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Dyeing of cotton and polyester blended fabric previously cationized with synthetic and natural polyelectrolytes

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Abstract

In this work, a plain weave composed by 50% polyester and 50% cotton (PES/CO) was functionalized by using two polyelectrolytes, in order to modify its surface to provide a dyeing with an uncommon dye class for cotton and polyester fibers. Several techniques of characterization were used to study the effects caused by the interaction between polyelectrolytes (Chitosan and PDDACl) and PES/CO fabric, such as: X-ray Photoelectronic Spectroscopy (XPS), dye solution drop absorption, Scanning Electron Microscopy (SEM) and whiteness by Berger degree. Good results of dyebath exhaustion with excellent values of color strength were obtained for the samples previously treated with PDDACl and Chitosan polyelectrolytes. These promising results mean the possibility of obtaining distinct and solid colors that cannot be obtained with the use of dispersed/reactive dyes, besides generating a lower energetic cost with the use of lower times and temperatures than those normally used to PES/CO dyeing process.

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Keywords: cotton; polyester; blending; polyelectrolytes; dyeing; functionalization

1. Introduction

The approval of polyester/cotton blended fabrics is increasing day by day because of their ease of use. Polyester

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has performance qualities, like wicking and quick-dry properties, so may be added to make the cotton absorb sweat better. On the flip side, polyester is not breathable and cotton is, so by blending the two materials, you can get a fabric that is both breathable and sweat-resistant. Thus, the selection of such fibers offer sufficient comfort level and better resistance due to the different properties of materials. However, the presence of both polyester/cotton substrates in textile causes difficulties in the dyeing process [1]. Polyester/cotton blends are dyed mainly by two dyeing bath methods using appropriate dyes and chemical auxiliaries. This dyeing method is relatively long and complex. Polyester and cotton are dyed under completely different parameters. Cotton is dyed by employing alkaline conditions at 60 ºC or 80 °C and using reactive, direct or vat dyes whereas polyester is dyed using disperse dyes in an acidic medium at 120 °C or 130 ºC. This two bath processes, despite offering high levels of shade reproducibility, are time consuming, often taking 12 - 14 hours [2]. The attractiveness of the application of new fibrous materials and functionalities has not stopped growing in recent years. Currently, various techniques and products have been used in order to modify the surface of textiles to create materials with new properties and there are numerous scientific works that show this reality [3-6].

The continuous search for new solutions has created great opportunities to enhance the value of traditional textile substrates, through the increment of different functionalities, development of new fibers [4] structures [5], finishes [6] or even by surface modification by use of physical or chemical processes [7-9]. Despite its undeniable importance, the textile industry is known for being extremely polluting, mainly due to chemical procedures in the finishing processes (bleaching, dyeing, printing, among others), which generate higher wastewater rates. Therefore, it is essential to find solutions that result in the reduction of pollution load or even diminish the cost with energy and chemical products of the previously cited textile processes. Among the causes for the high rate of effluent are the enormous finishing processes and low dye absorption into the fibers. Thus, modifications of fibrous substrates aims at decreasing the time and temperature of procedures or even to increase the dyebath exhaustion are extremely important. Using polyelectrolytes agents might be an interesting alternative allowing the modification the fibers' surface without altering their bulk properties.

In this paper, polyester/cotton (PES/CO) plain fabric was functionalized by applying two polyelectrolyte, with the main objective to dye the substrate using only one type of anionic dye and lower temperature process than the conventional one.

2. Materials and methods

A plain weave fabric (50%PES+50%CO) with 98 $g.m^{-2}$ was used in this study. The poly (diallyldimethylammonium) chloride (PDDACl) applied to functionalize the fabric is a polyelectrolyte with low to medium molecular weight, between 200.000 – 350.000 (average), has neutral pH and is soluble in water (Technical data: Textilchemie Dr. Petry GmbH .

Chitosan with a degree of 70% deacetylation was supplied by SelachiiInd.com.ImpE.Exp.Ltda (Fortaleza-CE, Brazil), solutions with concentration of $10g.L^{-1}$ were prepared to be used to functionalize the fabric. Fig. 1 illustrates the chemical structure of the natural and synthetic polyelectrolytes used.

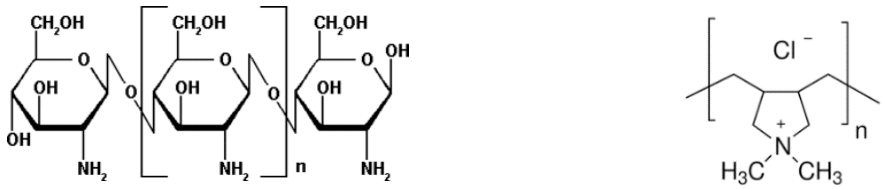

Fig. 1: Chemical structures of Chitosan and PDDACl.

The functionalization with different parameters (time, temperature and concentration) and the dyeing processes were performed through the use of BMA-B MATHIS equipment with automatic heating system.

Fig. 2 shows the scheme used for the cationization process and the graphic used to dye the PES/CO substrates.