Biodegradable microcontainers on a water soluble substrate fabricated by hot punching for oral drug delivery

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Publication date:
2019

Document Version
Peer reviewed version

Citation (APA):
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In recent years, microfabricated devices have been proposed as advanced oral 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 state-of-the-art material for fabrication of microcontainers is the epoxy-based SU-8 resist. However, preferably, the microcontainers should be fabricated with biocompatible or biodegradable polymers [3]. In this work, we are presenting the fabrication of microcontainers in materials that are in accordance with such requirements, namely polycaprolactone (PCL) and poly(lactic-co-glycolic acid) (PLGA), and we are assessing their versatility for the production of oral drug delivery devices.

Microcontainers with a diameter of 300 µm and a height of 100 µm were fabricated using hot punching (a modified hot embossing technique). The process started with the assembly of a polymer device layer (either PCL or PLGA), a thin polytetrafluoroethylene (PTFE) if needed, and a PVA substrate. The device layer was then molded by a robust Ni stamp and finally punched due to the backpressure exerted by the PVA layer. After the hot punching process, the microcontainers were physically separated from the surrounding films and remained on the underlying PVA substrate.

PCL and PLGA microcontainers were successfully fabricated in arrays of 20x20 microcontainers in a single-step process. PCL microcontainers were further loaded with the model drug paracetamol in a uniform manner by the modified powder embossing method. A pH-sensitive lid of Eudragit L100 was spray coated on the microcontainers and the PVA substrate was then dissolved in aqueous medium. The microcontainers were harvested and filled into gelatin rat capsules. The in vitro release studies were performed to assess the suitability of the PCL microcontainers for oral drug delivery. Finally, an in vivo oral pharmacokinetic study in rats indicated prolonged absorption of paracetamol administered in the biodegradable microcontainers compared to controls. This confirms the potential of the biodegradable microcontainers as an oral drug delivery system.

References: