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Electrospraying particles for loading into microcontainers for drug delivery

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Purpose:

To utilize electrospray to prepare biopolymer particles in the micrometer size range encapsulating a drug compound. Furthermore, the properties of the microparticles were investigated for its properties as an oral drug delivery system.

Introduction:

In drug delivery, it can be challenging to deliver drugs by the oral route, and to achieve an effect of the drug after delivery, it often needs to be encapsulated in polymeric particles. Novel techniques to produce such particles of polymer and drug, can be electrohydrodynamic methods, such as electrospraying. In this process, high voltage can be applied to e.g. a polymer-drug solution supplied through an emitter, producing a liquid jet resulting in particle formation (Figure 1) [1,2]. Some of the advantages using electrospray to produce polymer particles encapsulated with drug, can be a high efficiency of the drug encapsulation, several drugs can be encapsulated in the polymeric particles and also a flexible encapsulation capacity can be very beneficial. Moreover, the method is in general stable and gentle, and can be used to encapsulate sensitive species such as biopharmaceuticals [3]. The technique is in addition also industrial attractive, as it can easily be scaled up.

Results:

Microparticles were produced in the biopolymer, chitosan using electrospray with ethanol and acetic acid (10% in water) 1:1 as the solvent. The biopharmaceutical drug compound, ovalbumin was encapsulated into the chitosan particles in 40 w/w% of ovalbumin in relation to chitosan content. A scanning electron microscope image of the particles can be seen in the Figure 2. It was found that the size of the particles could be tuned adjusting the settings in the electrospray process. The size was depended on the flow rate of the polymer-drug solution and on the distance between the emitter tip and the collector plate, and it was observed that reducing the distance and the flow rate resulted in bigger particles. When the distance between the emitter tip and the plate was 10 cm and a flow of 10 $\mu\text{L}/\text{min}$, the average size of the polymer particles with drug was $5.4 \pm 0.4 \mu\text{m}$, whereas with a distance of 15 cm and a flow of 16 $\mu\text{L}/\text{min}$ the particle size was found to be $0.45 \pm 0.1 \mu\text{m}$ (Figure 3). The encapsulation efficiency of ovalbumin in the microparticles was shown to be close to 100 %, and a release of the ovalbumin from the particles within a time period of 5h.

These particles are planned to be filled into SU-8 micrometer sized drug delivery devices (microcontainers). The SU-8 microcontainers are fabricated using two-steps of photolithography and have an outer diameter of around 300 μm (Figure 4). The microcontainers have shown promise to be used for oral drug delivery [4].

- [1] M. Zamani, MP. Prabhakaran, S. Ramakrishna, Int. J. Nanomedicine. 8 (2013) 2997–3017.
[2] K. Stephansen, M. García-Díaz, F. Jessen, IS. Chronakis, HM. Nielsen, Int J Pharm. 495 (2015) 58–66.
[3]: A. Balaji, MV. Vellayappan, AA. John, AP. Subramanian, S. Razak, RSC Adv. 5 (2015) 57984–58004.
[4]: LH. Nielsen, A. Melero, SS. Keller, J. Jacobsen, T. Garrigues, T. Rades, A. Müllertz, A. Boisen, Int J Pharm. 504 (2016) 98-109

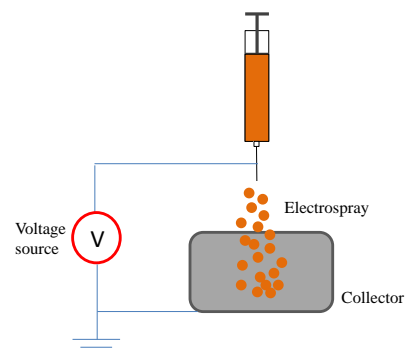


Figure 1. Schematic of the electrospray process resulting in formation of drug-polymer particles.

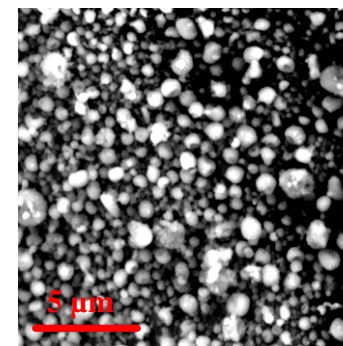


Figure 2. A scanning electron microscope image of the microparticles produced by electrospray.

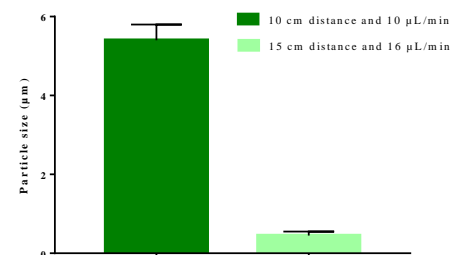


Figure 3. Sizes of the polymeric particles when using two different settings for the electrospray process.

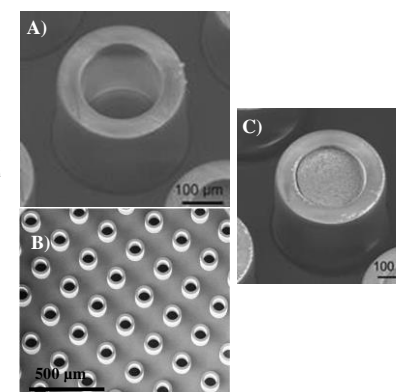


Figure 4. SU-8 microcontainers to be utilized for oral drug delivery loaded with the microparticles. A) a single microcontainer, B) microcontainers on a silicon wafer, C) a drug-filled microcontainer.