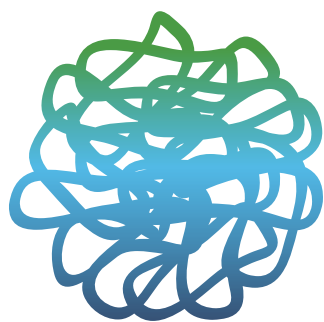




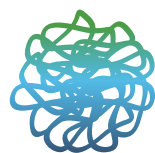
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ICNF 2019
4th International
Conference on Natural Fibers
Smart Sustainable Solutions

BOOK OF ABSTRACTS

Edited by R. Figueiro



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FOREWORD

The International Conference on Natural Fibers is established as a leading scientific event on fields related to natural fibers, from harvesting to its application in high demanding areas. Over the last 3 editions this event assumed a very important worldwide placement addressing and defining the most important trends in the field as an outcome of the high quality of the research works presented and the strong interaction among the participants.

Due to the increasing environmental concern and depletion of non-renewable resources, natural fibres are greatly enlarging their range of applications in different industrial sectors including automobiles, sports, architecture, design and many others. Consequently, extensive technological and scientific research and developments are being undertaken by various institutes and companies around the world, turning these amazing materials into eco-friendly added-value products and stepping towards a greener world.

ICNF2019 is dedicated to the topic "Smart and Sustainable Solutions". In fact, over the last few years, intensive research has been developed to turn natural fibers into smart solutions being able to respond to external stimuli, in addition to their intrinsic sustainable features. Besides, ICNF2019 is covering a wide range of trends defined for natural fibers, with particular emphasis on nanocellulose based fibers and structures, fiber surface treatments, functional natural fibers, smart natural fibers, environmental impact, ecocomposites, biomimetics, and, of course, product development based on natural fibers.

ICNF2019 is the meeting point for all those interested in these fantastic materials called Natural Fibers.

Guimarães, 27th June 2019

Raul Figueiro
Conference Chairman



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ASSESSMENT OF EXTENDED RETTED HEMP FIBRES FOR COMPOSITE REINFORCEMENT: FIBRE PROPERTIES AND ADHESION WITH POLYLACTIDE MATRIX

Laetitia Marrot^{1(*)}, Percy Festus Alao², Heikko Kallakas², Triinu Poltimäe², Jaan Kers²

¹InnoRenew CoE, Izola/Isola, Slovenia

²Department of Polymer Materials, Tallinn University of Technology, Tallinn, Estonia

(*)Email: laetitia.marrot@innorenew.eu

ABSTRACT

This study investigates the potential value of extended retted hemp fibres as a reinforcement of the polylactide (PLA) matrix. The hemp stems (Hungarian *Tisza* variety) underwent a particular retting consisting of harvesting them only 6 months after the end of cultivation, leaving them in a stand-up position for the whole autumn and winter seasons and part of spring in Estonia. Different hemp fibre surface treatments (water cleaning, sodium hydroxide in combination with silane) are conducted and their effects on the mechanical properties of the fibre and on the fibre adhesion with a PLA matrix are assessed.

INTRODUCTION

Natural plant fibres as reinforcement for composites have received growing interest from the scientific community for the last 15 years (Bourmaud, 2018). Industrial hemp (*Cannabis sativa L.*) is an annual crop that requires low input for its cultivation, and its fibres show interesting specific properties for the reinforcement of composites (Marrot, 2013). Nevertheless, the adhesion between natural fibres and thermoplastic matrices presents a challenge as the hydrophilic character of natural fibres induces a decrease in the interfacial contact between the natural fibre and the matrix polymer.

The hemp fibres (Hungarian *Tisza* variety) considered in this study were grown in Estonia, where, to date, there is no variety of hemp tailored for the climate. In Estonia, hemp is primarily cultivated for its seeds to produce oil. In this study, enhancing the knowledge of hemp fibres is a way to further promote their use in the Estonian industry and to find applications for the whole plant. The hemp stems underwent a particular retting consisting of harvesting them only 6 months after the end of cultivation, leaving them in a standup position for the whole autumn and winter seasons and part of spring in Estonia (Fig. 1). To the best of our knowledge, the effects of these conditions of retting on fibre performance have not been reported.



Fig. 1 Specific stand-up retting of hemp stems (*Tisza* variety)

This work considers the effects of various surface treatments on five batches of hemp fibres as summarized in Table 1. More specifically, the tensile properties of the fibres are determined and the interfacial shear stress with PLA matrix is assessed by pull-out tests. This direct measurement of the fibre/matrix bonding at the micro scale provides an accurate way to evaluate the impact of the fibre treatment on the adhesion with the matrix.

Table 1 Summary of the surface treatments included in the study

Batches	UH	WH	AlkH	WSiH	AlkSiH
Water treatment (72h at 23°C)		x		x	
Alkali treatment (5 wt%)			x		x
Silane treatment (3 wt%)				x	x

RESULTS AND CONCLUSIONS

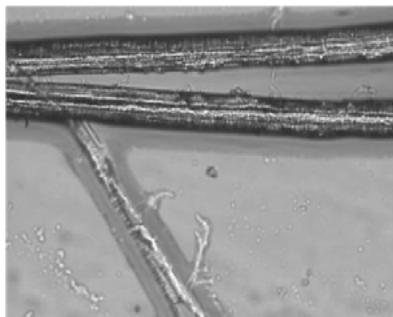


Fig.2 Untreated hemp fibre surfaces

The chemical composition of untreated fibres and treated fibres will be determined by extraction of polysaccharides and sugar analysis. These data, in correlation with the mass loss given by thermogravimetric analysis, the observation of the fibre surface with optical (Fig. 2) and scanning electron microscopes, the evolution of crystallinity of the fibres, and the creation of new chemical bonds detected by Fourier Transform Infrared Spectroscopy (FTIR), will allow assessment of the effectiveness of the chemical treatments.

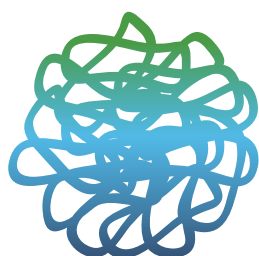
The effects of the treatments on the mechanical performance of the fibres will be investigated by tensile tests on fibre bundles. Finally, the impact of the treatment on the interfacial shear stress with PLA matrix will be assessed by pull-out tests, and the results will be compared with data obtained by debonding tests (Merotte, 2018). Based on the literature study (Liu, 2017), we expect an increase of the fibre adhesion with PLA matrix, which is essential for the enhancement of the mechanical properties of associated composites.

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