels.

Results

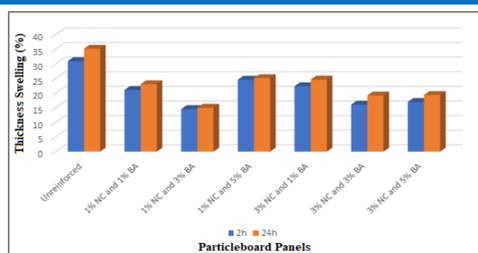


Figure 1. Thickness swelling values of the NC and BA reinforced particleboard panels.

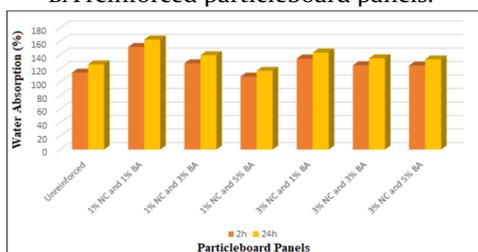


Figure 2. Water absorption values of the NC and BA reinforced particleboard panels.

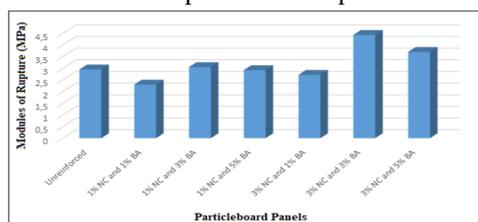


Figure 3. Modulus of rupture values of the NC and BA reinforced particleboard panels.

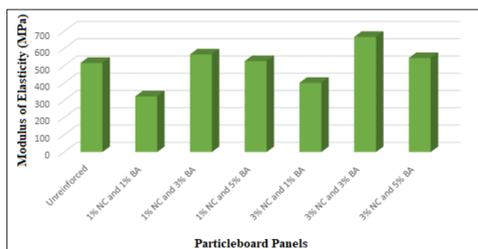


Figure 4. Modulus of elasticity values of the NC and BA reinforced particleboard panels.

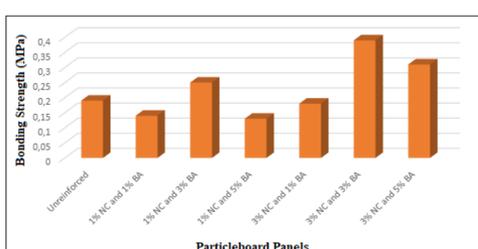


Figure 5. Internal bonding strength values of the NC and BA reinforced particleboard panels.

Conclusions

- ✓ Urea-formaldehyde adhesive could be reinforced with nanocellulose and boric acid at a proper loading level.
- ✓ Nanocellulose had a positive effect on the mechanical properties values of the urea-formaldehyde adhesive.
- ✓ By using nanocellulose, particleboard panels with increased mechanical properties could be produced.

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