Soil-release behaviour of polyester fabrics after chemical modification with polyethylene glycol

T M R Miranda[1,2], **J Santos** [1,2] **and G M B Soares** [1,2]
[1]Minho University, Centre for Textile Science and Technology, Guimarães, Portugal
[2] University of Minho, Department of Textile Engineering, Guimarães, Portugal
E-mail of the Presenting Author: tmiranda@det.uminho.pt

The ease of cleaning the fibers depends, among other characteristics, on their hydrophilicity. Hydrophilic fibers are easy-wash materials but hydrophobic fibers are difficult to clean due to their higher water-repellent surfaces. This type of surfaces, like polyester (PET), produce an accumulation of electrostatic charges that adsorbs and retain dirt. Thus, the polyester soil-release properties can be increased by finishing processes that improve fiber hydrophilicity [1, 2].
In present study, PET fabric modification was described by using polyethylene glycol (PEG) and dimetilol dihidroxy ethylene urea chemically modified resin. Briefly, the modification process was carried out in two steps, one to hydrolyse the polyester and create hydroxyl and carboxylic acid groups on surface and the other to crosslink the PEG chains. The resulting materials were characterized by contact angle, DSC and FTIR- ATR methods. Additionally, the soil release behavior and mechanical properties of modified PET were evaluated. For the best process conditions, the resulted PET presented 0º contact angle, stain release grade of 5 and acceptable mechanical performance.
Keywords: Soil-release; PET fabric; polyethylene glycol

Materials and Methods

A 100% polyester fabric was purchased from Lemar (Portugal). PEG (average molecular weight 1000 and 2000) was purchased from Merck (Portugal), Adipret P-LF was used as a crosslinking agent and kindly offered by ADI Group (Portugal).
PET samples were impregnated with the aqueous solution containing different concentrations of the modified DMDHEU (60 g/L and 120 g/L) and constant concentration of PEG (250 g/L) with average molecular weight 1000 or 2000. In a first approach, after impregnation, the samples were dried during 7 minutes at 60 ºC and cured for 3 minutes at 160ºC. Then, they were washed and dried during 24h.
Another attempt was made where the samples the samples were first dried at room temperature, then cured 90 s at 180ºC and finally washed and dried during 24h. Before being analysed, all fabrics were stored in conditioned atmosphere (20± 2ºC and 60% of relative humidity) during 24h, according ISO139:1977.
The thermal parameters of the fabrics were measured with a DSC – 822^{e} instrument (Mettler Toledo). The FTIR-ATR analyses were made on Fourier–transform infrared spectrophotometer Nicolet-Avatar 360. Zinc selenide was the ATR crystal material used in this work. The ATR correction was made with OMNIC 5.2 software (Nicolet, Izasa, Portugal). Angle of contact were carried out on system OCA 15 Plus, DataPhysics Instruments GmbH. Soil release tests were performed according AATCC Test Method 130-2000. Mechanical properties were evaluated according ISO Test Method 13934. These tensile strength tests were performed by Hounsfield Tester, model H1OKS.

Results and conclusions

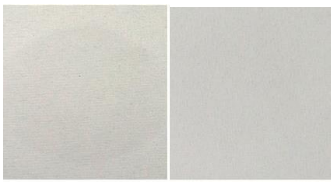
The modification process was studied in terms of PEG and resin concentrations and process conditions. It was observed that the dry process at 60ºC results in PEG degradation as described by J. Glastrup [3]. He noted that polyethylene glycol degradation can occur under air stream at 70°C, with formation of formic acid. Under dry conditions this acid reacts with the terminal hydroxyl group of the PEG, resulting in formic acid esters. Under wet conditions the acid stays in solution or evaporates. Therefore, the dry step previously described by T. L. Vigo and J. S. Bruno [4], in their polyester modification process with DMDHEU and adopted in our first trials was changed by a simple room temperature dry process. The best polyester saponification conditions were obtained with NaOH 3M, 55 ºC and 30 minutes of reaction time. In addition, the modified polyester with better conjugation of properties was obtained with PEG 2000 (250g/L) and resin (60g/L) applied by pad-dry-cure using 90% of wet-pick up and curing at 180ºC during 90s. The dynamic behavior of the contact angle for a drop of distilled water on the surface of PET samples is shown in Figure 1**.**

a) b)

Figure 1. Dynamic contact angles (θ) of water drop on the PET surface of a) untreated polyester b) PET fabric treated with PEG (2000) and modified DMDHEU (60 g/L).

The increasing in the hydrophilicity of treated PET surface was confirmed by decrease of contact angle from 99º to 0º.

The treated PET samples showed soil-release properties better, changing from 3-4 grade in case of original PET to 5 for treated PET fabric with PEG (2000) and modified DMDHEU (60 g/L) (Figure 2).



a) b)

Figure 2. Soil-release of samples a) untreated polyester b) PET fabric treated with PEG (2000) and modified DMDHEU (60 g/L).

Besides that, the tensile strength wasn't changed significantly.

Acknowledgments

Programme - COMPETE and by national funds through FCT – Foundation for Science and Technology within the scope of the project POCI-01-0145-FEDER-007136.

References

[1] Takke V, Behary N, Perwuelz A, Campagne C, 2011 *Journal of Applied Polymer Science* **122** 2621

[2] Butola, B S 2008 Polyesters and polyamides ed B L Deopura, R Alagirusamy, M Joshi, B Gupta (Woodhead Publishing Limited Cambrige England) chapter 12 pp 333

[3] Glastrup J 1996 *Polymer Degradation and Stability* **52** 217

[4] Vigo T L and Bruno J S 1987 *Textile Research Institute* **57** 427

Corresponding author:
Teresa MIRANDA
Minho University, Engineering School, Textile Engineering Department
E-mail: tmiranda@det.uminho.pt