Comparison of Binder Influence and Rigidity on Knitting Fabrics Treated with PCMs by Padding and Coating

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Comparison of binder influence and rigidity on knitting fabrics treated with PCMs by padding and coating

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Abstract. Nowadays the majority of textile industries are not able to characterize or to study the process of adhering the microcapsule to the fibre's surface. There are various industrial processes to apply PCM's microcapsules, but determining optimal amounts of products, temperature, conditions and other process variables are an important challenge for the textile sector in order to achieve the highest depositions and retention of this type of microcapsules. This work is focused on determining and quantifying presence PCMs microcapsules when applied onto fabrics by two systems padding and coating and determining which method is the most effective. Also, the influence of the concentration of resin used in the formulation on the flexural rigidity of the fabric has been studied.

1. Introduction

In order to ensure thermal comfort of the wearer, clothing directly contacting to the skin has to have good thermoregulation properties. Various types of phase change materials (PCM) are used in the production of smart materials capable actively to control the temperature of the body. PCM have the capacity to absorb, store and release heat energy [1]. Textiles incorporated with the phase change materials, especially in the microencapsulated forms, may establish a microclimate surrounding the modified goods in the temperature ranges of the melting points of the employed phase change materials (PCMs) and so may meet the requirement for comfort.

The step of encapsulation allows the active substance to be integrated in a textile by coating, by impregnation or exhaust bath [2], or directly incorporated in different artificial fibers, e.g. polyacrylonitrile fiber, polypropylene fiber, or polyacrylonitrile-vinylidene chloride fiber. They will remain effective as long as the coating or the fibers stay intact [3–4]. Finishing a textile with long-term fragrance-releasing properties is a desirable commercial goal, as well as a significant textile chemical and engineering challenge.

In this study microencapsulated PCMs were applied into the 100 % cotton knitted fabric by coating and padding method. The effect of binder in washing fastness and rigidity behaviour from the fabric with microcapsules is compared for both coating and padding method.

2. Materials and methods

A cotton knitting fabric was used to evaluate the influence of system and formulation used to apply PCM's microcapsules. Knowing there is not any affinity between microcapsules and fibres, acrylic resin STK-100, supplied by Color Center, was needed to adhere them to the fibre.

PCM microcapsules were applied to the cotton fabric by padding and coating. To carry out the padding treatment a horizontal foulard was used with the conditions required to obtain a pick-up (bath absorption) of around 88–90%. The same formulation of microcapsules was used to treat samples with coating process. But in this case, it is necessary to apply in each coating formulation 3 g/L of thickener in order to increase the viscosity of the bath.

Treatments of the cotton fabrics were made using different baths containing the binder and the microcapsules at different concentrations (table 1).

Table 1. Formulation and system used to treat different sample with PCMs

Samples	System	PCMs (g/L)	Resin (g/L)
4 JER P-50	Padding	50	0
4 JER P-50-10R		50	10
4 JER P-50-50R		50	50
4 JER P-50-100R		50	100
4 JER-C-50	Coating	50	0
4 JER-C-50-10R		50	10
4 JER-C-50-50R		50	50
4 JER C-50-100R		50	100

After the treatment, samples were dried at 80º C for 10 min, and were cured at 110º C for 5 min.

Treated samples were washed by following UNE EN ISO 6330 method no. 2A, 10 cycles of washes were carried out.

For surface observation, a scanning electron microscope (SEM) Phenom microscope (FEI Company) was used. Each sample was fixed on a standard sample holder and sputter coated with a gold - platinum mixture. Samples were then examined with suitable accelerating voltage and magnification.

In order to determine the quantity of the microcapsules lost from the fabric after 10 washes, waste water of each laundry was analyzed with a Coulter Counter apparatus (Multisizer Z2, Coulter Electronics).

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 below formulation.

- Flexural rigidity= 0,10 P c3 mg. cm.
- Rigidity total = (Ru x Rt)½

3. Results

To check the presence of microcapsules on surface fibre of the treated fabrics and each one after 5 and 10 washes, some images from SEM were taken of the fabrics that have been studied in this project. In figure 1, we can appreciate that there are some differences in the microcapsules that remain on the fabric

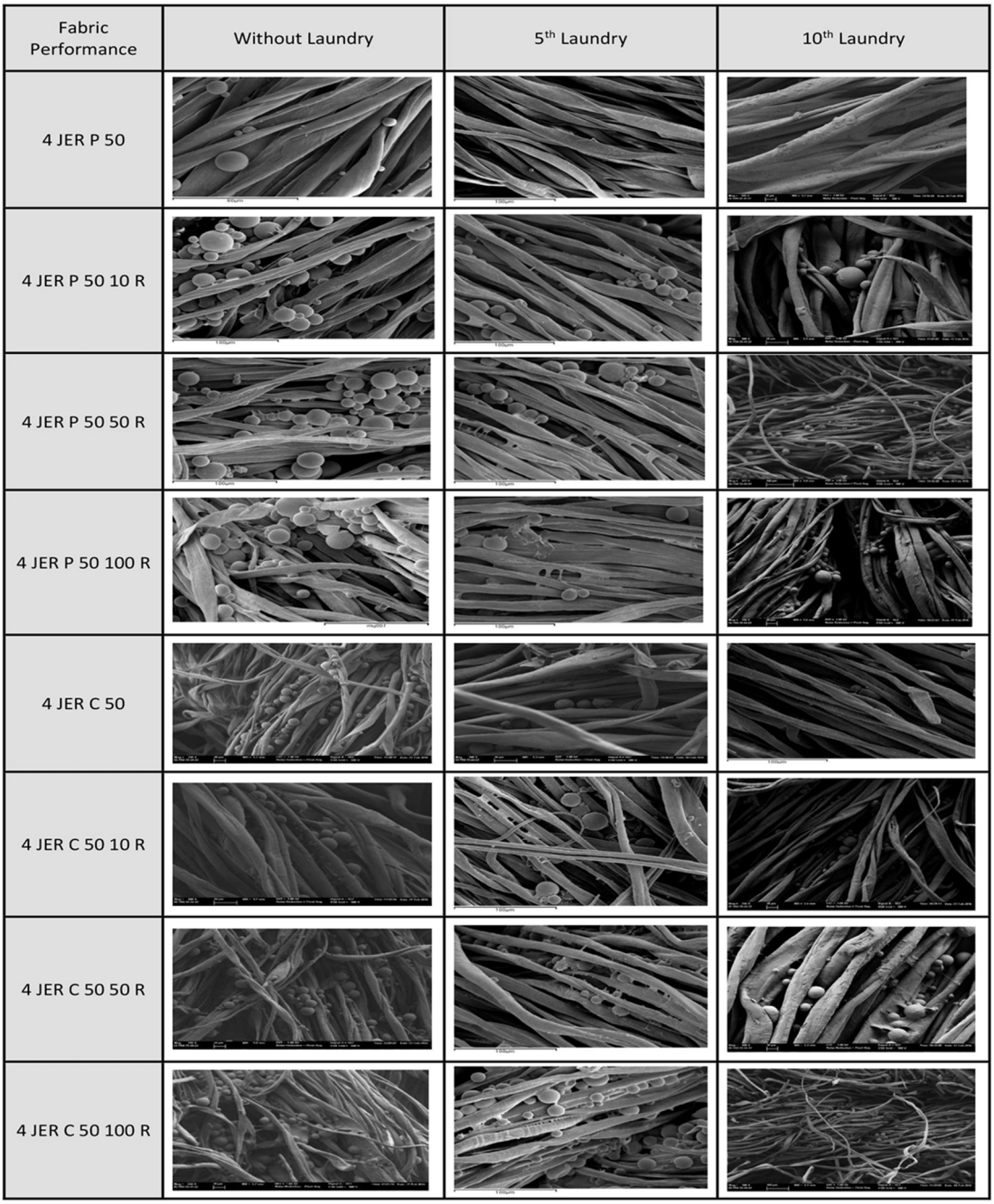

Figure 1. SEM images of cotton fabric after different treatments using padding and coating method and washed samples, 5 and 10 times.

SEM images show that both systems used, padding and coating, get to apply PCM microcapsules into the fabric successfully but after laundries most PCMs are lost. It can clearly be seen that coated samples show PCMs even after the 10th laundry, whereas there is no trace of microcapsules on the fibre after 10 washes when the fabric is treated by padding.

When the analysis is focused on the quantity of resin which has been added to the fabric, we can appreciate the effect that resin produces. A higher quantity of resin added to the padding bath, leads to fewer microcapsules going out of the fabric. It means that the resin works as a good adhesive to join the microcapsules to the fabric.

When we analyze wastewater from each washing, we can find the quantity of microcapsules that remain in the bath by particle measurement, so we can know how many microcapsules go out of the fabric. Figure 2 shows the amount of microcapsules that were found in the bath of 10 washes related after different treatments.

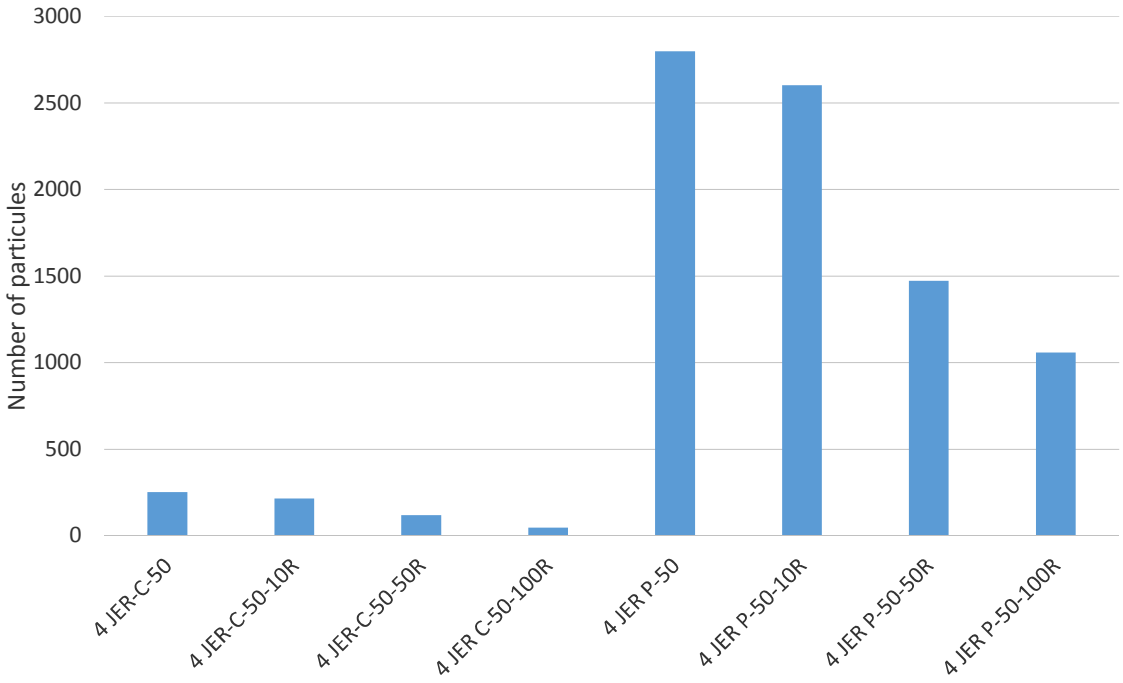

Figure 2. Total number of particles loss after 10 laundries for each treatment

It can be appreciated that the number of microcapsules that have been lost from the fabric is higher when the fabric is treated by padding than when the fabric is treated by coating. On the other hand, in both cases the number of microcapsules that goes out is lower when a higher concentration of resin is added in the treatment.

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. The results, table 2, show that using higher concentration of binder, the flexural rigidity is increased for both methods used to apply PCMs, padding and coating.

Table 2. Flexural rigidity of microencapsulated fabrics

FABRIC REFERENCES	FLEXUAL RIGIDITY (mg. cm)
4 JER P-50	57,72
4 JER P-50-10R	56,70
4 JER P-50-50R	109,25
4 JER P-50-100R	104,87
4 JER-C-50	39,63
4 JER-C-50-10R	42,72
4 JER-C-50-50R	49,22
4 JER C-50-100R	60,29

4. Conclusion

The experimental results, which have been taken by Coulter Counter and SEM, verifies that in both methods, coating and padding, increasing the concentration of binder in the bath treatment, the lost of PDM's after different laundries is lower. However, the concentration of binder used has a negative effect on rigidity of fabric. On the other hand, washing fastness is much better when the treatment is carried out by coating than by padding method.

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