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Fabrication and loading of polycaprolactone microcontainers on water soluble release layer for oral drug delivery

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Abstract: A novel strategy of hot punching has been developed for single-step fabrication of high aspect ratio biodegradable microcontainers for oral drug delivery. This method is up-scalable and can be used for various types of drugs and polymers. In addition to fabrication of microcontainers, in this abstract loading of the container cavities has been successfully demonstrated.

In recent years, microfabricated devices have been proposed as advanced drug delivery systems [1]. In particular, microcontainers have been demonstrated as promising new oral drug delivery systems with the potential to significantly enhance the bioavailability of drugs [2]. The microcontainers are preferentially fabricated with biocompatible or biodegradable polymers. In this study, we propose an advanced hot punching technique for the fabrication of microcontainers in polycaprolactone (PCL). As a major advancement, the previously used combination of embossing and thermal bonding are replaced with a single-step process, leading to a higher yield and a more time-efficient method.

The fabrication process is illustrated in fig. 1. First, the substrate is prepared by spin coating a Poly-Acrylic Acid-Polyethylene glycol (PAA-PEG) solution on a clean silicon wafer. After drying for 12 hours, a layer of PCL solution is spin coated at 800 rpm to achieve a thickness of 100 μm which is also dried for 12 h. Then the sample is embossed with a Ni stamp for 30 min at a room temperature of 70°C and a pressure of 1.9 MPa. In this step, the stamp features penetrate the PCL film until they reach the PAA-PEG film below, thereby punching out the microcontainers. Before peeling the surrounding polymer film off, the loading with microparticles into the cavities is performed by the powder embossing method [3]; Drug powder is placed in a recess and a pressure of 1.9 MPa is applied with a bonding press. The powder is embossed inside the container cavities after which the pressure is removed and the remaining PCL film is peeled off.

In conclusion, it is shown how to fabricate discrete biopolymer microcontainers in a single step and time efficient way. Furthermore, loading of the microcavities has been shown by using the punched PCL film as stencil and by using the powder embossing method.

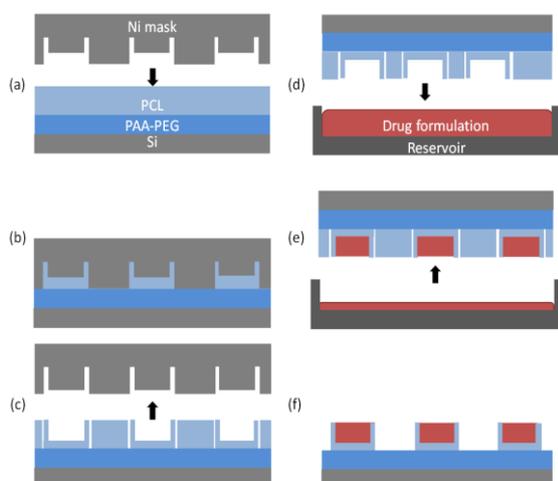


Figure 1: Graphical illustration of the single step fabrication of microcontainers

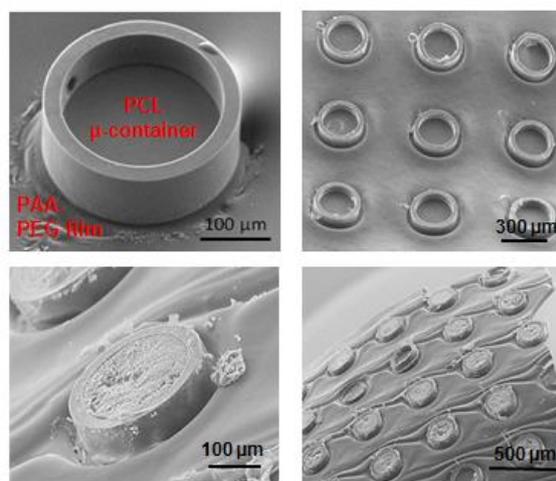


Figure 2: SEM images of PCL containers with and without powder loading

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