SURFACE TREATMENT EFFECTS OF THE COTTON TEXTILE PRE-FORMS ON THE PROPERTIES OF ALL-CELLULOSE COMPOSITES

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Abstract
All-Cellulose composites are produced based on the original concept of self-reinforced composite, a composite with matrix and reinforcement from the same polymer, which was primary developed for thermoplastic high density polyethylene. In this work "all-cellulose" composites have been successfully prepared from cotton textile preforms by means of a fibre surface dissolution method in lithium chloride dissolved in N,N-dimethylacetamide (LiCl/DMAc). Two different parameters have been studied: (i) surface treatment medium (alcaline/enzime/bleaching) and (ii) cotton textile preforms (knits, woven). All-cellulose composites with 85–95% fibre volume fraction were successfully prepared by using solutions of 3 (wt/v) cellulose concentrations in 8 % (wt/v) LiCl/DMAc for impregnation of cotton textile preforms.

1 Introduction

Recently, development of eco-friendly polymer composite materials was focused towards monocomponent, all-cellulose composites [1]. The all-cellulose composites were prepared by dissolving pre-treated cellulose pulp in LiCl/DMAc and then impregnation of the cellulose solution into the aligned ramie fibers followed by coagulation in methanol and drying. These composites exhibited significant prospect as being a biobased and biodegradable material with excellent mechanical properties. Examples of starting materials were pulp [2], filter paper [3], long fibers [4]. Duchemin et al. have studied the effect of dissolution time and cellulose concentration on the crystallography of precipitated cellulose, using microcrystalline cellulose (MCC) as a model material [5]. The results of that work contributed to further understanding of the phase transformations that occur during the formation of all-cellulose composites by partial dissolution.

In this work "self-reinforced cellulose" or "all-cellulose" composites have been successfully prepared from cotton textile preforms by means of a fibre surface dissolution method in lithium chloride dissolved in *N,N*-dimethylacetamide (LiCl/DMAc). Two different parameters have been studied: (i) surface treatment medium (alcaline/enzime/bleaching) and (ii) cotton textile preforms (knits, woven).

2 Materials and testing methods

All-cellulose composites have been successfully prepared from cotton textile preforms by means of a fibre surface dissolution method in lithium chloride dissolved in *N*,*N*-dimethylacetamide (LiCl/DMAc). Two different parameters have been studied: (i) surface treatment medium (alcaline/enzime/bleaching) and (ii) cotton textile preforms (knits, woven). All-cellulose composites with 85–95% fibre volume fraction were successfully prepared by using solutions of 3 (wt/v) cellulose concentrations in 8 % (wt/v) LiCl/DMAc for impregnation of cotton textile preforms. FTIR spectroscopye was used to characterize the structure of the cotton-based composites. FTIR spectra were recorded with a Perkin Elmer Paragon 500 analyzer, using 64 scans and a resolution of 2 cm^{-1}. Mechanical tests were performed using Instron Tensile test machine. Scanning electron microscopy-SEM FEI QUANTA 200 FEG system was used to study the composite morphology.

3 Results and discussion

It was found that a dissolution time of 24 h lead to biobased materials with the best overall mechanical performance, as this time allowed for the dissolution of a sufficient amount of fiber surface to obtain good interfacial bonding between fibers, while keeping a considerable amount of remaining fiber cores that provide a strong reinforcement to the composite. Characteristic mechanical curves are presented in fig. 1.

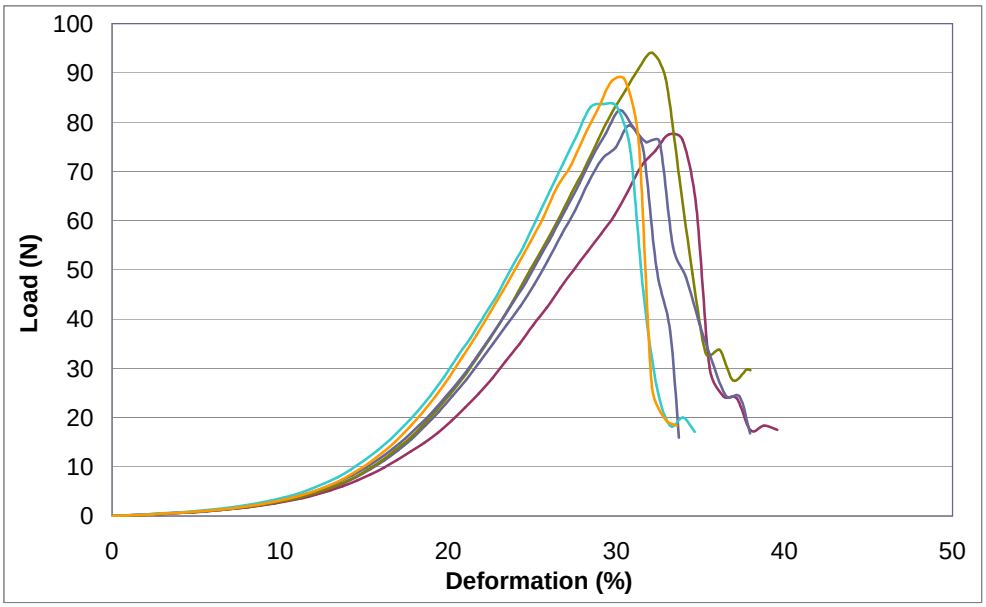


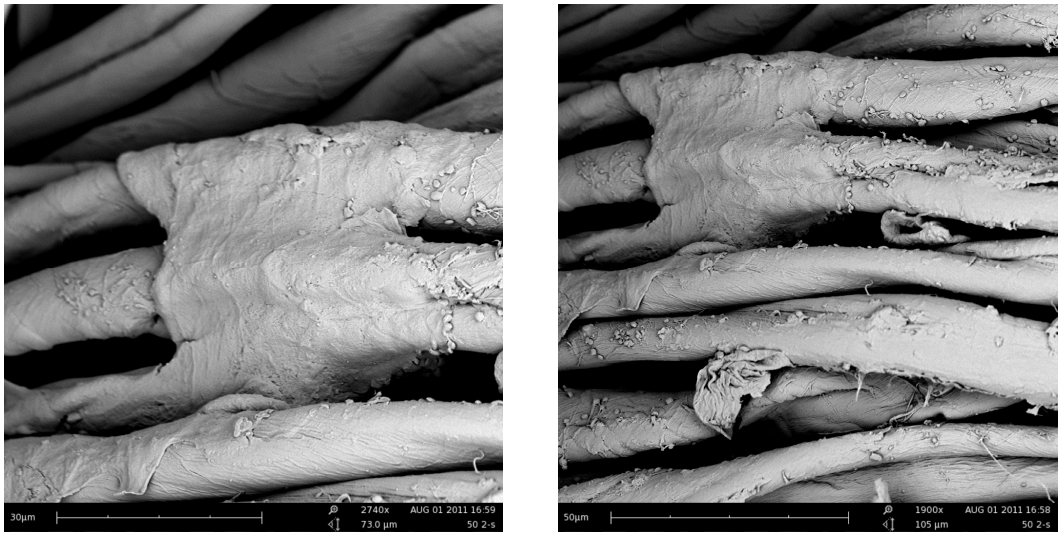
Fig. 1. Characteristic curves obtained with mechanical testing of all-cellulose composites (all-cellulose composites based on alkali treated and bleached woven preform)

Comparison of the mechanical performances of all-cellulose composites based on alkali (max load =84 N) and enzyme (max load =86,1 N) surface treated cotton woven preforms has shown that higher values were obtained for enzyme treated all-cellulose composites. Although the composites based on enzyme and bleach treated pre-forms have shown the best mechanical properties, alkali treated cotton woven preforms have shown higher lateral crystalline index in the obtained composites compared to enzyme treated ones. Crystalline index for the studied all-cellulose composites, obtained as a ratio of the FTIR bands at 1430cm^{-1} (CH_2 symmetric band) and 898 cm^{-1} (Group C1frequency: -CH2=C-R) is presented in Table 1.

Table 1 Crystallinity of all-cellulose composites

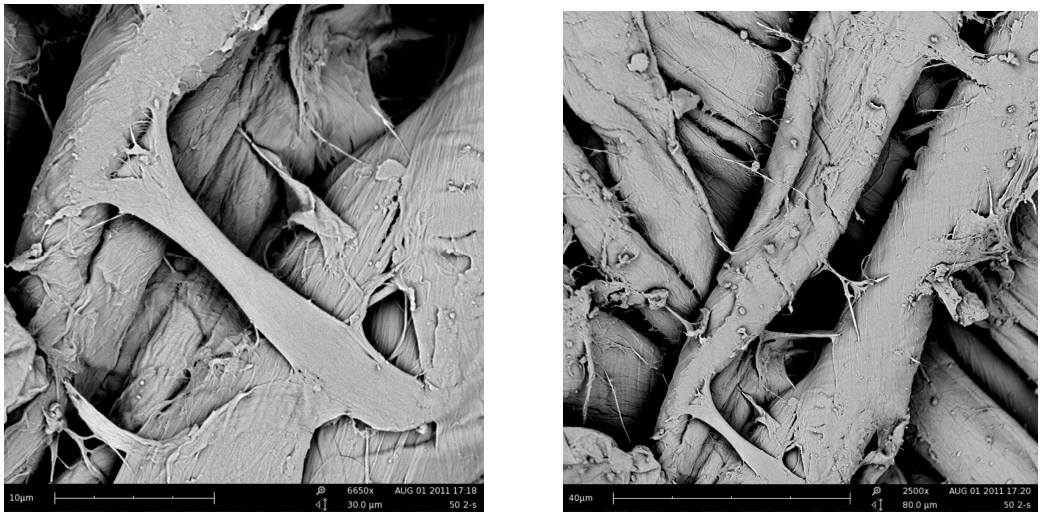
Sample	*CrI* (A_{1430}/A_{898})
Control sample	*3,7*
Alkali treated	*3,8*
Enzime treated (alkali pektinaze)	*3,1*

Characteristic SEM microphotographs for the morphology of the obtained all-cellulose composites are shown in Fig. 2 and Fig. 3. Figures 2a and 2b, show morphology of alkali-treated cotton all-cellulose composites, while in fig. 3, morphology of enzyme/alkali pektinaze treated cotton performs were shown.



(a) (x2740) (b) (x1900)

Fig. 2 Morphology of all-cellulose composites based on alkali treated and bleached cotton pre-forms



(a) (x6650) (b) (x2500)

Fig. 3 Morphology of all-cellulose composites based on enzyme treated (alkali-pektinaze) cotton pre-forms

SEM microphotographs of the studied all-cellulose composites based on alkali and enzyme treated cotton performs confirmed that good the fiber-fiber adhesion was registered in both type of cotton performs. For alkali treated performs progressive build-up of covering films around the fibers were found, while for enzyme treated performs bonding bridges were registered between two fibers.

4 References

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