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INFLUENCE OF FLAX CELL WALL COMPONENTS ON THE INTERFACIAL BEHAVIOR OF FLAX WOVEN FABRIC / EPOXY BIOCOMPOSITES

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ABSTRACT

In this work, the effect of the selective extraction of flax fibre components on the properties of flax woven fabric / epoxy biocomposites is investigated. Six treatments were applied to flax woven fabrics and their influence on fabric characteristics and the consequences on the fibre/matrix interface were studied. Components removal was evaluated by chemical composition and FT-IR analysis. Mechanical tests and SEM observations were used to study the composite interface. A defibrillation phenomenon within the fibre bundles with the extraction of some specific components was responsible for a significant decrease of the transverse strength of the biocomposites whereas the porosity was reduced for all the treatments used. Our results highlight the key role of cell wall components on the morphology and properties of flax woven fabric / epoxy biocomposites.

INTRODUCTION

Natural fibres based composites are increasingly used as alternatives to glass fibres based composites, mainly because of their low density and positive life cycle assessment. Nevertheless, these biocomposites present lower mechanical properties than those of glass fibres reinforced composites (Liang, 2012). The improvement of their mechanical properties requires a better understanding and control of the fibre/matrix interface and the intra-fibrillar interface within the fibre bundles which are composed of several cell wall components, i.e. cellulose micro-fibrils, hemicelluloses, lignins, pectins and lipophilic extractives (Marques, 2010). The aim of this study is to investigate the influence of different treatments used to remove selectively flax fibre components, and their effect on flax fabrics properties and on the interfacial behaviour of flax fabrics / epoxy biocomposites.

In this study, flax woven fabrics supplied by *Fibres Recherche Développement Co. (FRD*, France) were used. Epoxy resin 1800/1805 was supplied by *Resoltech Co.* (France). Composites were made by thermo-compression technique. Fabrics were treated with six different solutions for 1h at 95ºC: 1) hot-water, 2) 70%w non-ionic and 30%w anionic surfactants solutions, 3) NaOH 1%, 4) NaOH 5%, and for 1h at 75ºC 5) ethanol and 6) toluene/ethanol ($2{:}1_w$). After treatment, flax fabrics were washed for 10min at 50ºC then for10 min at room temperature in order to remove the residual solvents and extracted components, and then dried at 60ºC. Dimensional and gravimetric studies were applied to flax woven fabrics. Chemical composition of flax fibres was determined by chemical analysis according to several specific standards for the quantification of soluble extractives, hollocellulose,

lignins, α-cellulose and ashes and by ATR-FTIR analysis. Surface characterizations were carried out by contact angle measurements and optical microscopy and SEM observations. Mechanical tests and SEM observations have been conducted to study the biocomposites interfacial behaviour and the effect of the different treatments.

RESULTS AND CONCLUSIONS

Lipophilic extractives and lignin removal were highlighted by ATR-FTIR spectrometry. Strong peaks at 2848 cm^{-1} and 2916 cm^{-1}, corresponding to C-CH_3 stretching vibrations, disappear after ethanol and toluene/ethanol treatments. In contrast, a reduction of 1731cm^{-1} peak after NaOH 1% and 5% treatments can be attributed to the removal of lignins (C=O stretching in carboxylic groups).

SEM section observations were carried out on untreated and treated flax fabrics/epoxy composites (Fig.1). Pronounced defibrillation was observed for NaOH 5% (Fig. 1b) treated composite as well as a strong decrease of the transverse strength. At the same time, reduced porosity (black areas) was noticed for all treated composites.

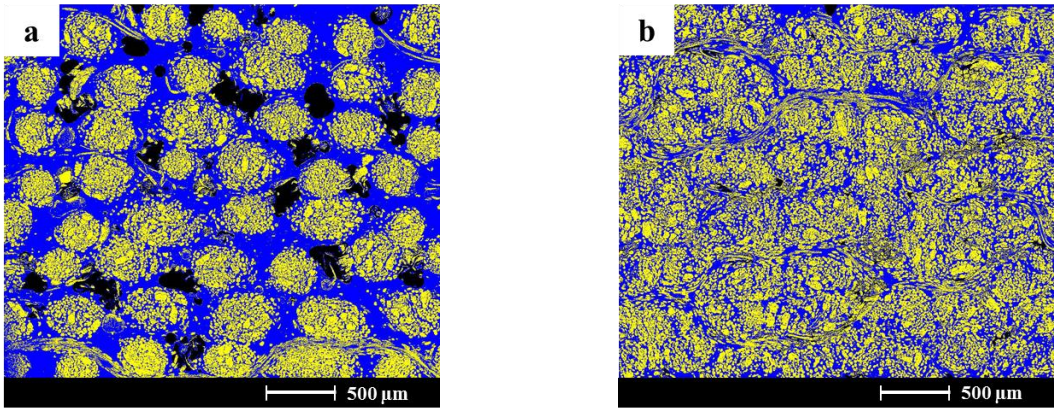

Fig. 1. SEM section images of a) untreated and b) NaOH 5% treated flax fabric/epoxy composite

Treatments used to remove flax fibre components modify the physico-chemistry and the texturing of flax fabrics. These modifications affect the morphology and the fibre / matrix interface as well as the intra-fibrillar interface within the fibre bundles, influencing the transverse mechanical properties of the composites.

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