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FIBRE SURFACE INFLUENCE ON COMPOSITE'S MECHANICAL PROPERTIES

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Abstract: *The first step in obtained new composite materials from wood fibres is the surface analysis and treatment of fibres. Chemical treatments carried out on fibres modify their surface, increasing the adhesion between fibres and matrix, respectively increasing the mechanical properties of the composite material. The treatment of wood fibres with alkaline solutions on different concentrations shows that the mechanical properties increase significantly with the concentration of alkaline solution.*

Key words: *composite materials, wood fibres, surface analysis, mechanical properties.*

1. Introduction

Composite materials obtained by using wood fibres may be a potential candidate for partial replacement of the classical fibres (glass, carbon or Kevlar) used in polymer matrix composites.

Composite plates with wood fibres could provide an excellent eco-solution to real problems regarding the fast consumption of natural resources.

These new material configurations are attractive both in terms of lower costs but also because of their mechanical properties which recommend them as a new generation of materials [13], [2], [3]. Concerning the length and geometry of classical fibres, generally they are cylindrical with approximately constant diameter and specific area, uni- or multi-filamentary. This is not the case for wood fibres which present many defaults caused by wood processing [10]. These defaults are apparent at the fibres surface and constitute points where the fibres may fracture more easily. In the case of wood fibres, including its physical structure, mechanical properties, and density, change from species to species [1].

A first step, in obtaining new composite materials, consists in chemical treatment of fibres. Natural fibres can be chemically treated due to the presence of hydroxyl groups in lignin and cellulose. These OH groups can change the surface energy and polarity of the natural fibres during various treatments. The most common methods of surface treatment are alkali treatment, isocyanate treatment, acrylation, benzoylation, permanganate treatment, silane treatment and peroxide treatment [4-7], [11], [12].

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All these treatments can improve the adhesion of the fibres with the polymer matrix and lead to higher impact resistance in comparison with samples containing fibres with no chemical treatment [8], [9].

This paper presents a comparative study regarding the influence of the interfaces quality over the mechanical properties of the composite plates. The morphology of the fibres was investigated using scanning electron microscopy (SEM).

2. Materials and Methods

Chemical treatments can increase the adhesion at the interface between the fibres and matrix by removing the non-cellulosic compounds, which constitute the main objective of those treatments.

2.1. SEM Microscopy analysis in the case of wood fibres

A usual method to study the morphology of wood fibres is the SEM method. SEM analysis was made on untreated and treated wood fibres. In this study we used a mixture of hardwood sawdust. One aspect to be taken into account in the characterization of wood fibres is the size (Figure 1).

The morphology of the wood fibres, cell size and shape were investigated using scanning electron microscopy (JOEL JSM5510 LV). We observed the wood fibres before and after alkaline treatments. In the case of untreated fibres we can see the normal unchanged cellular structure of wood fibres. The SEM images (Figure 2) show the difference between treated and untreated wood fibres.

Untreated fibres surface has many large impurities.

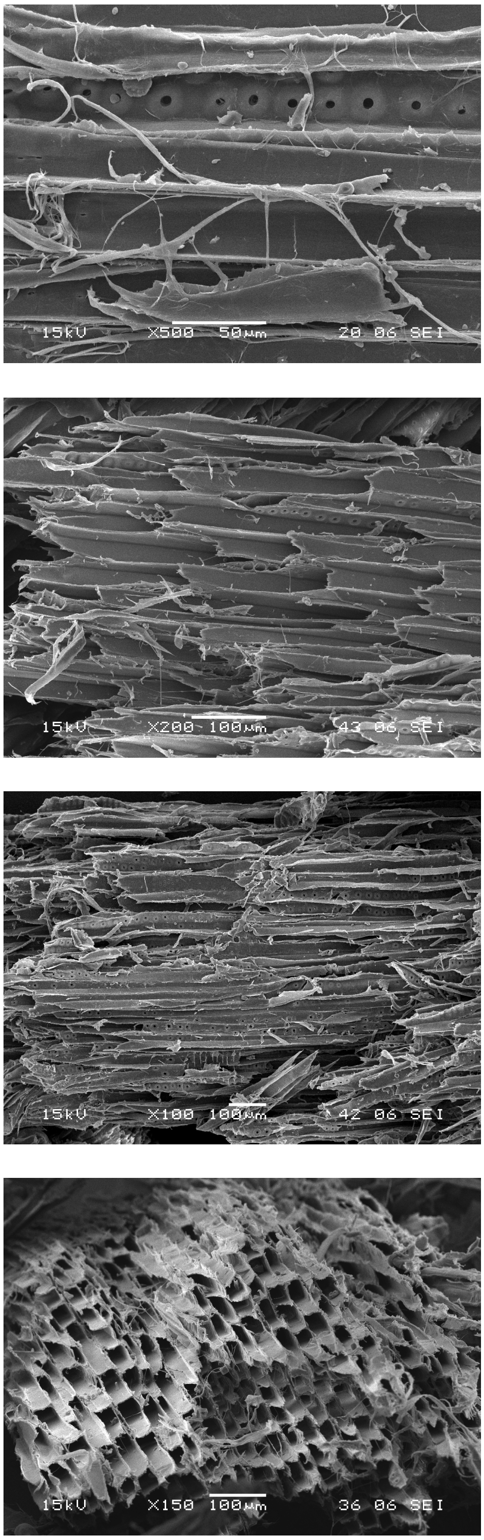
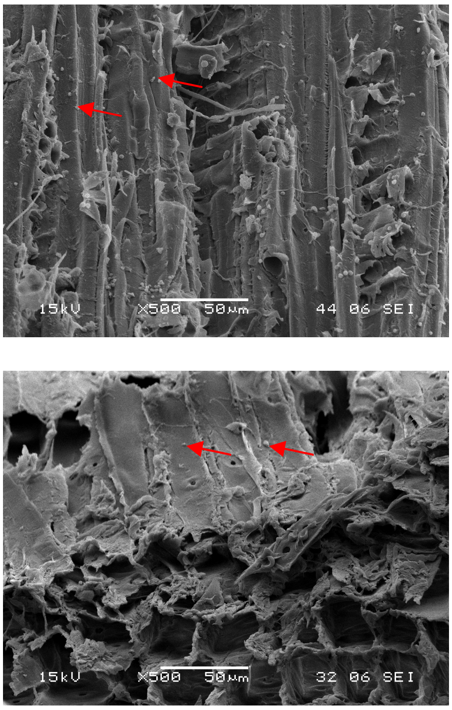
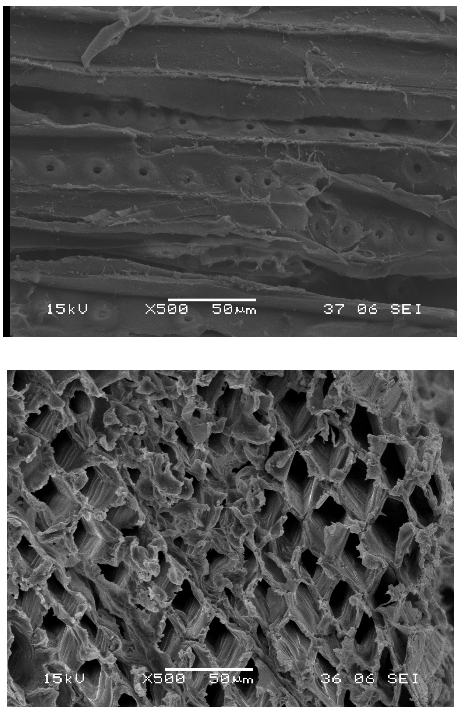


Fig. 1. *SEM images of wood fibres*



a)



b)

Fig. 2. *SEM images of untreated* (*a*) *and treated* (*b*) *wood fibres*

2.2. Composite plates manufacturing

The composite plates (Figure 3) were obtained from wood fibres and a polymeric resin mixed until homogenization in a fibre-resin ratio as in Table 1.

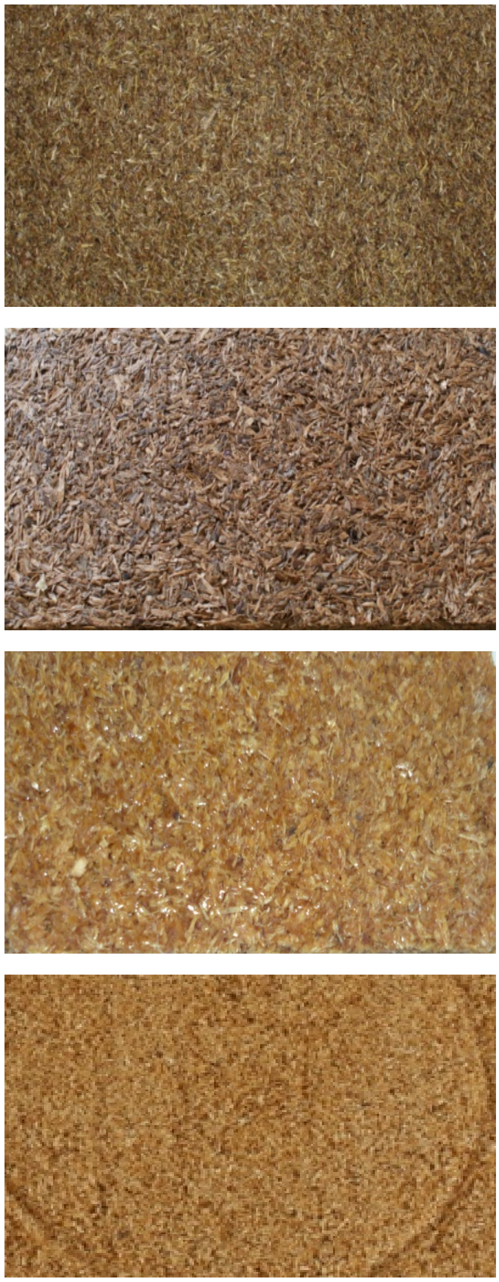


Fig. 3. *Particle boards from wood fibre and polymeric resin*

Composite plates mixture Table 1

Sample No.	Wood fibre type	Mass participation [wt%]	
		Fibre	Resin
1.	Untreated Cherry fibres	40	60
2.	Untreated mix fibres, 0.44 ÷ 0.8 μm	26	74
3.	Untreated mix fibres, 0.16 μm	23	77
4.	Mix fibres treated with NaOH 2%	43	57
5.	Mix fibres treated with NaOH 5%	30	70
6.	Mix fibres treated with KOH 5%	28	72
7.	Mix fibres treated with KOH 10%	29	71

Mix = hardwood and softwood

3. Test Results and Discussion

3.1. Tensile strength at perpendicular load

The experimental data obtained directly by tensile test [14], [15], using the equipment from Figure 4, for wood fibre composite plates shows higher values for sample 9 (2.37 N/mm^2) and samples 6 and 7 with fibres treated with alkaline solution of KOH with concentrations of 5% and 10%. The lowest value 0.14 N/mm^2 was obtained when we use wood fibres sample 4, see Figure 5.

Fig. 4. *Tensile test equipment*

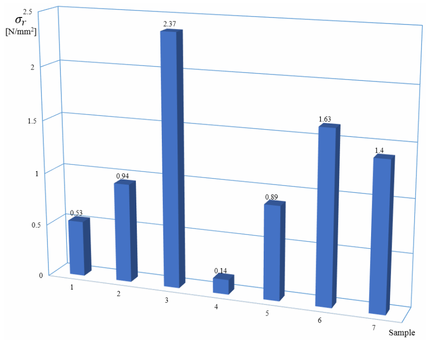


Fig. 5. *Transverse tensile strength*

3.2. Compression strength

The experimental data, according to the European standard [14], [16], shows higher values for sample 9 (34.35 N/mm^2) and sample 6 and 7 with fibres treated with alkaline solution of KOH with concentrations of 5% and 10%. The lowest value 1.2 N/mm^2 was obtained when we use wood fibres sample 4, see Figure 6.

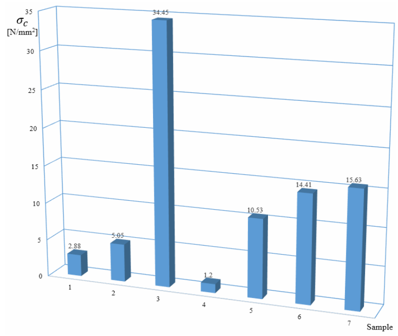


Fig. 6. *Compression strength*

The experimental equipment used for this test is shown in Figure 7.

Fig. 7. *Compression test equipment*

3.3. Bending strength

To obtain the experimental data for the bending strength of the wood fibre composite plates [14], [17] we used the equipment shown in Figure 8.

Fig. 8. *Bending test equipment*

The experimental data shows higher values for sample 9 (28.1 N/mm^2) and sample 6 and 7 with fibres treated with alkaline solution of KOH with concentrations of 5% and 10%. The lowest value 1.79 N/mm^2 was obtained when we use wood fibres sample 4, see Figure 9.

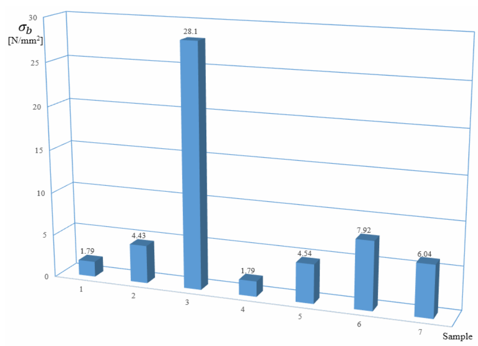


Fig. 9. *Bending strength*

4. Conclusions

Using scanning electron microscopy to highlight the morphological changes showed that the alkaline treatments partially remove the impurities and we have a clean fibre surface. The main objective of the chemical treatments is to increase the adhesion between the fibre and matrix, by removing the impurities from the fibre surface. Therefore, chemical treatments can be considered in modifying the properties of natural fibres if the concentration of the alkaline solution used in the fibre treatment is less to 5%. Improving the fibre surface quality by alkaline treatment we can improve the mechanical properties of the composite material plates.

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