Reed lignocellulosic thermoplastic composite

Ragab, E. ABOU-ZEID[1,2], Nahla, A. EL-WAKIL[1], Yehia, FAHMY[1] and Alain DUFRESNE[2].

[1]Cellulose and Paper Department, National Research Center, Dokki, Cairo (Egypt).

[2]LGP2 – Laboratory of Pulp and Paper Science - 461, Rue de la Papeterie – BP 65 - 38402 Saint Martin d'Hères Cedex (France).

8th PAGORA DAYS , July 2nd & 3rd 2009

Objective

Untreated and benzylated reed fibers were used as reinforcing fillers in thermoplastic composites. Lignocellulosic fibers are a new generation of fillers, which are favored due to their capacity of making composites more environmentally friendly. Two levels of reinforcement were studied, 30 and 40%. They were used to fill polypropylene (PP), high density polyethylene (HDPE), low density polyethylene (LDPE) and polystyrene (PS). The presence of fibers decreases the modulus and strength of the composites but benzylated reed fibers improve these properties.

Current work

Introduction

Lignocellulosic fibers are a favored new generation reinforcing materials in thermoplastic composites. Among other things, lignocelluloses make composites more environmentally friendly. The present work aims to prepare reed-based thermoplastic composites. Furthermore, due to the strong cellulose backbone structure, lignocellulosic fibers possess good strength properties compared with other reinforcing materials, such as glass and minerals.

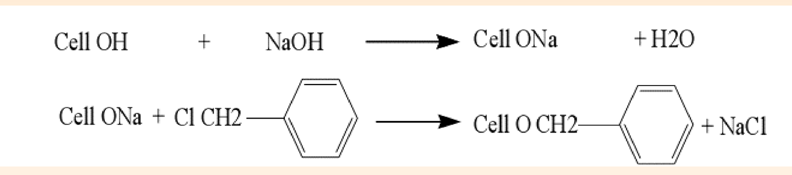
The mechanical and physical properties of the thermoplastic composites obtained were characterized and thermogravimetric and scanning electron microscopy analysis were also performed.

Material & Methods

was collected and cut into small pieces and then dried to reduce moisture content to about 4–6%. The pieces were ground and screened through a mesh of 0.2 mm to remove larger size particles. The chemical composition of reed was analyzed and verified to be 47.95% cellulose, 24.85% lignin, 22.3% pentosan, 2.9% ash and 2.0% silica.

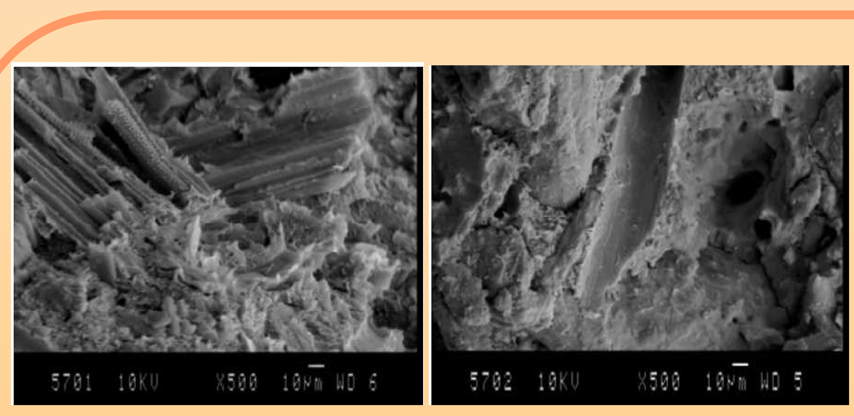
Thermoplastic polymers: four kinds of the most commonly used thermoplastic polymers were selected, namely, polypropylene, high density polyethylene, low density polyethylene and polystyrene. They were delivered from Alcudia Company, Spain.

Preparation of Benzylated Reed:
The screened reed was dried overnight under vacuum at 60° C before being use. After being mixed with 40% NaOH solution for 0.5 hour, the mixture was transferred into a three necked flask and benzyl chloride was added.



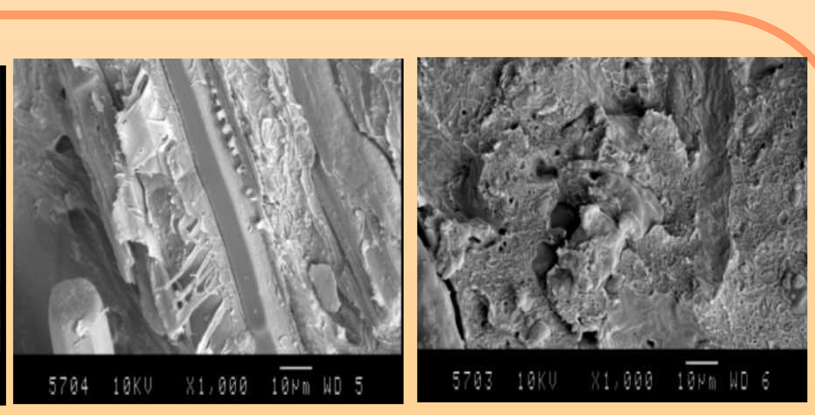
Preparation of Thermoplastic Composites:

Firstly, the thermoplastic polymers were melted in a Electronic Plasticorder. Untreated and benzylated reed fibers were added in two different proportions (30 and 40%, respectively) to the melted polymer at the above mentioned temperatures. The time of the mixing process was about 8 minutes.



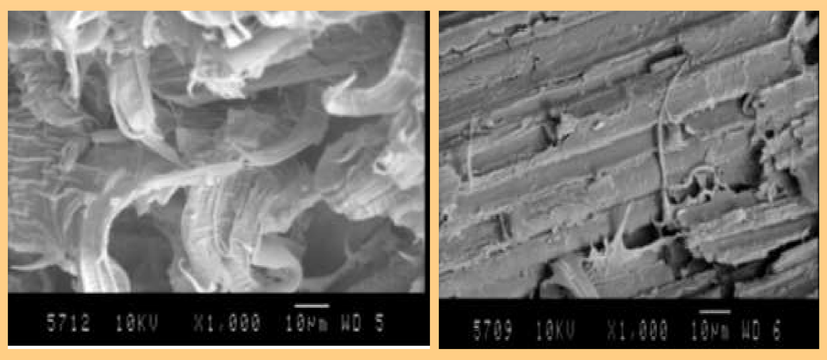
(a) (b)

SEM photographs of a surface fracture of untreated reed fibrs filled PP (a) and benzylated reed fibers filled PP (b).



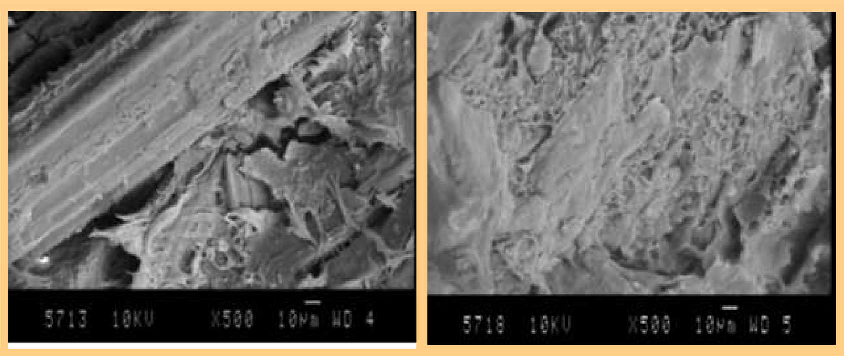
(c) (d)

SEM photographs of a surface fracture of untreated reed fibers filled PS (c) and benzylated reed fibers filled PS (d).



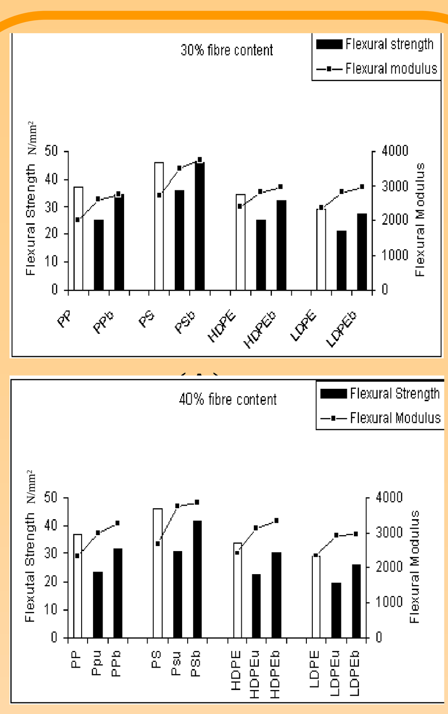
(e) (f)

SEM photographs of a surface fracture of untreated reed fibers filled HDPE (e) and benzylated reed fibers filled HDPE (f).



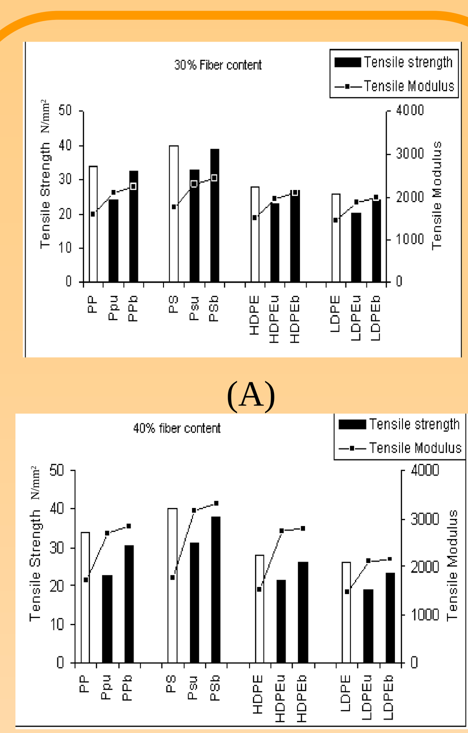
(g) (h)

SEM photographs of a surface fracture of untreated reed fibers filled LDPE (g) and benzylated reed fibers filled LDPE (h).



(B)

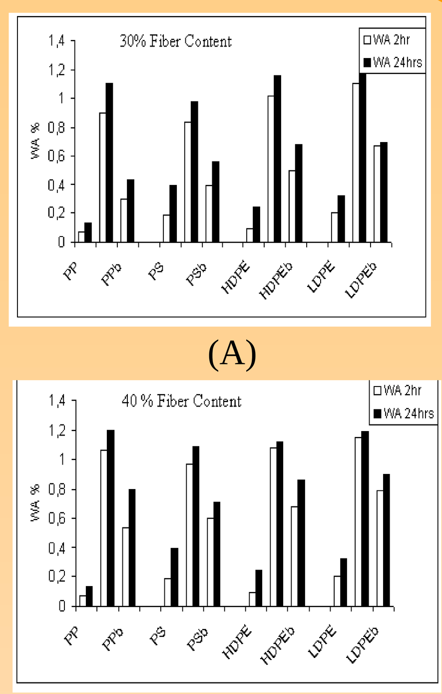
Flexural strength and modulus of untreated and benzylated reed fibers filled PP, PS, HDPE and LDPE with 30 % (A) and 40% (B) fiber content, respectively.



(A)

(B)

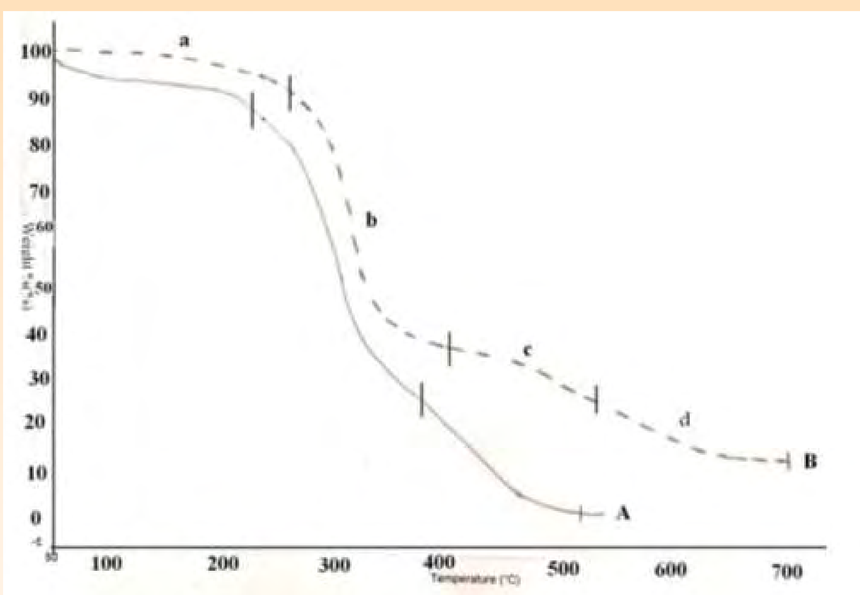
Tensile strength and modulus of untreated and benzylated reed fibers filled PP, PS, HDPE and LDPE with 30 % (A) and 40% (B) fiber conten, rspectivelyt.



(A)

(B)

Water absorption of untreated and benzylated reed fibers filled PP, PS, HDPE and LDPE with 30 % (A) and 40% (B) fiber content, respectively.



TGA curves of untreated A (__________), and benzylated reed samples B (-----------).

Temperature (°C)	Weight losses (%)	
	Untreated reed-PS composites	Benzylated reed-Ps composites
100	2.0	0.3
200	3.6	1.6
300	14.7	8.3
400	89.6	68
500	99.8	94.4

Weight losses of untreated and benzylated reed at different temperatures

References

[1] Rowell R. M., Young R. A. and Rowell J. K. "Paper and Composite from Agro- based Resources". Raymonda, Young: Ed.; CRC Lewis Publishers, Chapter 6, (1997).
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Discussion

In this work chemical modification of reed fibers was carried out through etherification, specifically benzylation.

The flexural modulus of benzylated reed fibers filled PP, PS, HDPE and LDPE with 30 and 40% fiber content, respectively, achieved values comparable to those of the pure polymers.
Benzylation improved the compatibility between cellulose fibers and thermoplastic matrices and, consequently, the fiber-matrix adhesion. This compatibility is clear in the SEM photographs.
Polystyrene composite reinforced with benzylated reed fibers showed the best MOR due to the similarity between the phenyl-structure present in both benzylated reed fibers and polystyrene, which makes them thermodynamically compatible.
Benzylation of reed fibers has led to a mass gain of 81 %. Characterization of the benzylated reed samples was carried out through TGA analysis.

It was clear that the functionalization of cellulose OH groups by benzyl moieties, resulted in samples with higher thermal stability. This was probably due to the incorporation of benzyl groups in the reed raw material, which increased its resistance toward thermal degradation.

Conclusion

Among all the thermoplastic composites prepared in this work, polystyrene composite reinforced with benzylated reed fibers showed to have the best MOR due to the similarity between the phenyl-structure present in both matrix and filler, which makes them thermodynamically compatible. A significant increase in the flexural modulus was observed upon filling all polymers with both fibers (30 and 40% untreated and benzylated reed fibers, respectively). Tensile strength of the benzylated reed fibers composite was improved to a great extent.

Contact: r_abouzeid2002@yahoo.com