

Cosmetic Textiles: Concepts, Application and Prospects

Haifeng Shi and John H. Xin*

Institute of Textiles & Clothing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China

*Tel: (852) 2766-6474; Fax: (852) 2773-1432; E-mail: tcxinjh@inet.polyu.edu.hk

Abstract

Clothes have always fulfilled a variety of functions – be it fashion, warmth, protection or support. In recent years, however, the cooperation between physicians, surgeons, microbiologists, physiologists and textile scientists has produced a multitude of innovative applications for textiles, especially in the function and intelligent field. In these studies, the active cosmetic textiles are a novel concept of releasing cosmetic active substances to the human skin. Due to the textile be in contact with the skin, all kinds of skin care ingredients (anti-aging, whitening, sunscreens, vitamin etc.) can be incorporated into textile materials and the release substances from the clothing may directly be absorbed by the skin. These textiles are able to help people who are not able to use any cosmetic products and one-spot care the sensitive skin which the filled active substance can, over time, slowly released onto your skin. In combination with our recent studies, the progress and application of active cosmetic textiles has been introduced in this paper. The preparation and characterization has also been introduced with examples.

Keywords: Skincare; Release, Cosmetic function, Active textile

1. Introduction

In people's daily life, clothing plays an important role in protecting the human body from dangers in the environment such as weather (e.g. strong sunlight, extreme heat or cold), insects, noxious chemicals, weapons, and contact with abrasive substances, and other hazards materials. As human's second skin, they not only protect the human skin from danger, but also care the health of human skin. How to maximise the health-related function of textile is becoming more important in designing and fabricating the active textile and apparel. ^[1] Compared with common textile, active textiles are defined as the textiles that can sense and react to environmental conditions or outer stimuli, such as those from mechanical, thermal, chemical, electrical, magnetic or other sources. They have, for example, been extensive innovations in clothing fabrics that can provide extra protection to human body in hot or cold condition. Whatever their role, active textiles can either alter their nature in response to external factors or confer additional benefits to their users. Active textiles are still largely in their infancy, but it is clear that they can provide an interesting life and also offer the health-related protection to our body when it is needed. It is well-known to all that the applications of active textiles are very wide ranging, e.g. sports & leisure clothing, biomedical, engineering & construction

materials, chemical & bullet-proof applications, as well as skincare textiles. In this proceeding, we address the development of cosmetic textiles which directly offer the similar function as the cosmetic cream or lotion used in our everyday life. Here, cosmetic textiles are just one type of active textiles, which provide an easy alternative to cosmetics, suitable for the modern day busy life. ^[2]

Cosmetic textiles, as its name showing, can be defined as the textiles materials have the same properties to those of cosmetic products. Like our known cosmetic products, cosmetic textiles can also be divided into different catalogues according to their end-use applications. In view of different application objectives, the type of cosmetic textiles is listed as the following items (Figure 1):

- Moisturizing,
- Whiten & Anti-wrinkle,
- Aromatic & Perfumes,
- Slimming & keeping fit,
- Antimicrobial & Antifungal,
- UV protection,
- Energizing & Refreshing,
- Relaxing & pressure-release,

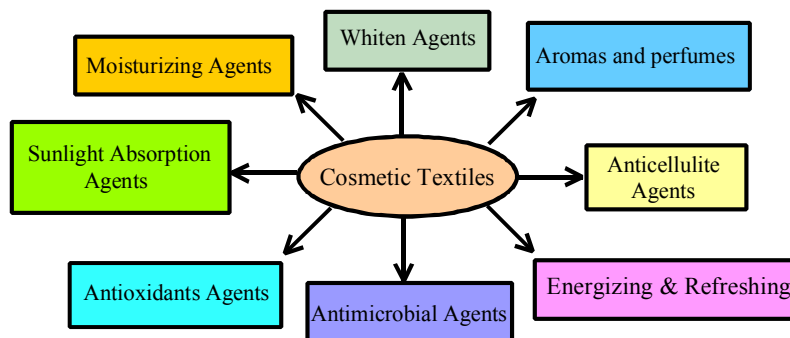


Fig. 1. Schematic illustrations of the type of the cosmetic textiles.

The difference between cosmetic textiles and cosmetic products lies with the fact that the time-release behaviour is different according to their end-uses action. Usually, the cosmetic creams or lotions only take effect at a certain time range, and once out of this time range the skincare ingredients will lose their effect; while the cosmetic textiles can keep skincare performance for a long time until the skin benefiting ingredients were used out. Of course, compared with cosmetic products cosmetic textiles also have their disadvantages in the aspect of skin absorption and ingredients release, e.g. effect absorption ratio, time-dependant release and confined release behaviour, etc. At present, the preparation process of cosmetic textiles can be realized by two methods: (1) microencapsulation techniques; (2) cyclodextrin-grafting methods with the aim of prolonging the skincare efficacy fulfilled by the active ingredients loaded in the above materials. Figure 2 and 3 shows these two different processing techniques.

1) Microencapsulated active ingredients coated onto textile surface.

Microcapsule technique is very widely applied, and now more and more scientists had participated to improve the added value of products. As the active ingredients were encapsulated with organic/inorganic materials, the physical and chemicals properties will be better protected from UV radiation and oxidative processes. For microencapsulation process, many important literatures and reviews can be referenced.^[3-5] In our studies, the microspheres or nanoparticles can be well fabricated by using nanoprecipitation and physical methods (spray drying process), and the diameter of particles can be controlled in a range of 0.2~3 μm . Figure 2 shows the SEM photos of Vc particles and treated cotton with Vc particles.

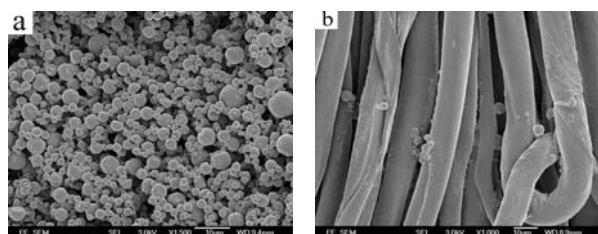


Fig. 2. SEM of Vc particles (a) and treated cotton with Vc particles (b).

2) Cyclodextrin-grafting technology.

Cyclodextrin molecules, as the biopolymer and biocompatible materials, have attracted lots of research effort both academic and practical applications. In solid or solution state, cyclodextrins

form a cone shaped molecule with the hydroxyl groups on the outside of the molecule, providing a hydrophilic outside and a hydrophobic cavity. This results in high solubility in water and the ability to host hydrophobic non-water-soluble substances in the hydrophobic cavity. Due to this special feature, cyclodextrins have been applied in textile industry, pharmaceuticals and cosmetics fields. For textiles, however, two possible methods, one is to use the cyclodextrin itself and the other is to use derivatives (Monochlorotriazinyl- β -cyclodextrin, CDMCT) are applied in view of their different chemical structure. The detailed fabrication process utilizing cyclodextrin complex is shown in the following Fig 3.^[6,7] By this way, the guest molecules (active ingredients) can be included in inner cavity of cyclodextrins, and thus the time-release behavior of ingredients can be realized via this hydrophobic and hydrophilic transition process. Moreover, the more important point is that the textile treated with cyclodextrins can realize the reloading function again by using the complex property between host and guest molecules. By this process, we found that the treated fabric with cyclodextrin and its derivatives had better ability of improving the freshness and anti-odour performance of fabric. Due to the loading limit of the cyclodextrin molecules, however, the performance will have to discount, and thus next work should be focused on how to improve the loading ability and the substitution degree onto fabric surface.

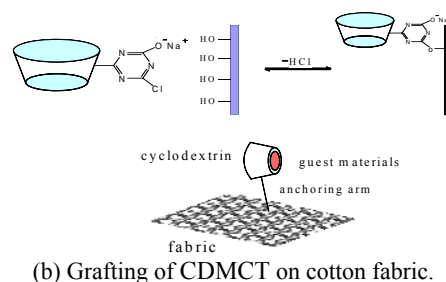
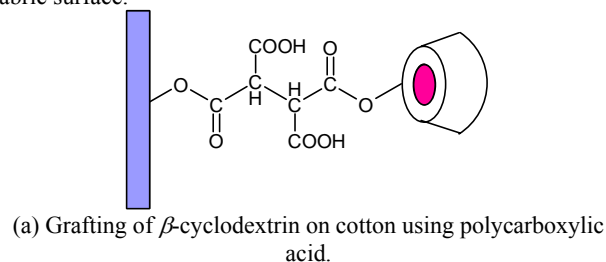


Fig. 3. Schematic illustrations of β -cyclodextrin-grafting process on cotton surface.

2. Cosmetic textiles application

For cosmetic textiles, although certain products are available, few reports can be found in analyzing their effects when applied to active textiles. Moisturizing, whiten, anti-wrinkle and anti-cellulite represent popular functions used. Skintex® from Cognis uses an innovative technology that the textile treated contains microcapsules with active ingredients e.g moisturizing agents.^[9] For the release mechanism of moisturizing agents, two steps are involved. Firstly, the release is helped by light friction created when wearing the clothes. Secondly, the biopolymer shell is slowly reduced or broken over time, and thus activates the ingredients and enables them to move from the fabric onto your skin. Up to 45% of the active Skintex® agents will still remain after 10 washes at 40°C. When the microcapsules were ruptured at outer pressure, the moisturizing agents (Vitamin E, Squalane and Aloe vera) will be released to the body.

At present, slimming is popular all over the world. Recently, anti-cellulite underwear development was reported by REUTERS. The opinion pointed out that the high-tech fabrics encapsulating slimming agents will promote the addition of wardrobes.^[8] Skintex® Slimming, as one of the anti-cellulite fabrics, contains a combination of recognized ingredients, such as caffeine, retinol, Vitamin E, and algae extract, which may reduce the outer appearance of cellulite. In addition, it was claimed that the slimming effect persists even after the garment has been washed several times, and it can be simply and easily renewed at home. Unfortunately, no data are available on the slimming effect and skin absorption. L-ascorbic acid (Vitamin C), as an important nutrient necessary of human life also plays an important role in maintaining our healthy skin. Recently, Fuji Spinning Co. Ltd fabricated the Vitamin C and E fabric, named by V-UP or V-UP C+E.^[13] In the fabric surface, the pre-vitamin was coated onto the textile. Once the pre-vitamin was contacted with the skin, the pre-vitamin will be turned into Vitamin C by an enzyme existed in the skin and absorbed by the body. Note that, due to the different type of enzyme existing on the human body, the transition efficiency will be greatly different and hence affecting absorption ability. And more importantly, the pre-vitamin also has weak absorption efficiency. Although the L-ascorbic acid is not stable in the common situation, the absorption efficiency by the skin is much higher compared to pre-vitamin. In our studies, encapsulation techniques were utilized to realize the coating of Vitamin C aiming at maintaining its stable state. Compared with pure Vitamin C, encapsulated Vitamin C has much better stability both in wetting and in relatively high temperature environment. We also developed an indicator system that can detect the existing of vitamin C. In general, the microcapsule with liquid core delivers the ingredients by the solvent-diffusion mechanism based on the shell porosity and the cross-linking density. As for the solid core, the mixed mechanism of shell rupture, diffusion of core and the skin temperature, pH value of skin and the amount of perspiration, might also contribute to the delivering process from fabric to skin. However, no scientific report for the transfer of Vitamin C can be found. Figure 4 shows schematically the release process of vitamin fabric under the possible contributing factors. In order to detect the existence of Vc on the fabric surface, we developed a indicator utilizing the redox reaction between Vc and indicator, shown in Figure 5. From the figure, it can be seen that once dropping the indicator solution to the vitamin cotton fabric, the red colour of the indicator will be changed to colourless, while no colour change will be noticed on the blank cotton.

As the small molecules can be embedded via the hydrogen bonding or complex to the inner cavity of cyclodextrins molecules, that system can also be considered. Usually, fragrant oil, Vitamin or some other active ingredients can be successfully loaded.^[14] The complexes with cyclodextrins are stable in the presence of light and oxygen. The formation of the inclusion complexes can also protect sensitive compounds over a long time period. The complexed substances are released from the cavities of the cyclodextrins in the presence of humidity. As water is always present on the skin surface, it provides the right environment for release of active substances. Therefore, once the textiles are in contact with the human skin, the ingredients will be released to the skin. Compared with the solution release, the solid release behavior will be more complex. With cyclodextrins system, however, the substances complexed inside the cavities of the cyclodextrin molecules or embedded into the fabric are removed during a normal washing process of the textiles.

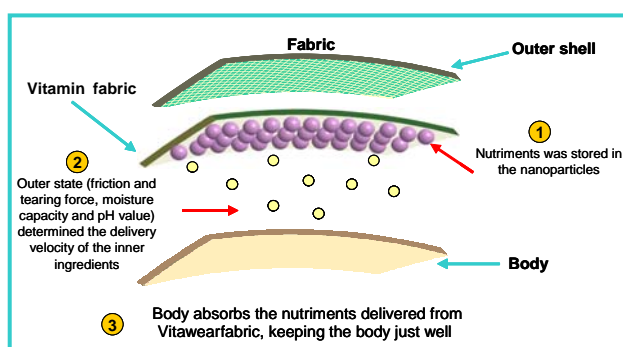


Fig. 4. Schematic illustrations of Vitawear release process.

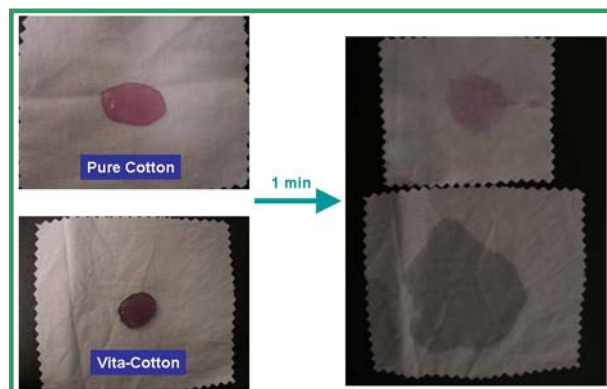


Fig.5. The detection of vitamin C on the fabric with an indicator.

The addition of fragrances to textiles has been carried out for many years and no successful cases were relatively long-lived before the microencapsulation techniques become success in textile applications. Fragrances can smooth and calm both body and mind, and can also keep our body in an excitation state. For textile application, two methods can be realized. First is encapsulation techniques and the second is cyclodextrin-grafting methods. In microcapsule process, many related reports can be found according to their different aroma types and shell materials. For microencapsulation treatment, one thing needs to be noticed that the temperature of post-treatment process should be kept lower than that of degradation temperature of fragrant oils. In addition, the shell selection is also important for fragrance

delivering. Presently, most works focus on using melamine-formaldehyde or urea-formaldehyde resin as shell materials. However, the slow releasing of formaldehyde presents a problem. Greener shell materials should be used. For cyclodextrin-grafting methods, it is novel and interesting process aiming at obtaining the stable inclusion complex with active ingredients. Once the textiles are in contact with the human skin, the released ingredients will directly be absorbed by the body. However, no data is available about the kinetics of their dissociation process. In addition, as the substances complexed inside the cavities of cyclodextrin molecules or embedded into the fabric are removed during a normal washing process of the textiles people can do it yourself to load what they like, and truly realize the so-called renewing process.

3. Market trends and prospects

Various preparation & treatment processes on textiles provide positive way of improving the added value of textile and upgrade the textile industry. As one type of smart textiles, cosmetic textiles will bring a high impact for our daily life. The occurrence of cosmetic textiles not only alters our viewpoints on cosmetics used in cream or lotion state, but makes us benefit from this novelty delivery method. Once you wear the cosmetic textiles, the body will be cared all the time until the active ingredients were used out. In addition, it makes the skin application easier and can cover much large proportion of the body when comparing with common cosmetics.

As REUTERS reported, cosmeto-textile is just an idea ahead of its time. From the regional standpoint, one report pointed out that the total market could be worth up to 500 million euros.^[8] And in 2003, his company's sales are 4.5 million euros which was attributed to the sale of tights with a slimming agent. At present, Addias, Nike and L'Oreal also have strong interest on cosmetic textiles, indicating that the market is just beginning to accept the novelty active textiles. The trend shows that the development of cosmetic textiles reflects the needs of self-care consciousness of people in the present living condition. Of course, to further accelerate the process of cosmetic textile from idea to product, much more research activities should be conducted especially on the efficiency, toxicity and durability of products.

Current study of cosmetic textile products, such as its fabrication, effects, delivery, is still in its infancy while cosmetic textile products are gaining interests from the consumers. More research in this area is needed. Undoubtedly, cosmetic textiles can provide certain advantages to the wearers; the effects should be objectively assessed and reported. The outlook of the cosmetic textiles as a new type of highly added-value products is promising with the improved living standards and increasing numbers of living quality conscious consumers.

Acknowledgement

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