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# IMPROVEMENT OF MICROCAPSULES ADHESION TO FABRICS

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# IMPROVEMENT OF MICROCAPSULES ADHESION TO FABRICS


## ABSTRACT

The presence of microcapsules has increased in textile field. They have been applied as a possibility to introduce new products to textiles such as fragrances, antibiotic, skin hydrant, etc. This work studies the resin influence on the adhesion of microcapsules to cotton fabrics. To paste microcapsules to fabrics, they should be in contact with a bath which contains microcapsules resin and water. Different resin concentrations were applied to fragrances microcapsules bath by impregnation. The research was focused to determine the influence of resin quantity in the microcapsules resistance to go out from the fabrics while washing treatments. Two experimental techniques, Scanning Electron Microscopy (SEM) and Counter apparatus, are used in order to determinate this influence.

We can conclude that with higher quantity of resin, more microcapsules remain on the fabric surface. It is shown than longer microcapsules go out from the fabric faster than the little ones.



## KEY WORDS

Adhesion

Resin

Microcapsules

Fabric

Cotton

## 1.- INTRODUCTION

Microencapsulation technology has been improved because there are a wide range of applications such as food and other business sectors. The number of commercial applications of microencapsulation in the textile industry continues growing.

The move by the more developed countries into textiles with new properties and added value (into medical textile and other technical textiles for example) has encouraged the industry to use microencapsulation processes as a means of imparting finishes and properties on textiles which were not possible or cost-effective using other technology [1].

Textile manufacturers are demonstrating an increasing interest in the application of durable fragrances to textile as well as skin softeners. Other potential applications included, insect repellents, dyes, vitamins, antimicrobials, phase change materials and in specific medical applications, antibiotics, hormones and other drugs [2-5]. The microcapsules active material is released, when the microcapsule shell is broken, and then the active material, and it can be smelt or goes in contact with the skin.

When microcapsules are applied on the fabric, producers try to develop a fabric which can offer to users some new properties than non treated ones. Fabrics are made of fibres and functionality is not inherent to fibres, it should be introduced by finishing treatment with microcapsules. Thus, it is necessary to determine the way microcapsules can remain on the fabric as much as possible.

Usually microcapsules shell, is not a reactive agent that can react with the fibres. Because of that, we need to make them adhere to the fibre by means of a resin, otherwise they will be lost.

Microcapsules are not appreciated by human eyes. Some characterization techniques have been applied to study microcapsules product [6-8]. They can be seen by means of Scanning electron microscopy (SEM), what reveals the surface of fabric increasing the surface over 2000 times. Nevertheless, it is not easy to quantify the quantity of microcapsules on the fibre surface. They should be counted one by one, which is not quite useful. In this work, we try to check the adhesion of microcapsules to the fibre, and to determine the application procedure that allows them to remain on the fabric longer.

The aim of this work was focused to determine the resin influence on the presence of microcapsules on fabric surface after washing cycles were applied to. Therefore we treated the fabrics with some domestic washing cycles, and analyze the way microcapsules go out from the fabric surface by means of image analysis or by counting the particles ant their size in washing baths.

## 2.- MATERIALS AND METHODS

### *2.1.- Materials*

Microcapsules (CENTER FINISH 164/01 MT) were supplied by COLOR CENTER (Tarrasa, Spain). The wall material was melamine formalin, and the microcapsules contained peppermint fragrance. No further information was supplied by the provider, as companies disclose as little information as possible. In order to bond the microcapsules to the fabric, an acrylic resin (CENTER FINISH BC) was applied, also supplied by Color Center.

The fabric used was a 100% cotton twill 210 g/m$^2$, which had been chemically bleached with peroxide in an industrial process.

### *2.2.-Methods*

Commercial microcapsules were applied to the surface of the fabric by padding. In the finishing process a resin was used as a binder. As a result thermal treatment in the form of hot air was applied to cure the resin and to induce adhesion of the microcapsules to the fabric. Fabric sample were obtained by padding what allows to impregnate fabric. We used a 2608 TEPA foulard. The bath treatment for padding  comprised different resin concentrations (0, 5 and 10 g/L), and 60 g/L of microcapsules in all baths. Foulard is the machine used for padding and its work was performed in order to obtain a pick-up (bath absorption) of around 89–90%. Samples were thermally fixed in a scale pin stenter at different temperatures for 10 min in WTC BINDER 030.

Microcapsules commercial products are a dispersion of microcapsules on a fluent. Samples were shaken gently for resuspension of eventually sediment particles just before measurements. Microcapsules dispersion was diluted with a balanced electrolyte solution (ISOTON II-pc, Beckman Coulter Inc., USA) in order to determine microcapsules size and quantity.

The particle size distribution of the microcapsules was measured by a Coulter® Counter apparatus (Multisizer Z2, Coulter Electronics, Northwell, UK). The particle size was expressed as the equivalent volume diameter and two replicates were performed for each batch of microcapsule, to reduce error an average curve was calculated and analysed.

For surface observation, a JEOL JSM-6300 scanning electron microscope (SEM) was used. Each sample was fixed on a standard sample holder and sputter coated with gold. Samples were then examined with suitable acceleration voltage and magnification.

## RESULTS

In order to determine the quantity of microcapsules that were left on the fabric, we analyzed the bath we used to treat samples before padding. We determined that there were 444,110,000.00 microcapsules in 1L of liquor padding with a concentration of 60 g/L of microcapsules. As we know the pick up (increase of weight because of water in fabric) of every sample, and the gramaje of them (210 g/m$^2$) we can calculate the quantity of microcapsules which are on the fabric surface, as expression one indicates.

$$MICS\ \ DISTRIBUTION = \frac{PICK\ \ UP(\%)\ \ \ \times\ \ \ MICS\ \ IN\ \ A\ \ LITTER\ (number)}{1000} \times \frac{gramaje\ (g/m^2)}{100}$$

Where "mics distribution" equals the number of microcapsules on surface area (number/ m$^2$). "Pick up" indicated de percentage of bath that fabric absorbs (mL/100 g). "Mics in a litter" is assigned to the number of microcapsules we calculated there should be in a litter of liquor padding (number), and gramaje equals the grams of fibre in a m$^2$ (g/m$^2$).

Table 1 shows the pick up for every sample and the quantity of microcapsules there should be for every sample. It has been calculated referred to the pick up and the quantity of microcapsules we calculated before for each mL.

Insert table 1 about here.

When we analyze wastewater from washing as standard ISO 105 C10 indicates, we could know the quantity of microcapsules that remain in the bath by particle measurement, so we can know how many microcapsules go out of the fabric and how they do it. Table 2 shows the quantity of microcapsules that were found in the bath related to the number of bath cycles samples have suffered. Results show measurements from cycle one to five, then we accumulate all microcapsules from six to tencycles and results are shown as 10 cycles. The same was done for treatments from eleven to 15 (shown as 15 cycles) and from 16 to 20 (shown as 20).

Insert table 2 about here

It can be appreciated that the number of microcapsules that goes out of the fabric is higher in the first washing cycle. We can observe wastewater of the first washing treatments present more microcapsules than in wastewater from more than 10 cycles. After 10 cycles, the quantity of microcapsules leaving the fabric is not so high and moreover it tends to be more or less constant.

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 less microcapsules going out of the fabric. It means that the resin works as a good adhesive to join the microcapsules to the fabric.

This information enables to figure 1 show the size distribution of microcapsules related to the number of washing cycles applied to the samples. Figure 1 shows results for 0 washing cycles.

Insert figure 1 about here

Figure 1 shows that the number of microcapsules that goes out in the first washing cycle is the highest one, as shown in table 2. Moreover, we can conclude that microcapsules with a high size leave the fabric more quickly (first washing cycles) than the little ones that remain on the fabric for more washing cycles.

To check these results, some images from SEM were taken from the fabrics that have been studied in this project. In figure 2, we can appreciate that there are some differences in the microcapsules that remain on the fabric. It can be seen in figure 2b that some filaments goes from one cotton fibre to other, which indicates the presence of resin, which can’t be observed in figure 2a because that sample didn’t present resin in the bath recipe.

Insert figure 2 about here

After the washing cycles, we can observe the presence of microcapsules on the fabric, but when resin was used, the quantity of microcapsules on the fabric surface is higher. Figure 3 shows the SEM analysis for cotton fabric with 20 washing cycles, and it is noticeable the higher presence of microcapsules when resin was used for pasting the microcapsules to the fabric.

Insert FIGURE 3 about here

Figures 2 and 3 show the influence of resin as a useful product to paste microcapsules to the fibre surface. When 20 washing cycles were applied to fabric, samples with 0 g/L in the recipe did not show microcapsules, on the other hand, when either 5 g/L or 10 g/L were used to paste microcapsules, fabrics still presented microcapsules after 20 washing cycles, figure 3b and 3c).

Obviously, the higher concentration of resin is used, the more quantity of microcapsules can be observed on the fabric. Nevertheless, we can observe in figure 3c), that some microcapsules are nor spherical at all. This shows the washing effect on microcapsules. When no resin was used, microcapsules went out from the fabric although they were not broken, when we use resin, we paste them to fabric and it avoids them to be lost so quickly with active product. They are pasted and we can observe washing effect. They have been deflated as they have lost the core partially, and do not allow observing them as a sphere.

## 4.- CONCLUSIONS

Microcapsules have been used on textiles for a long time, however their adhesion behaviour on fibres is not well known. Commercial brands usually use them as the supplier recommends without any control or testing because it is not easy to characterize how the microcapsules adhere to the fabric. Moreover authors know microcapsules products are relatively expensive.

In this work we established a fixed quantity of microcapsules and we varied the resin concentration in the padding bath. The purpose of the research was to evaluate the influence of the resin in order to make microcapsules remain more time on fabric.

The results show that if we do not use resin in the padding bath, we can get microcapsules on the textile fabric until approximately 10 washing cycles. On the other hand, when 10 g/L of acrylic resin were used, microcapsules were still on the fabric after 20 washing cycles. It should be noted that the microcapsules were not in perfect conditions as some of them were partially deflated because part of the fragrances that were inside the microcapsules was lost. Resin quantities higher than 10 g/L are not recommended by commercial brands because it changes fabric hand.

As we studied the way microcapsules leave the fabric, we have demonstrated that the total quantity of microcapsules going out from the fabric in the washing process decreases when resin concentration increases in padding bath. We can observe that the microcapsules that go out from the fibres in the first washing cycles are the bigger ones, and latter go out the ones with less volume. We observed that in the first five cycles a big quantity of microcapsules leave the fabric, but after 5 washing cycles it can be considered more or less constant until 20 washing cycles.

As the core of the microcapsules is a fragrance, we can confirm that fabrics still smell peppermint after 20 washing cycles. It means that although there are little microcapsules on the fabric and these are partially filled, the active material is still on the fabric and can be appreciated by the user.

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## FIGURE CAPTIONS

Figure 1.- Particle size distribution on a function of the number of washing cycles. Cotton fabric without resin. Number = number of microcapsules. 1L= 1 cycle; 2L=2 cycles; 3L=3 cycles; 4L= 4 cycles; 5L=5 cycles; 10L= 10L cycles; 15L=15 cycles; 20L=20 cycles.

Figure 2. Cotton fabrics with microcapsules. a) 0 g/L of resin. b) 10 g/L of resin.

Figure 3. SEM images form cotton fabrics after 20 washing cycles. a) 0 g/L of resin. b) 5 g/L of resin, c) 10 g/L of resin.

**FIGURES**

Figure 1

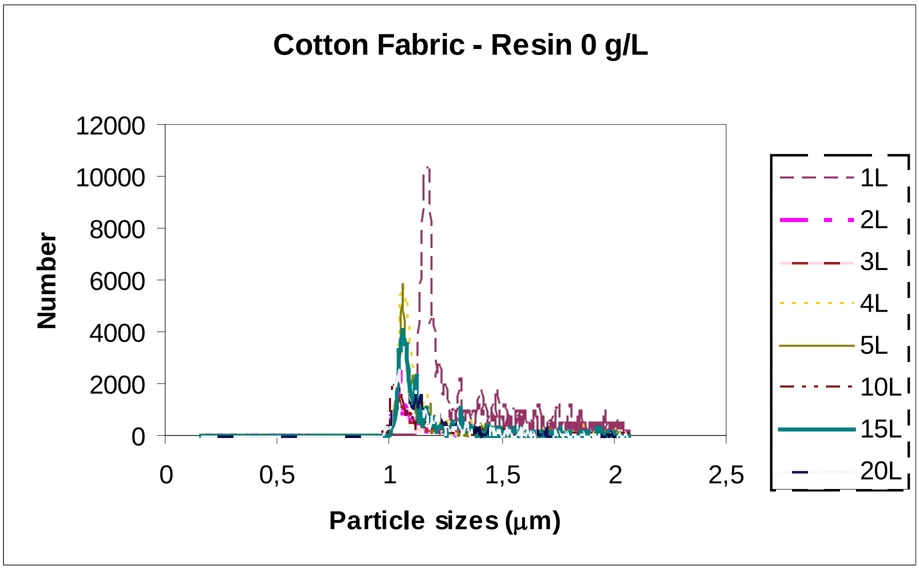


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FIGURE 2

a) b)

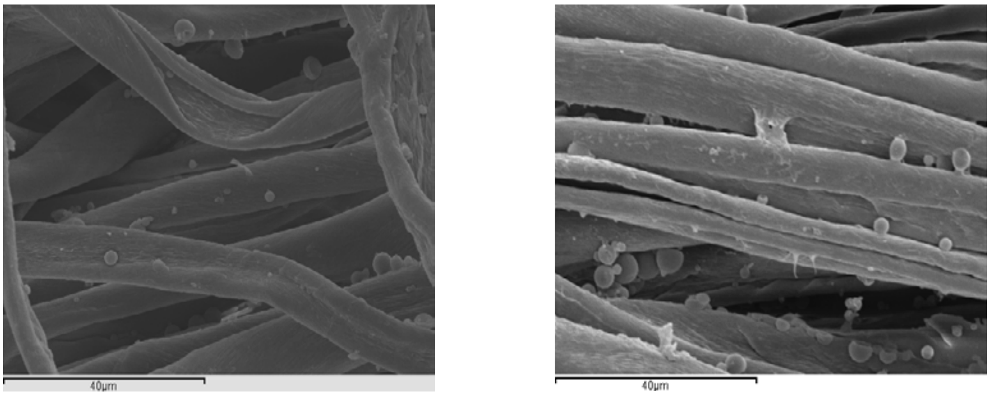
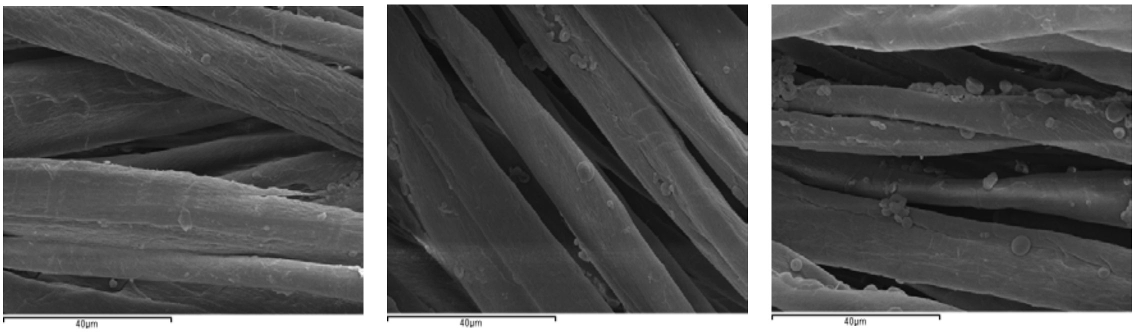



Figure 2. Cotton fabrics with microcapsules. a) 0 g/L of resin. b) 10 g/L of resin.

FIGURE 3



a) b) c)

Figure 3. SEM images form cotton fabrics after 20 washing cycles. a) 0 g/L of resin. b) 5 g/L of resin, c) 10 g/L of resin.

## TABLES

Table 1.- Microcapsules on fabric surface after treatment with resin.

| SAMPLE | RESIN (g/L) | PICK-UP (%) | MICROCAPSULES (NUMBER/$m^2$) |
|---|---|---|---|
| Co1 | 0 | 93.08 | 86.809.293 |
| Co2 | 5 | 84.15 | 78.480.899 |
| Co3 | 10 | 95.71 | 89.262.113 |

Table 2.- Microcapsules leaving out of the fabric surface after washing cycles.

| WASHING CYCLES | Co1 (0 g/L) | Co2 (5 g/L) | Co3 (10 g/L) |
|---|---|---|---|
| 1 | 166,038 | 26,928 | 9,627 |
| 2 | 26,179 | 14,404 | 3,420 |
| 3 | 18,258 | 3,666 | 1,985 |
| 4 | 57,163 | 6,179 | 2,952 |
| 5 | 49,557 | 9,535 | 3,639 |
| 10 | 27,909 | 3,693 | 3,639 |
| 15 | 51,545 | 4,530 | 4,041 |
| 20 | 43,943 | 5,201 | 4,546 |