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Synthesis and applications of scented microcapsules in textile products

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INTRODUCTION AND OBJECTIVES

Microencapsulation offers technical solutions to improve the quality of textiles, or to give them new properties, functions, and appearance. Detailed literature reviews of microencapsulation applications in textiles have been published in our previous works (Boh et al. 2003, 2006). Typical examples of patented microcapsule applications in textile products include microencapsulated fire retardants, fragrances and perfumes, dyes and pigments for textile dyeing and printing, thermochromic and photochromic effects, microencapsulated catalysts and enzymes for special textile treatment, agents for textile sizing, adhesive bonding, water proofing, blowing agents for leather substitutes, softener and antistatic compositions, ingredients in textile detergents, and microcapsules for special functional textiles, e.g. with microencapsulated antimicrobial, disinfectant and deodorant components, insect repellents, bioactive medical and cosmetic ingredients, and microencapsulated phase change materials for active thermal control.
Microcapsules for textile finishing or for the incorporation into the textile fibres have to be resistant to mechanical and thermal stress. In the past, microcapsules for textiles were based on coacervation processes (e. g. gelatin-gum arabic microcapsule wall), and later on polymerization methods such as interfacial polycondenzation (polyamide, polyester, polyurethane wall) and *in situ* polymerization (aminoaldehyde resin wall). Physical microencapsulation methods, such as fluidized bed, spray drying and spray cooling, were applied when microcapsule walls needed to be water soluble or heat sensitive to dissolve or melt at a desired temperature and release the content during textile dyeing, washing or drying. When microcapsules with impermeable and pressure-sensitive walls are needed for textile applications, *in situ* polymerization of aminoaldehyde polymers continues to be the microencapsulation process of choice.

The main **purpose of our work** was to present synthesis and applications of aminoplast microcapsules, containing fragrances and antimicrobial essential oils, on different textile carriers, and visualise their morphology and distribution on textiles with the use of SEM.

MATERIALS AND METHODS

Microcapsules were prepared by *in situ* polymerization method of aminoaldehyde prepolymers (Sumiga et al., 2011) in 1 L laboratory reactor, and in 10 L and 200 L industrial stainless steel reactors, using essential oils and fragrances (Etol and Parfumelle, Slovenia) as core materials, partly methylated trimethylolmelamine (Melamin) as wall prepolymer, a polyacrylic acid emulsifier/modifying agent (BASF), and ammonia as a scavenger for formaldehyde removal. Main parameters of *in situ* polymerisation process for microencapsulation of fragrances and essential oils were (Fig.1): stirring during emulsification and polymerization 1500 rpm, emulsification 20 min at 25°C, polymerization 60-90 min at 60-70°C, heating/cooling rate 1-2°C/min, wall to core material ratio 1:4.

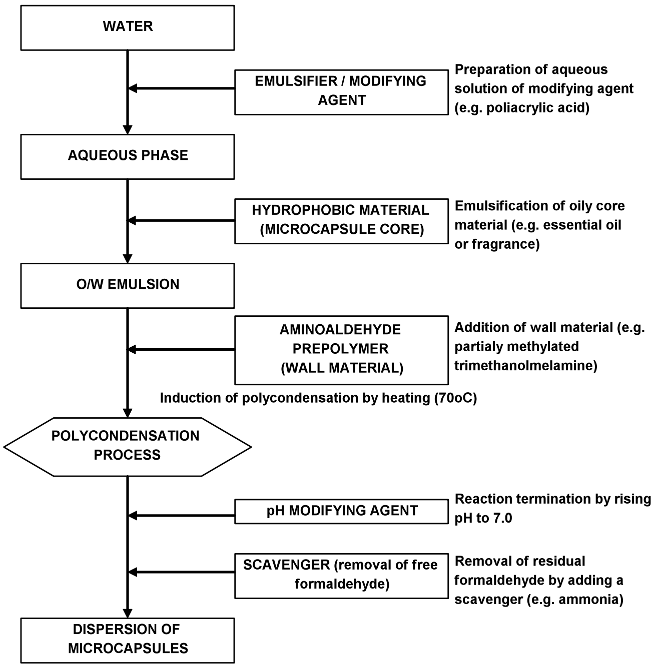

Figure 1: Microencapsulation process

Aqueous microcapsule suspensions with acrylic latex as a binder were applied to textiles by impregnation, using a technique based on a transport of the textile through the impregnation basin, by screen printing or by coating using a semi-industrial coating machine (Dixon).

For scanning electron microscopy (SEM), samples of textiles with microcapsules were coated with an ultra thin coating of carbon, gold and platinum, by high vacuum evaporation. The observations were performed by JEOL JSM 6060LV SEM microscope at 10kV.

RESULTS AND DISCUSSION

Main parameters and properties of fragrant microcapsules produced by *in situ* polymerisation were: microcapsules content in suspension 32-38%, pH 6-8.5, viscosity 200–300 mPas, microcapsule size 1-5 µm, microencapsulation efficiency ≥95%.

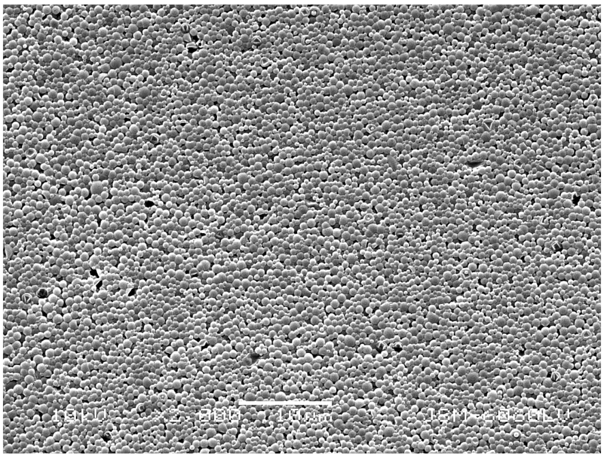

Figure 2: Microcapsules containing eucalyptus oil, 1-2 μm in diameter (SEM 2000x)

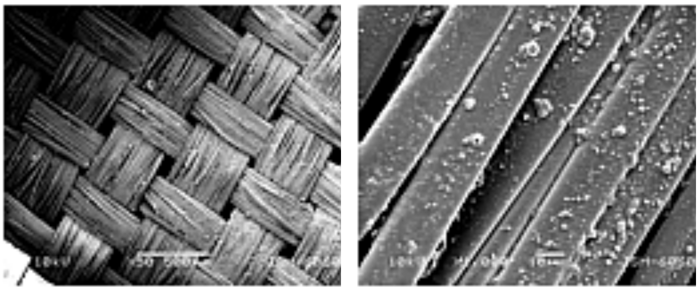

Figure 3: Pressure-sensitive microencapsulated rose oil on a decorative wrapping ribbon; scent is released by mechanical pressure applied by handling (SEM 50x left, 1000x right)

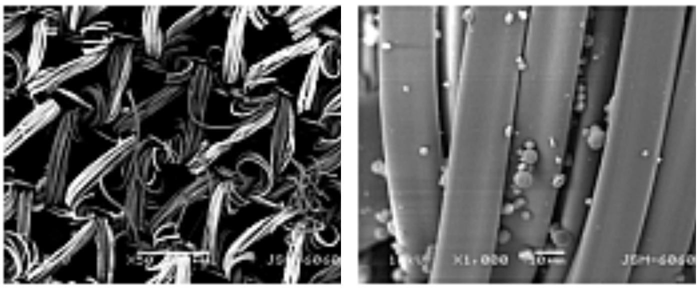

Figure 4: Scented nylon pantyhose with microencapsulated rose oil in pressure-sensitive microcapsules (SEM 50x left, 1000x right)

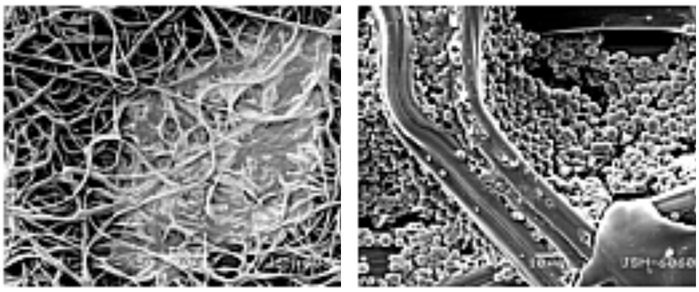

Figure 5: A dry long-lasting refreshing handkerchief, made of a synthetic non-woven textile, printed with pressure-sensitive microencapsulated eucalyptus oil. Essential oil is preserved in the microcapsule core, protected from oxidation, until microcapsule wall bursts open by mechanical pressure, when the handkerchief is used (SEM 50x left, 1000x right)

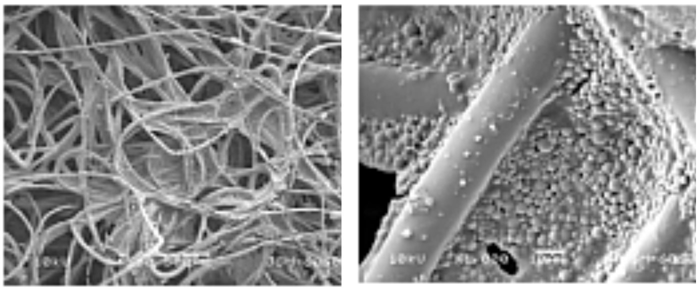

Figure 6: Textile shoe insole, made of a non-woven textile impregnated with pressure-sensitive microcapsules, containing a composition of antimicrobial essential oils of lavender (*Lavandula sp.)*, rosemary (*Rosmarinus officinalis) and* sage (*Salvia officinalis)*. Essential oils are stored and protected until microcapsules open by mechanical pressure during walking, and the antimicrobial composition is released.

CONCLUSIONS

Microcapsules, produced by *in situ* polymerization, have non-porous, pressure-sensitive, durable and stable walls. Essential oils are protected from evaporation and oxidation. The SEM visualization confirmed that microcapsules had a sufficient mechanical and thermal resistance not to be damaged, broken or decomposed during the processes of applying microcapsules to textile carriers by immersion or printing, and during drying at an elevated temperature. When using the textile product, essentials oils are released from the microcapsule core due to the mechanical pressure. The characteristic scent can be preserved and released even after several years of storing the samples at room temperature.

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