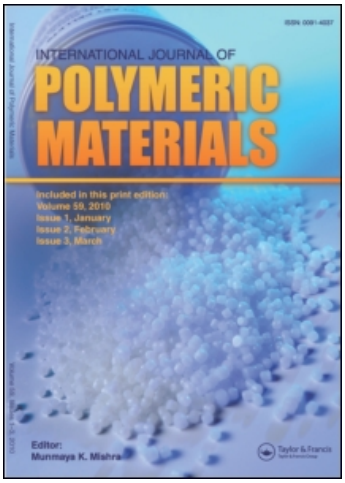

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E. Knez[a]; M. Kukovič[a]; V. Pipal[a]; B. Boh[b]
[a] Aero d.d., Slovenia [b] Faculty of Natural Sciences and Engineering, University of Ljubljana, Ljubljana, Slovenia

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Microcapsules on Woven and Non-woven Materials

E. KNEZ[a], M. KUKOVIČ[a], V. PIPAL[a] and B. BOH[b,*]

[a] *Aero d.d., Celje, Slovenia;* [b] *University of Ljubljana, Faculty of Natural Sciences and Engineering, Vegova 4, SI-1000, Ljubljana, Slovenia*

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Properties of textiles can be improved or changed by applying a special finishing, which contains microcapsules and contributes to an antimicrobial, deodorising, medicinal or insect repelling effect. For the impregnation of woven and non-woven textiles, the compatibility of microcapsules with various water-based additives was tested: (1) water suspensions of binders based on latex (styrene-butadiene, polyvinylacetate, acrylate) with anionic and/or non-ionic emulsifiers, (2) binders based on solutions of water-soluble polymers (polyvinyl alcohol, carboxymethyl cellulose, modified starch, xanthanes), (3) finishing media based on urea- and melamine-formaldehyde resins and dimethylolethylene urea. The suspension of microcapsules can be mixed with the above binders in all ratios. To determine the optimum conditions for the preparation of finishing formulations with microencapsulated ingredients, the coating system, the target effect of finishing, the textile properties and the target properties of the final product have to be defined.

Keywords: Textiles; finishing formulations; microcapsules; polymerization *in situ*; essential oils; deodorising effect; antimicrobial effect; water-based additives; binders; impregnation; coating

1. INTRODUCTION

Microcapsules are small liquid, solid or gaseous particles coated with another substance (microcapsule wall) which protects the core material against environmental conditions, separates reactants, transforms liquid substances to powders, reduces evaporation or enhances controlled release of active substances.

*Corresponding author.

Microencapsulation was first used in the production of pressure-sensitive carbonless copying paper. Since then, the technology has been improved and modified for a variety of purposes. Today, there is practically no major industrial field where microcapsules would not be introduced, and there are still numerous additional applications possible. Microcapsules found their place in graphic industry, cosmetics, agriculture, textile and food industry, construction building and electronics (Fig. 1).

Microcapsules have been frequently used with textiles. Possible applications are shown in Figure 2, which was prepared by an analysis of documents, obtained by processing international bibliographic databases (Chemical Abstracts, World Patents Index) for the field of

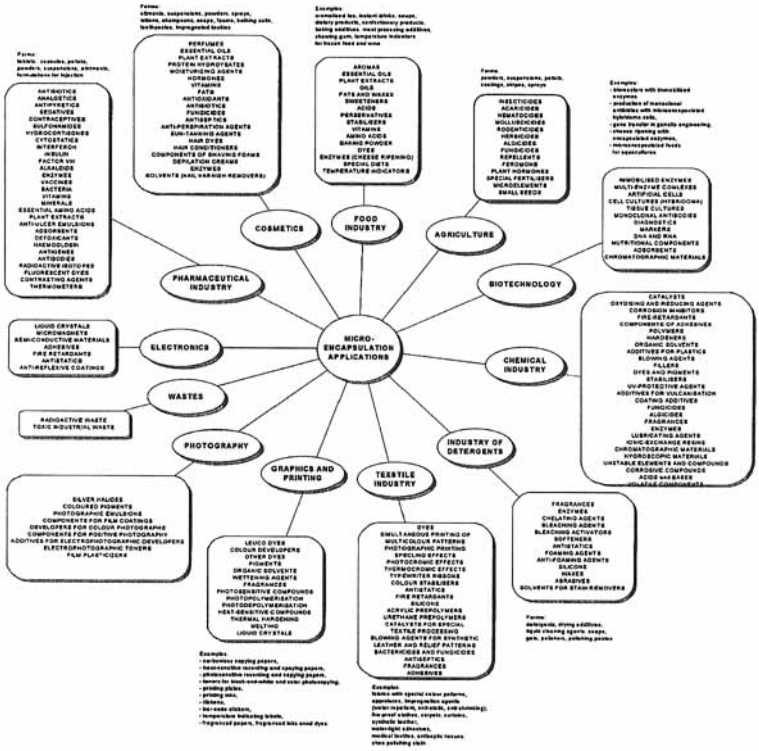

FIGURE 1 Examples of microencapsulation applications in different industrial branches (the scheme was developed by analysis and structuring of data from over one thousand documents) [1].

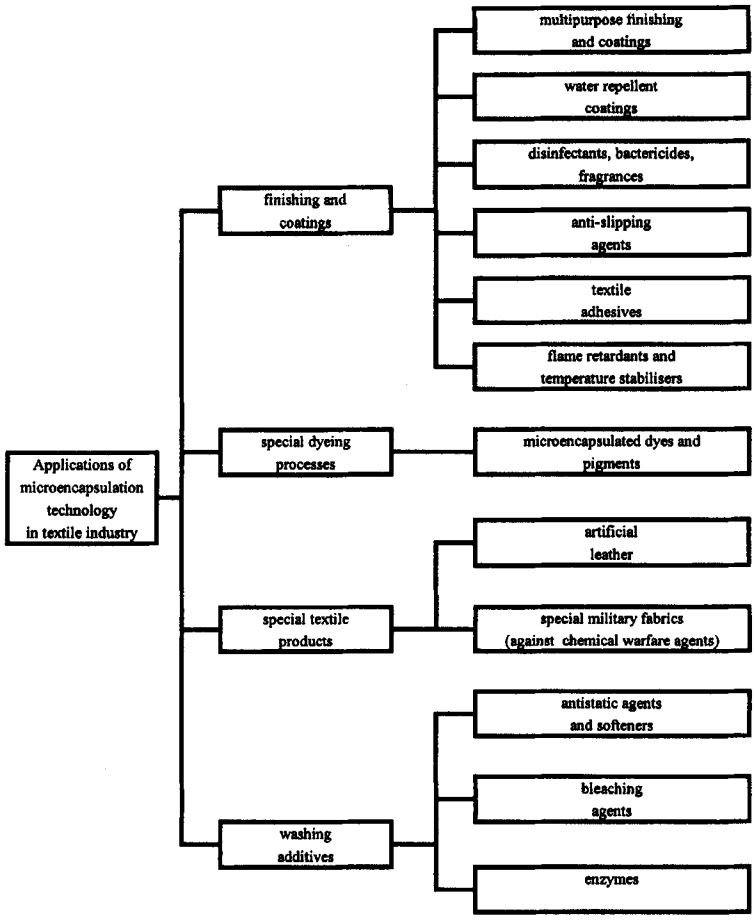

FIGURE 2 Applications of microcapsules on textiles [2].

microencapsulation. The majority of publications are patents, which suggests a great market potential.

The textile development and production are directed towards the manufacturing of high-quality products. The main aim is to produce the textile fast and with least expense, and to make a product that will satisfy the needs and expectations of a customer. Textiles are thus given additional functions: deodorising, antiseptic, bactericidal, antiasthmatic, antiallergic, hydrophilic or hydrophobic *etc.* The textile

industry follows these aims by permanently improving the type, structure and form of the fibre, and by introducing new chemical treatment procedures.

The main purposes of chemical treatment are to emphasise the favourable characteristics of the natural material, to improve less favourable ones, and to achieve new properties. Chemical treatment procedures differ regarding the type of the textile and fibre that is treated, as well as regarding the demanded final effect. During this stage of the production, characteristic properties are formed, which determine further applications of the textile [3].

There are numerous chemical additives on the market, available to textile producers. One of the possibilities, and frequently the only possible solution to a given problem, is the application of a special finishing in a form of microcapsules. The recent microencapsulation technology provides a prolonged activity and controlled release of active substances. Perfumed textiles and energy shirts with microcapsules are already available on the market. However, with a finishing containing microcapsules other effects can be achieved, such as antimicrobial, deodorising, medicinal or insect repelling effects, which give improved or completely new functions to textiles.

2. EXPERIMENTAL PART

2.1. Microencapsulation

Microencapsulation denotes a series of physical and chemical procedures for the formation of protective membranes around microcapsules cores. The most frequently used methods include mechanical processes (*e.g.*, spray drying or solvent evaporation from emulsion), and chemical methods, such as simple and complex coacervation, interfacial polymerisation and *in situ* polymerisation.

Aero has developed its own technology of microencapsulation, based on the *in situ* polymerisation reaction [4–6]. According to this method, hydrophobic liquids or solutions of solids in water-insoluble solvents can be microencapsulated. Microcapsules are obtained in the form of an aqueous dispersion containing 35 to 40% of dry matter and with a viscosity of 150 to 500 mPas. By changing the parameters of the

microencapsulation process, the regulation is possible of the microcapsule size and particle size distribution, surface morphology, wall thickness and permeability. The mechanism of the active substance release is an outer pressure or, according to the modified procedure, a combination of outer pressure and diffusion.

2.2. Incorporation of Microcapsules into Textiles

When designing a textile with microcapsules, the final product properties have to be determined first; we either with to improve the existing product or to develop a completely new one. Therefore, a suitable active substance has to be selected. Then the conception of the microencapsulation procedure follows: the properties of microcapsules, their shape, active substance release mechanism, the way of application, and the compatibility with other additives have to be determined.

Microcapsules in a form of water dispersion can be mixed with the finishing and other chemical additives, which are applied on the already formed textiles, *i.e.*, during the phase of chemical treatment. Although very thin, the microcapsule wall is, when in wet, strong enough to resist the pressure of passing the rollers and to keep the active substance inside the microcapsule (important with essential oils), when passing the drying channel.

The compatibility of microcapsules with various water based additives for woven and non-woven materials has been tested:

- water suspensions of binders based on latex (styrene-butadiene, polyvinylacetate, acrylate) with anionic and/or non-ionic emulsifiers,
- binders based on solutions of water-soluble polymers (polyvinyl alcohol, carboxymethyl cellulose, modified starch, xanthanes),
- finishing media based on urea- and melamine-formaldehyde resins and dimethylolethylene urea.

The suspension of microcapsules can be mixed these binders in all ratios. However, to determine the optimum conditions for the preparation of finishing formulations with microencapsulated ingredients it is necessary to define the coating system, the target effect of finishing, the textile properties and target properties of final product.

2.2.1. Incorporation of Microcapsules into Non-woven Materials

Incorporation of microcapsules into non-woven textiles is possible either during the stage of chemical treatment or by coating procedure.

(*a*) *Incorporation during the stage of chemical treatment of non-woven materials* The development of microcapsule incorporation procedures for non-woven materials was focused primarily on the preparation of coatings containing microcapsules for the impregnation of non-woven polyester materials to achieve long deodorising, fungicidal and bactericidal effect. The research was performed in three phases:

- Identification of a suitable core material with deodorising, bactericidal and fungicidal effect. It is well known that certain essential oils possess deodorising, bactericidal and fungicidal effects. An antimicrobial effect of non-woven materials is often based on the incorporation of essential oils [7].
- Modification of the microencapsulation procedure to achieve a controlled and prolonged release of active ingredients from microcapsules.
- Design, testing and optimisation of the impregnation procedure of polyester non-woven materials. When dealing with chemically treated non-woven materials, it is convenient to have all finishing additives mixed with the binder itself, if possible. The way of coating further depends on the carrier, machine equipment and the desired final effect.

(*b*) *Applications of microcapsules by a coating procedure* Applications of microcapsules with air knife or rod coater (wire wound) were tested and optimised. Considering the type of tissue, the appropriate binder has to be used.

2.2.2. Incorporation of Microcapsules into Woven Materials

The first tests of textile samples, tests of their compatibility with textile finishing and rinse tests were performed with the woven textile materials.

3. CONCLUSION

Microencapsulation is one of the technologies finding ways to the most sophisticated and mature industrial fields. It can be an efficient answer to numerous technological demands, such as environmentally friendly products, exact and precise dosing, long lasting materials, saving, and improved quality.

References

[1] Boh, B. (1996). Microencapsulation for Pollution Prevention. In: Kornhauser, A. (Ed.), DaSilva, E. (Co.-Ed.): Developing Information Support for Research and Education in Toxic Waste Management. UNESCO – ICCS, Ljubljana, pp. 205–222.

[2] Boh, B. (1987). Aplikacije mikrokapsul na tekstilu – Informacijska študija za AERO. Fakulteta za naravoslovje in tehnologijo, Oddelek za kemijsko izobraževanje in informatiko, Ljubljana.

[3] Lunenshloss, J. (Ed.) (1985). Non-woven Bonded Fabrics. John Wiley and Sons, Chichester.

[4] Patent YU 43370, 1984. Postopek za pripravo mikrokapsul. Aero, Kemična, grafična in papirna industrija, Celje (Knez, E.).

[5] Patent SI 9400362, 1995. Postopek priprave nosilcev, impregniranih ali premazanih z mikrokapsuliranimi dišavami. AERO, kemična, grafična in papirna industrija, Celje (Kukovič, M. in Knez, E.).

[6] Patent EP 0 782 475 B1, 1998. Process for Preparing Carriers Saturated or Coated with Microencapsulated Scents. Aero, Kemična, grafična in papirna industrija, Celje (Kukovič, M. and Knez, E.).

[7] Zavod za zdravstveno varstvo Celje, 1997. Mnenje o delovanju mešanice eteričnih olj sivke, rožmarina in žajblja na bakterije in glive, 22. 9. 1997.