UV LIGHT IN TEXTILE BLEACHING

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Abstract
Cotton fabrics are typically pretreated by many chemical steps. One of them is bleaching focused on improve the whiteness of textiles by oxidative chemical such as H_2O_2 or NaClO. In this study is this chemical technology replaced by UV light from different sources. The whiteness of treated cotton samples was measured. The time and other parameters of irradiation are optimized. The chemical damage of fibers is observed as well.
Key words: UV, bleaching, textile, TiO_2

1. Introduction

White of raw natural fibers is not acceptable for lot of application. We should improve the light reflection properties if we would like to use white cotton textile in clothing industry or in the dyeing to light shades. This process is cold "bleaching".
Before the 18th century was used for bleaching only the sun light which takes long time to increase the whiteness of textile. From the 18th century were used many chemical methods of bleaching based on oxidative or reductive chemical reaction in textile fibers. These chemical processes can be characterized as quickly and effective. The developed and optimized chemical technologies are used in this time in industrial scale.
This chemical bleaching process is not enough ecological, because we are using hard chemicals and we producing a lot of waste water.

In this study we observed the possibility haw to replace the standard bleaching technology by a new method, which is based on combination of original historic light bleaching and actual technical and chemical knowledge (especially the high effective UV sources and photocatalytic nanoparticles [1], [2]).

2. Experiment

Textile fabric

Experimentally were used 3 cotton fabrics with different areal weight and different woven structure. The description of fabric structure is in the tab. 1. All textiles are standard boiled before the experiments.

Table 1. Description of used textiles

sample	weave	areal weight $g.m^{-2}$	fineness of warp yarn TEX	fineness of weft yarn TEX
S	plain	70	20	20
N	plain	80	20	20
K	twill	235	50	35,5

Chemical bleaching

The standard technology of peroxide bleaching is applied on our samples. The peroxide solution with supporting chemicals (20 ml.l^{-1} 30% H2O2, 20 ml.l^{-1} water glass, 0.5 g.l^{-1} wetting agent) was applied by the boiling technology (pH 11, 1:50, 90°C, 60 min).

UV light bleaching

The samples were irradiated by different light sources wit different spectral characteristics in UV light (UVA, UVB and UVC). All used UV sources improved the whiteness of textilie, but the best results we obtain on high power source "ULTRAMED 400W" (OSRAM, Czech Republic). This UV source produced 88W in UVA and 8W in UVB. The spectral curve is presented in fig. 1. The textile samples were irradiated by the intensity 18,8 W.m^{-2} of UVA and 1,7 W.m^{-2} of UVB.

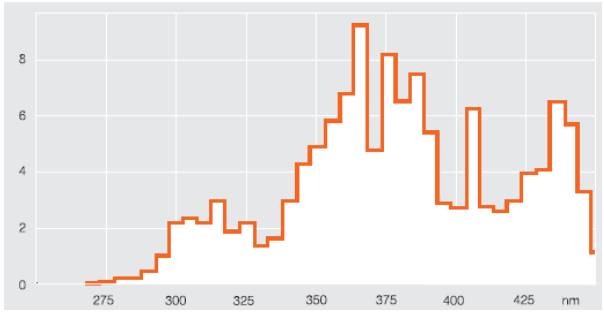

Figure 1. UV light emmision - ULTRAMED 400W (horizontal axis – wavelength, vertical axis – W.5nm^{-1})

ULTRAMED 400W was used for irradiation of textile samples at the set temperature 24°C. The samples were wet by distilled water during all time of irradiation.

In selected experiments we add nanoparticles of TiO_2 to used distilled water in concentration of 0,5 g.l^{-1}. These high photocatalytic nanoparticles with size 10 nm are prepared for this experiment in laboratory scale. Solution of these nanoparticles is transparent – without any interaction with visible light. The maximal light absorption on these nanoparticles is measured at the wavelength 310 nm.

Using of these TiO2 nanoparticles was based on the idea that the UV light will be used more effective in the system, because on these particles is the UV light easy transformed to chemical energy – to unstable radicals with high oxidative properties.

3. Results and discussion

The effect of bleaching technology on textile samples are evaluated from two different points of view: whiteness and damage of fibres.
The whiteness was calculated according the well-know Bergmann formula. This calculation is based on reemission properties of sample in visible light.
The damage of fibres was evaluated by the average polymerization degree (cuoxam viscometry method), quantification of α-cellulose (solubility in NaOH) and mechanical testing (elongation, initial module, strength).

The change of whiteness of textile samples by the UV light bleaching is presented in following Fig. 1 (short times of irradiation) and in Fig. 2 (long time of Irradiation). In both figures we can see that the whiteness of samples is increasing during the time of irradiation. This increase is more visible in short time of irradiation. The obtained whiteness is comparable with standard method of chemical bleaching – be the peroxide bleaching we obtain on this substrate whiteness 180.

Figure 2. UV light blaeching of textile (sample S) by ULTRAMED (squars are data obtained on TiO2 nanoparticles)

Figure 3. UV light blaeching of textile (sample S) by ULTRAMED (squars are data obtained on TiO_2 nanoparticles, triangle is nonirradiated sample)

On the other textile samples we obtained the similar results.

Damage of fibres in textiles by the bleaching methods was measured at the highest used time of irradiation (225 minutes). The results are compared with the standard peroxide bleaching method.

In all used methods (mechanical and chemical tests) we obtain comparable results – the chemical damage of fibres is not very high in all used methods and the change of fibres is similar in peroxide and UV bleaching. UV bleaching damages the fibres lighter, then the peroxide bleaching, but the obtained whiteness is not so high.

4. Conclusion

The UV light bleaching is useful methods to create high whiteness of textile without deeper damage if fibres. Time bleaching is comparable, but the chemical bleaching is easy to use in large scale.
The influence of photocatalytic nanoparticles is small, probably because the radicals are created only on the surface of fibres.

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