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Encapsulation of active principles in PCL for knitted fabric functionalization

MuSyChEn Multiphase Systems & Chemical Engineering

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INTRODUCTION

Can a garment become a reliable controlled delivery system for dermal and trans-dermal applications using microencapsulation techniques? And why such a garment should be of commercial interest in the pharmaceutical field?

In principle, a tight-fitting and elastic knitted fabric is an ideal substrate for hosting microcapsules, because it allows a firm and continuous skin contact and its porous structure can act as a reservoir for microcapsules.
Since an elastic fabric can adapt itself to the body shape, it would be commercially interesting to design specific garments for people affected by chronic diseases spread over large body areas, such as psoriasis or atopic dermatitis. The patients would be dedicated to the therapy if it only requires to wear a comfortable garment.

This research was focused to the development of functionalized knitted cotton fabrics able to release active principles (APs) to the skin, starting from the production of the microcapsules to the kinetics release from the functionalized fabrics.

MATERIALS AND METHODS

Nano and- microcapsules were prepared in a confined impinging jet mixer and recovered in quench water, obtaining stable suspensions (Figure 1).

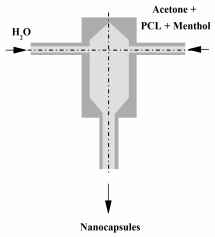

Figure 1 Scheme of the confined impinging jet mixer.

The microcapsule suspension was uniformly distributed over a single jersey knitted cotton fabric (Nm30/1). No binder was needed to enhance adhesion of the microparticles on the fiber surface, physically entrapped in the fiber network.

RESULTS

By tuning the polymer-to-AP mass ratio and the mass-flow rates of the solvent and anti-solvent streams, particles of different size have been obtained (Figure 2).

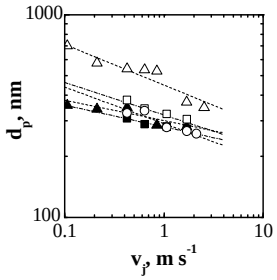

Figure 2 Size of nanoparticles prepared loading PCL M_w= 14000, 6 mg/mL in acetone, with different substances, dissolved in acetone with the polymer :△, miglyol® (MR=2); □, caffeine in acetone and ■, caffeine in water (MR=1.5); ○, menthol (MR=1.27); ▲, melatonin (MR=2).

The smallest microcapsules were hosted in the cavity of the bean shaped cotton fibres and the biggest in between fibers (Figure 3).

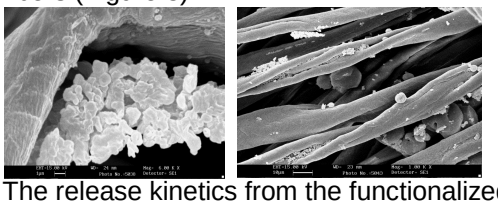

Figure 3. Image of fabric samples impregnated with the nanosuspension containing 36 ml/ml melatonin and 6 mg/ml PCL, obtained from the scanning electron microscopy analysis

The release kinetics from the functionalized fabrics was in-vitro assessed in a vertical Franz cell- equipment (Figure 4), using a mix of cellulose esters membrane (Pall, USA). In most cases, the release kinetics can be described by the Higuchi model (Figure 5), which is typical of a planar system with constant drug diffusion in one dimension and a perfect sink condition (hypothesis suitable for many trans-dermal systems).

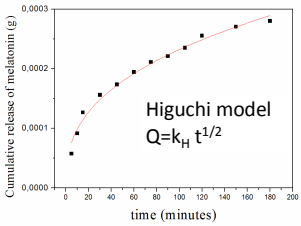

Figure 4 Cumulative release of melatonin (Q) from a knitted cotton functionalized fabric as a function of time t.

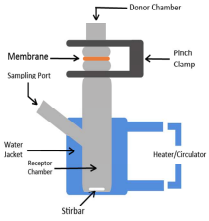

Figure 5 Scheme of the Franz-cell used for in-vitro transdermal release tests.

CONCLUSIONS

The kinetics of active principles' release from knitted cotton fabrics functionalized with PCL microcapsules demonstrated that a fabric can be a similar substrate to conventional trans-dermal patch. This work adds some pieces of information for the development of bio-functional textiles.

SHORT LIST OF REFERENCES

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[2] Barresi AA, Vanni M, Fissore D, Zelenkova´ T. 2015. Synthesis and preservation of polymer nanoparticles for pharmaceuticals applications.
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