Improvement of ductility and toughness of wood polypropylene-composites

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Given the wide range applications, wood-polymer composites (WPC) are occupying an undeniable position in the industrial composite market. However, WPCs suffer from low ductility and weak toughness even when only small fiber proportions are used. Fibers in thermoplastic polymers promote the propagation of cracks as well as the fracture of beams. In addition, wood beam assembly and fixation by screw or nail could become difficult due to the limited deformation behavior. Thus, the main objective of this study was to assess the enhancement of toughness and ductility of wood-polypropylene composites. The specific objectives were: (i) to establish a comparative analysis on the ductile and tenacious behavior of WPC according to the type of fiber and (ii) to investigate the effect of the addition of glycerol and elastomer on the mechanical behavior. WPCs were produced through two types of fiber (kraft and white birch), polypropylene (PP), maleated styrene-ethylene/butylene-styrene (SEBS-MA) and maleated polypropylene (MAPP). The composites were manufacturing using a two-step process, pellets extrusion using a twin-screw extruder and injection of test samples using an injection-molding machine. WPCs (Table 1) were characterized by mechanical (tensile, three point bending and impact) and thermal (differential scanning calorimetry and thermogravimetry) tests.

Table 1 : Composition of the various PP/WF composites

Composite code	Composite compositions for polymers (%-by weight), impact modifiers and compatibilizer					
	PP	White birch fiber	Kraft fiber	Kraft treated with glycerol	MAPP	SEBS-MA
1	67	30			3	
2	67		30		3	
3	67			30	3	
4	57		30		3	10
5	47		30		3	20
6	47			30	3	20

Results showed that the incorporation of wood fiber reduced the elongation at break of the PP from 600% to 12.9 % for PP/kraft fiber WPC and to 5.4% for PP/white birch fiber. Treated kraft fibers with glycerol solution reduced deformation and ductility of composites, the corresponding elongation at break was equal to 7.21%. Adding 10% and 20% of SEBS-MA to the WPC formulation increased the elongation at break by 29.3% and 61.8, respectively (Figure 1)%. Adding SEBS-MA to WPC made with glycerol treated kraft fibers led to a substantial improvement of elongation at break (95.1%) Similarly, SEBS-MA substantially improved the WPC impact strength. Adding 10% and 20 of this elastomer improved the impact strength by almost 100% and 380%, respectively (Figure 2). WPC made with glycerol treated kraft fibers showed a 685% improvement of the impact energy. The improvement of toughness and ductility is explained by the encapsulation of filler by the SEBS-MA [1-2].

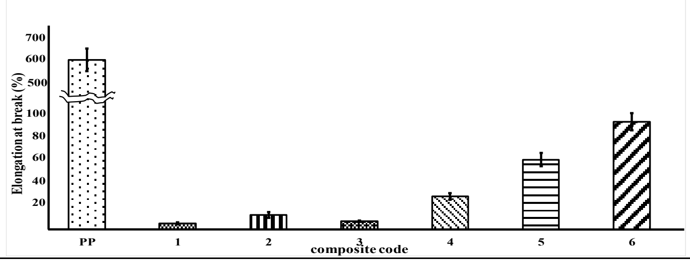

Figure 1 : Elongation at break for different composites

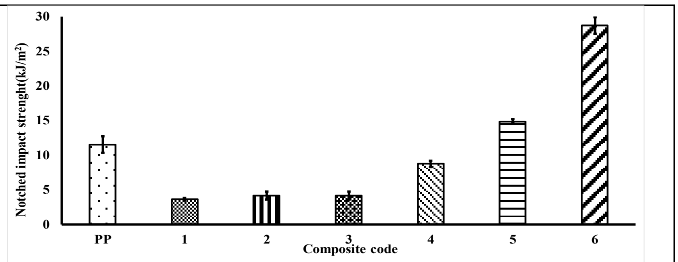

Figure 2 :Notched Impact strength for different composites

[1] K. Oksman, C. Clemons: Mechanical properties and morphology of impact modified polypropylene–wood flour composites. *Journal of applied polymer science,* 67 (1998), 1503-1513.
[2] K. Oksman, H. Lindberg: Influence of thermoplastic elastomers on adhesion in polyethylene–wood flour composites. *Journal of Applied Polymer Science,* 68 (1998), 1845-1855.

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