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COSMETOTEXTILE AS INNOVATION IN THE PRODUCTION OF PROTECTIVE CLOTHING

UDK 677.027.625:687.17

RECEIVED: 2010-05-24

ACCEPTED: 2011-03-23

SUMMARY: A cosmetotextile is a textile article containing a substance or a preparation that is released over time on different superficial parts of the human body, notably on skin, and claiming special properties such as cleaning, perfuming, changing appearance, protecting, keeping in good condition or correcting of body odours and therefore very convenient to use for protective clothing. Cosmetic preparations are usually in liquid form so it is necessary to encapsulate them. A cosmetotextile is a textile product which combines a cosmetic preparation, a textile and a linking agent. Because cosmetic preparations are usually in liquid form they need to be encapsulated before applying on textiles. Man-made encapsulation can be divided into two groups: microencapsulation and molecular encapsulation. Microencapsulation is described as a process of enclosing micron-size particles of solids or droplets of liquids or gasses in an inert shell, which in turn isolates and protects them from the external environment. Molecular encapsulation involves all intermolecular interactions where covalent bonds are not established between the interacting species. The majority of these interactions are of the host-guest type. In our research we grafted molecular capsules onto various textile materials using a polyfunctional reagent. We prepared textile materials with additional functionality: with increased adsorption capacity and delayed release of volatile active compounds. Some results of research work within the INO-09 project are presented.

Key words: *cosmetotextile, microcapsules, molecular encapsulation, textile materials*

INTRODUCTION

Protective clothing has to meet specific protection and comfort requirements and cosmetotextile is an innovative way of meeting these requirements (Kisilak, 2009). A cosmetotextile is a product which combines a cosmetic preparation, a textile and a linking agent which is usually

a capsule. Cosmetic preparations (essential oils, vitamins, moisturizing and anti-ageing agents, etc.) are usually in liquid form so it is necessary to encapsulate them. Encapsulation technologies offer many methods of improving the properties of textiles and give them completely new functions. Man-made encapsulation can be divided into two main groups:

1. Microencapsulation where the capsules can be as big as a couple of microns to a few hundred microns;
2. Molecular encapsulation, where capsules are the same range as molecules.

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Cosmetotextile materials can be prepared also by using various other coating materials such as stimulus-responsive gels or microgels, or by incorporation of various nanoparticles into textile materials.

Molecular encapsulation

Supramolecular chemistry involves all intermolecular interactions where covalent bonds are not established between the interacting species: i.e., molecules, ions, or radicals. The majority of these interactions are of the host-guest type. Among all potential hosts, the cyclodextrins (CDs) seem to be the most important. (Szejtli *Chem. Rev.*, 1998). Odour control is a very important issue in the apparel and underwear items. Odour can be controlled by applying an antimicrobial finish that removes odour molecules as they are formed or covers up odour with a fragrance (BNITH CEN/TC248/WG25, 2006). The odour molecules, being hydrophobic, become trapped in the cavities of the cyclodextrins and are removed during laundering (Figure 2).

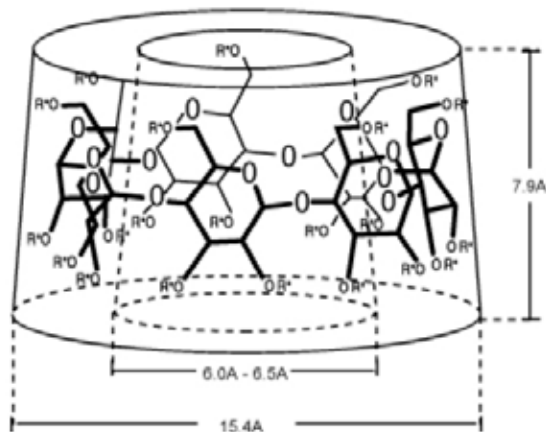


Figure 1. Structure of β -CD
Slika 1. Građa β -CD-a

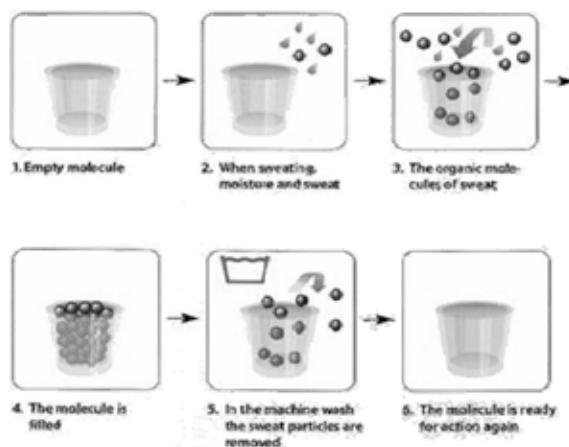


Figure 2. Trapping of odour molecules in cyclodextrin

Slika 2. Fiksiranje mirisnih molekula u ciklodekstrinu

Well-being aromatherapy

Today the subject of well being is an area which is receiving much interest, with scent being one of the most important aspects of personal care. The definition of the word aromatherapy is as follows: therapeutic uses of fragrances which through mere volatilization cure and mitigate diseases, infections and indispositions by inhalation alone (Buchbauer, 1994).

The term aromachology was coined in 1982 to denote the science that is dedicated to the study of the relationship between psychology and fragrance technology to elicit a variety of specific feelings and emotions such as relaxation, exhilaration, sensuality, happiness and well-being through odours via the stimulation of olfactory pathways in the brain, especially the limbic system.

EXPERIMENT

Pure cotton with mass of 140 g/m² was used after it was first desized, scoured, bleached and mercerized on continuous production equipment. It was supplied by MTT, Maribor, Slovenia. Cotton textile materials were treated with β -CD and cross-linking system (1,2,3,4 butan-tetracarboxylic acid (BTCA) and cyanamide); (Vončina, Vivod, Chen, 2009). Concentrations of β -CD and BTCA were 10 and 6 g/l, respectively. For reduction of curing temperature a catalyst, cyanamide, in the concentration of 5g/l was added. The fixation was carried out at 115°C for 3 minutes. The weight gain of the finished fabrics was measured to yield the efficiency of the treatment according to standard test method DIN 53814. The weight gain of the finished fabrics was 9%.

Secondary cigarette smoke stream was adsorbed to treated and untreated cotton textile materials (untreated and treated with molecular capsules) (Figure 3). To quantify odour-releasing behaviour of β -CD treated textile materials, we organized a sensory panel of people to whom the odour was presented under controlled conditions. Treated textile materials were exposed to 8 people who ranked their preferences from 1 to 5.

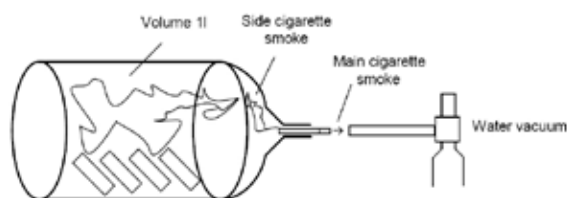


Figure 3. Smoke chamber

Slika 3. Dimna komora

RESULTS AND DISCUSSION

Figure 4 presents the intensities of smell of untreated and treated textile materials exposed to secondary cigarette smoke stream. It is shown that unpleasant smell of treated textile is reduced compared to untreated due to encapsulati-

on. The influence of the structural parameters of cotton fabrics on the fibre smelling can be neglected because the same textile structure parameters (the same cellulose materials) were used for smell measurements of treated and untreated samples.

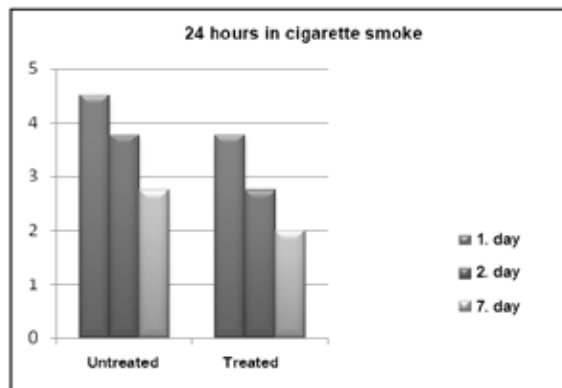


Figure 4. Intensity of smell after 24 hours of exposition to cigarette smoke of untreated and treated textile materials

Slika 4. Intenzitet mirisa nakon 24 sata izlaganja cigaretnom dimu kod netretiranih i tretiranih tekstilnih materijala

Further we extracted cigarette smoke from treated textile materials in water. With UV/Vis spectroscopy we measured the quantity of extracted smoke (Figure 5). It is possible to see that the quantity of adsorbed smoke increases with the time of exposure to smoke.

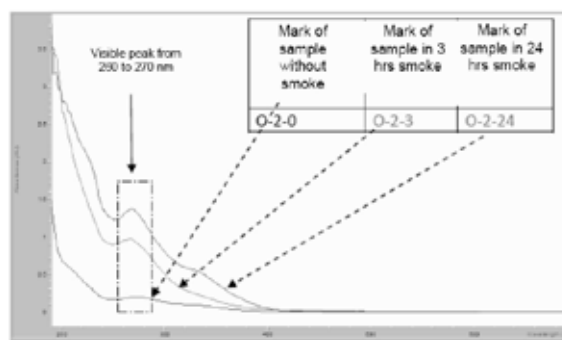


Figure 5. UV/Vis spectra of smoke extracted from treated textile in water

Slika 5. UV/Vis spektri dima izvađeni iz tretiranog tekstila u vodi

In our previous research work (Vončina, Vivod, Chen, 2009) we proved that nano-assembly between molecular capsules and cross-linking reagent was formed and simultaneously linked on textile substrate as shown in Figure 6. The main advantages of such nano-assembly is that the whole part of the textile surface is covered with molecular capsules which can adsorb small volatile molecules, the thickness of the covering is just few nanometers, and further, nano-assembly is covalently bonded to hydroxyl groups of cellulose which makes the treatment durable.

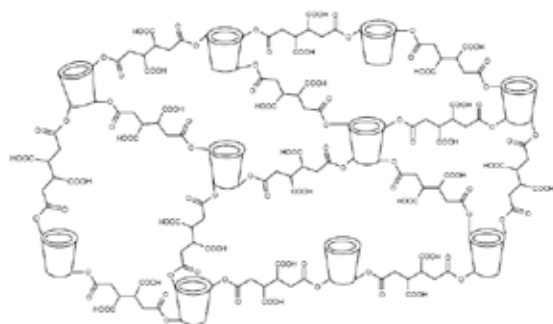


Figure 6. Nano-assembly of molecular capsules on textile substrate

Slika 6. Nanoskupina molekularnih kapsula na tekstilnoj podlozi

CONCLUSION

Using the results of the INO-09 project we proved that molecular encapsulation could be used for cotton textile materials (underwear, interlinen, bed linen) to prepare products with additional value. With molecular capsules treatment textile material can adsorb secondary cigarette smoke in higher quantity compared to untreated textile material. It was proven that nano-assembly, which was formed uniformly at the textile surface, is capable of adsorbing small volatile molecules (in our study: secondary cigarette smoke stream) which can be washed out during laundering. Because nano-assembly is covalently bonded to hydroxyl groups of cellulose such treatment is durable in washing.

Acknowledgement

This research was supported by INO-09 project funded by the **Ministry of Higher Education, Science and Technology &** Public Agency for Technology of the Republic of Slovenia.

REFERENCES

BNITH CEN/TC248/WG25, 2006

Buchbauer, G.: Aromatherapy: Use of fragrance and essential oils as medicaments, *Flavour and Fragrance Journal*, 9, 1994, 217-222.

Kisilak, D. & al.: *Adsorpcija cigaretne dima s pomočjo uporabe nano-enkapsuliranja. Nanos dišeče apreture s pomočjo uporabe nano-enkapsuliranja : končno poročilo projekta INO-09 (številka pogodbe INO-09/5/4) za podporo nacionalnemu sistemu inovacij v letu 2009: Obdelava tekstilnih materialov za doseganje različnih funkcionalnosti - prenos raziskovalnih dosežkov v tekstilno prakso podjetja E-stil, Brestanica*. Ljubljana: Euronitka, 2009. 1 mapa (loč. pag.). [COBISS.SI-ID 13561110]

Kisilak, D. & al.: *Anti - celulitni efekt na ženskih spodnjih hlačah. Aroma-terapija na ženskih spodnjih majicah. Antimikrobni efekt na ženskih spodnjih hlačah : končno poročilo projekta INO-09 (številka pogodbe INO-09/5/4) za podporo nacionalnemu sistemu inovacij v letu 2009: Obdelava tekstilnih materialov za doseganje različnih funkcionalnosti - prenos raziskovalnih dosežkov v tekstilno prakso podjetja Komet, Metlika*. Ljubljana: Euronitka, 2009. 1 mapa (loč. pag.). [COBISS.SI-ID 13561366]

Kisilak, D. & al.: *Nanos apreture za izboljšanje spremembe dimenzij po pranju : končno poročilo projekta INO-09 (številka pogodbe INO-09/5/4) za podporo nacionalnemu sistemu inovacij v letu 2009: Obdelava tekstilnih materialov za doseganje različnih funkcionalnosti - prenos raziskovalnih dosežkov v tekstilno prakso podjetja Zvezda, Kranj*. Ljubljana: Euronitka, 2009. 1 mapa (loč. pag.). [COBISS.SI-ID 13561878]

Kisilak, D. & al.: *Navzemanje vonjav na moških spodnjih hlačah s pomočjo nano-enkapsuliranja. Navzemanje neprijetnega vonja cigaretne dima na bombažni majici s pomočjo nano-enkapsuliranja : končno poročilo projekta INO-09 (številka pogodbe INO-09/5/4) za podporo nacionalnemu sistemu inovacij v letu 2009: Obdelava tekstilnih materialov za doseganje različnih funkcionalnosti - prenos raziskovalnih dosežkov v tekstilno prakso podjetja Lanteks, Celje*. Ljubljana: Euronitka, 2009. 1 mapa (loč. pag.). [COBISS.SI-ID 13561622]

Szejtli Chem. Rev., 1998, 98, pp 1743-1753.

Vončina, B., Vivod, V., Chen, W.: Surface modification of PET fibers with the use of [beta]-cyclodextrin, *J. appl. polym. sci.*, 113, 2009, 6, pp 3891-3895.

**KOZMETOTEKSTIL – INOVACIJA U
PROIZVODNJI ZAŠTITNE ODJEĆE**

SAŽETAK: Kozmetotekstil je odjevna tkanina s ugrađenom tvari ili pripravkom koji se vremenom otpuštaju na vanjske dijelove ljudskog tijela, tj. na kožu, a ima sposobnost da čisti, zamiriši, mijenja, štiti, drži u dobrom stanju i djeluje na miris tijela i stoga je pogodan za izradu zaštitne odjeće. Kozmetički su pripravci obično u tekućem stanju, pa ih je potrebno enkapsulirati. Kozmetotekstil je proizvod u kojem su sjedinjeni kozmetički pripravak, tekstil i vezivo. Kozmetički su proizvodi u tekućem stanju, pa ih treba enkapsulirati prije primjene na tekstilu. Enkapsuliranje se dijeli na dvije skupine: mikro enkapsuliranje i molekularno enkapsuliranje. Mikro enkapsuliranje je postupak kojim se mikronski sitne čestice krutih tvari ili kapljice tekućine zatvaraju u čvrstu ovojnica koja ih izolira i štiti od okoline. Molekularno enkapsuliranje jest skupina intermolekularnih interakcija tijekom kojih se ne stvaraju kovalentne veze. Većina tih interakcija je tipa domaćin-gost. U našim smo istraživanjima fiksirali molekularne kapsule na različite vrste tekstila uz uporabu polifunkcionalnog reagensa. Tekstilu smo dodavali dodatne funkcije: povećanu sposobnost adsorpcije i polaganije otpuštanje isparivih aktivnih spojeva. Prikazani su neki rezultati istraživanja u sklopu projekta INO-09.

Ključne riječi: kozmetotekstil, mikro kapsule, molekularno enkapsuliranje, tekstilni materijali

*Izvorni znanstveni rad
Primljeno: 24.5.2010.
Prihvaćeno: 23.3.2011.*