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Materials of the Future

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FOREWORD

The International Conference on Natural Fibers is established as the leading scientific event on fields related to natural fibers, from harvesting to its application in high demanding areas. Over the last 4 editions, this event has assumed a very important worldwide position, addressing and defining the most important trends in the field, as an outcome of the high quality of the research works presented and of the strong interaction among the participants.

With a very transversal view on the extraction, processing, functionalization and use of natural fibers, including linen, wool, silk, hemp and cotton, ICNF2021 focuses, in this edition, on the topic “Materials of the Future”, clearly assuming the fundamental role of these materials in building a more sustainable future. In fact, areas such as automobiles, aeronautics, fashion, civil construction, architecture or health-care, have been benefiting strongly from the scientific advances occurred in the last decades in this field, focused mainly on the combination of intrinsic characteristics associated with sustainability and the performance provided by these materials. Biocomposites for use in automobile and aircraft components, geotextiles for use in soil reinforcement, nanocellulose for use in medical devices and fibers for reinforcing construction mortars, are just some examples of fundamental themes for the use of advanced natural fibers. In this context, nanotechnology is also of particular importance in the search for the most appropriate solutions for specific applications, in a logic of multiscale analysis of materials, with a view to their manipulation at the nano, micro and macro scales. 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.

ICNF2021 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.

ICNF2021 is the meeting point for all those interested in these fantastic materials called Natural Fibers.

Guimarães, 14th May 2021

Raul Fangueiro
Conference Chairman

FUNCTIONAL PH-SENSITIVE CELLULOSE FABRIC DYED WITH BACTERIAL EXTRACT FROM STREPTOMYCES SP.

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ABSTRACT

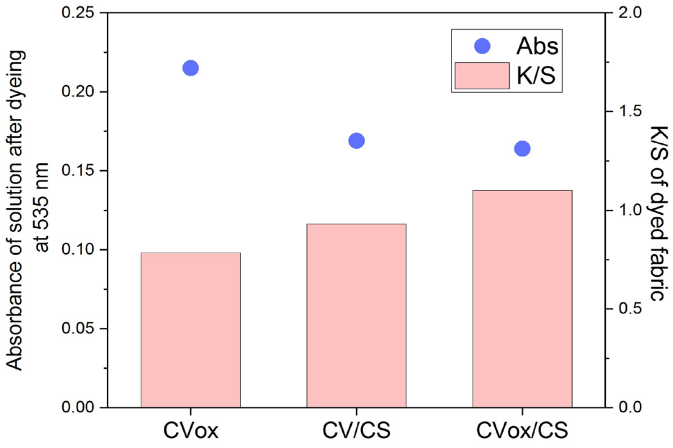
In this work, cellulose (viscose) was functionalized with chitosan and dyed with an extract of Streptomyces sp. NP4 bacterial culture. Cellulose was first converted to dialdehyde cellulose; afterward chitosan was deposited, making fabric susceptible to dyeing. The dyed fabric exhibited pH responsiveness in a broad range of pH, 4-7-10, where colour shade of the fabric, exposed to buffer solutions, was pink, red, and blue, respectively. Response to the pH change was measured in seconds, whereby faster colour shift is from blue to red/pink. The dyed fabrics can withstand 10 cycles of colour change. Due to the broad range of pH activity, the presented cellulose product has the potential to be used as a textile pH sensor, and, more importantly, it is completely made from natural and sustainable resources.

INTRODUCTION

Functionalization of cellulose textile materials is usually performed to introduce new functionalities and to obtain a new class of materials for special purposes. The pH-responsive textiles can have an important role as various sensors, i.e. for wound dressings, sweat, or detection of various compounds (Sun et al., 2015; Van der Schueren & de Clerck, 2012) and the development of cellulose-based pH-responsive textiles can contribute to the expansion of application areas for cellulosic materials. Prodigiosins, as bacterial secondary metabolites, have a very high affinity towards textiles and represent a diverse source of colouring agents for textiles (Stankovic et al., 2014). Extract derived from Streptomyces sp. NP4 however, does not have an affinity towards cellulosic material (Kramar et al., 2014). In this work, the hydroxyl groups of cellulose were converted to aldehydes using sodium periodate and afterward low molecular weight chitosan was deposited onto viscose fibres, making fabric susceptible to dyeing with NP4, due to the presence of aldehyde and amino groups on the surface of the fibres (Kramar et al., 2021). The samples used for dyeing experiments were marked as CV/CS (untreated viscose with chitosan), CVox (oxidized viscose), and CVox/CS (oxidized viscose with chitosan). Dyeing was performed at 85 °C for 60 min using 1 % o.w.f. of crude extract NP4. The UV-VIS spectra of residual dye baths were measured and absorbance at 535 nm was compared for different samples. The colour of dyed fabrics was measured using Spectrophotometer under illuminant D65 and 10° standard observer, and their reflectance was also determined. The intensity of the colour K/S was derived from reflectance value at 535 nm. For testing pH responsiveness, samples were placed in a buffer solution of pH 4, 7, and 10, dried and their colour was also measured.

RESULTS AND CONCLUSIONS

The absorbance measured after dyeing at 535 nm, and K/S values of the dyed fabrics are given in Fig.1 (left). As can be seen, the addition of chitosan onto cellulose fibres improves the exhaustion of the dye bath and causes the higher intensity of the fabrics' colour. The oxidation alone (sample CVox) increases the susceptibility to dyeing with NP4, knowing that pristine viscose is only stained, having K/S value ~0.2.



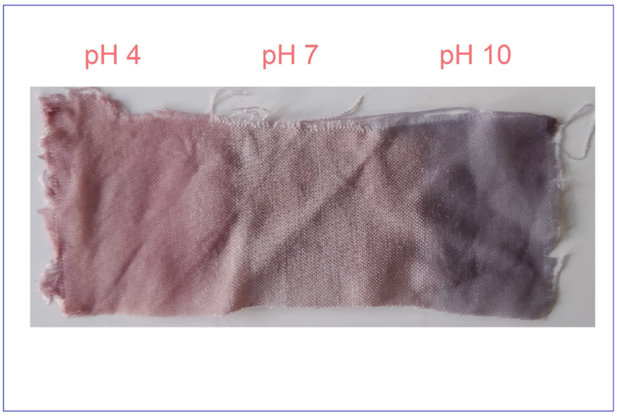


Fig.1 The absorbance of dyebaths after dyeing measured at 535 nm and corresponding K/S of dyed fabrics derived using Kubelka-Munk equation including the reflectances of samples at 535 nm (left); Photograph of the sample CVox/CS exposed to pH 4, 7 and 10

The photograph of the dyed sample CVox/CS and exposed to different pH buffer solutions is given in Fig.1 (right). This study shows that with functionalization of viscose by the introduction of aldehyde and amino groups on fibers surface, cellulose becomes susceptible to dyeing with NP4 and exhibits pH responsiveness in the wide range of pH 4-10.

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