ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

BINDER INFLUENCE ON KNITTING FABRICS TREATED WITH PCMs BY PADDING

DIRLIK UYSAL Çagla Dilara, BOU-BELDA Eva, BONET-ARACIL Marilés, MONTAVA Ignacio, DÍAZ-GARCÍA Pablo

[1,] *Universitat Politècnica de Valencia, Alcoy (Alicante), SPAIN*

Corresponding author: M. A. Bonet, maboar@txp.upv.es

Abstract: *Knitting fabrics are characterized by the confort they confer on the wearer. Textiles with mcirocpsules are bocoming more popular and nowadays Phase Change Materials (PCM) are used for thermal control and to avoid temperature changes to be clearly noticeable. Consequently, they can control variations in temerpature and make the user feel more confortable. Washing durability and rigidity are very important when considering fabrics treated with microencapsules. In this study we first aimed to study what influence has the resin concentration with the durability of microencapsules on the fabric after having washed it and its confort. To observe the presence of microcapsules after washing procedure the scanning electron microscopy (SEM) was used. SEM analysis showed different density of microcapsules with PCMs depending on the binder concentration used. It could be clearly noticieable that 5times washed fabric and 10times washed fabric still show microacapsules on it. On the other hand we used padding method for the application of PCMs into the fabris and this study put forth the binder effect on rigidity. We have demonstrated that when we increase the binder concentration for padding bath, after 10^{th} laundry cycles for the same fabric, we still have microcalsules on it. On the other hand, density of binder effect negatively influences on rigidity of the fabric.*

Key words: *Microencapsulation; Phase Change Material; Functional Textiles; Rigidity; Washing Durability; SEM.*

1. INTRODUCTION

Since the end of the 1980s, functional textiles have been developed to enhance textile performances according to the consumers' demand and to include a large range of properties with a higher added value. One possibility to manufacture functional or intelligent textile products is the incorporation of microcapsules as a finishing of textile. Many substances can be encapsulated for potential textile applications [1]. One of these substances, phase change materials (PCMs), has been used to manufacture thermoregulated textiles to improve thermal comfort of the wearer [2]. One of the methods to obtain textile materials with the thermoregulating properties is the use of the microcapsules containing phase change materials (M-PCM). Microcapsules are made of polymer shell and PCM core, which bidirectionally changes physical state in the specified temperature range [3].The design and development of a functional textile providing an ability of dynamic heat regulation next to the skin have attracted more and more attention in recent years.[4] This property obtained by microencapsulated PCM in textile material and in this study microcapsules with PCM is aplicated by padding method into the fabric.

The step of encapsulation allows manufacturing textile containing microcapsules by various ways to fix the microcapsules within the fiber structure permanently, to embed them into a binder or to mixed them into foam [4,5]. They will remain thermally effective as long as the coating or the fibers stay intact [6].

2. EXPERIMENTAL

We used a 100% cotton knitted fabric because of its comfort and good flexural rigidity properties. All cotton fabric samples were impregnated with four diferent solutions containing PCM. To study the behavior of the resin, PCM particles and acrilyc binder STK-100, suministrated by Color-Center, were used. We prepared four different solutions; these are shown in the table 1.

Table. 1*: Formulation used in each treatment.*

Samples	PCMs (g/L)	Resin (g/L)
4 JER P 50	50	0
4 JER P 50 10R	50	10
4 JER P 50 50R	50	50
4 JER P 50 100R	50	100

The samples were immersed in the aqueous solution and then were passed through squeeze rolls to give a specified pick-up, we obtained 80% in both treated samples. Treated samples were washed by following the Standard UNE EN ISO 6330 method no. 2A, during 5 cycles of washeing.

We evaluated the modification in the flexural rigidity of the treated cotton fabrics. It was measured according to UNE 40-392-79. The results obtained were the average of 10 measurements taken along the warp and weft directions and rigidity calculated according to the formulation shown below.

Flexual rigidity= 0,10 P c3 mgr. cm.

Rigidity total = (Ru x Rt)½

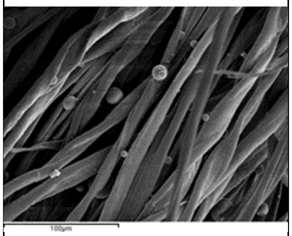
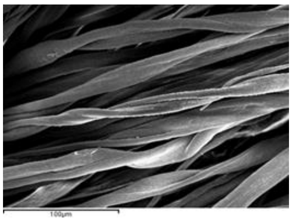
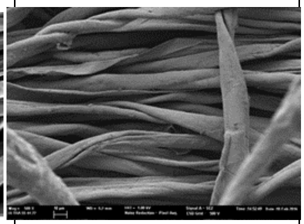
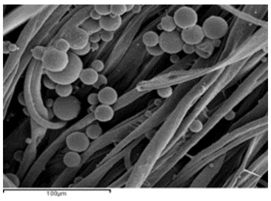
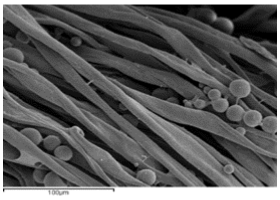
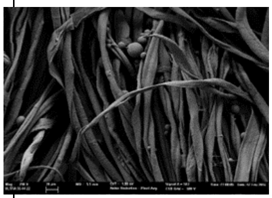
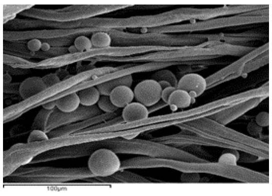
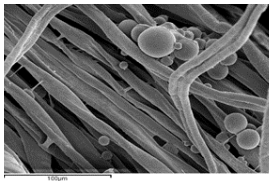
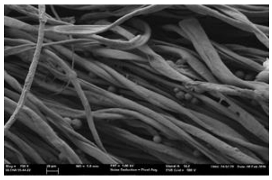
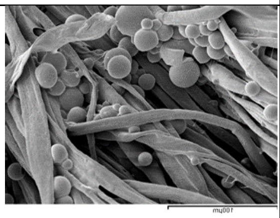
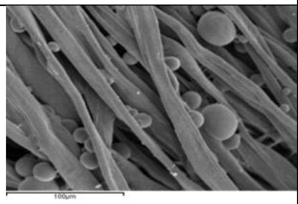
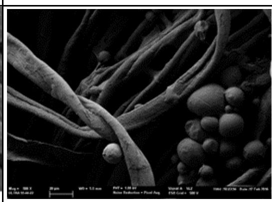
To verify the existece of silica particles on the fiber surface, treated samples were observed by a scanning electron microscope FEI model Phenom (Fei, Oregon, USA). Prior to sample observation, samples were covered with a gold–palladium alloy in a Sputter Coater EMITECHmod. SC7620 (QuorumTechnologiesLtd., EastSussex, UK). Samples were then examined with suitable accelerating voltage and magnification.

3. RESULTS

3.1. SEM RESULTS

We washed the fabric containing the micorocapsules up to 10 cycles and classified fabric three group as after 5th laundy, 10th cycles and without any laundry. By using SEM, we scanned all fabrics in order to monitorize the microcabsule density in fabric and we obtain below images in table 2 and its results are showns n this page.

Table. 2: *SEM images of fabrics with Mcs.*

FABRIC REFERENCE	Without laundry	5th laundry	10th laundry
4 JER P 50			
4 JER P 50 10R			
4 JER P 50 50R			
4 JER P 50 100R			

When we compare the SEM images, we can say tha when we increase the binder influence durin microencapsulation by padding, the washing durability increase. Up to 10th laundry we have still microcapsules in fabric.

3.2. FLEXUAL RIGIDITY

We evaluated the modification in the flexural rigidity and wrinkle recovery angle (WRA) from the treated cotton fabrics. It was measured according to UNE 40-392-79 and UNE EN 22313, respectively. Results showed the average of 10 measurements taken along both, the warp and weft directions.

Table 3: *Flexual rigidity of microencapsulated fabrics*

FABRIC REFERENCES	FLEXUAL RIGIDITY
4 JER P 50	22,42804209
4 JER P 50 10R	39,36339458
4 JER P 50 50R	45,46060312
4 JER P 50 100R	79,1204978

4. CONCLUSIONS

In this work we have tested the influence of binder concentration for pasting PCM on some confort paramters such as flexural rigidity. This value is directly related with the rigidity of the fabric and consequently its confort during its use. We have demonstrated that when we increase the binder concentration for padding bath, after 10^{th} laundry cycles for the same fabric, we still have microcalsules on it. On the other hand, density of binder effect negatively influences on rigidity of the fabric.

REFERENCES

[1] F. Salaüna, E. Devauxa, S. Bourbigot, P. Rumeaud, *” Thermoregulating response of cotton fabric containing microencapsulated phase change materials”,* Thermochimica Acta 506 (2010) 82–93.

[2] S. Mondal, Appl. Therm. Eng. 28 (2008) 1536–1550.

[3]. Alicja Nejman, Małgorzata Cieslak, Bogumił Gajdzicki, Bogna Goetzendorf-Grabowsk, Agnieszka Karaszewska, *”Methods of PCM microcapsules application and the thermal properties of modified knitted fabric”*, Thermochimica Acta 589 (2014) 158–163, June 2014

[4] . Nihal Sarier, Emel Onder, “*The manufacture of microencapsulated phase change materials suitable* for *the design of thermally enhanced fabrics*”, Thermochimica Acta 452 (2007) 149–160, 22 August 2006

[5] W. Bendkowska, in: H.R. Mattila (Ed.), Intelligent Textiles and Clothing, Woodhead Publishing Ltd, Cambridge, 2006, pp. 34–62..

[6] R. Cox, Chem. Fibers Int. 48 (1998) 475–479.