Fabrication of biodegradable microneedles for peptide delivery

Liliana R Pires, Rizwan Gill, Hélder Fonseca, Rosana Dias, Paulo Freitas, João Gaspar
INL – International Iberian Nanotechnology Laboratory, Av Mestre Veiga, Braga, Portugal
liliana.pires@inl.int

Abstract (Arial 10)

Microneedles have been extensively investigated in the recent years as means to mediate the delivery of drugs and/or peptides to the epidermal and/or intradermal space, overcoming the skin stratum corneum barrier. These devices hold the potential of allowing self-administration and painless application. Microneedles can be designed to dissolve in the skin, assuring biodegradability and safe disposal without biohazardous waste [1]. Particularly in the field of vaccination, the intradermal administration of antigens through the application of microneedle devices showed improved efficiency comparing to conventional injection procedures, being currently under clinical trials [2]. In this study we aim at designing and fabricating fully biodegradable polymeric microneedles that allow the sustained release of biologically active peptides to the intradermal space.

The approach used is to prepare a Si needle that acts as the master for a mold fabricated afterwards. Silicon microneedle masters were firstly prepared using a sequential isotropic-anisotropic-isotropic deep reactive ion etching (DRIE) process, previously developed for sub-5-µm needles [3] and extended here to structures in the range of 100-500 µm. A silicon wafer (700-750 µm thick) with silicon dioxide mask was patterned using lithography. Microneedle shape was determined by DRIE. Wafers were diced into 2 x 2 cm pieces and characterized by scanning electron microscopy (SEM). Poly(dimethylsiloxane) (PDMS) molds were prepared as previously described [4] after silanization of the silicon masters to facilitate removal of the molded materials. To obtain the polymeric microneedles mixtures of poly(vinyl acetate) (PVA) and poly(vinyl pyrrolidone) (PVP) were poured onto the prepared PDMS molds. Vacuum was applied to fill the molds and subsequently the solution was allowed to dry (24hrs). Solid microneedle patches were peeled off from the molds and analyzed by optical microscopy. Different PVA/PVP ratios were tested in order to optimize microneedle degradability, drug release and ability to pierce the skin.

Silicon microneedles were obtained by microfabrication techniques (Figure 1 A). Results show PDMS molds replicating the silicon master shape (Figure 1 B). Polymeric microneedles were successfully prepared showing around 400 µm height and 200 µm width (Figure 1 C). An aspect ratio ≥ 2 is considered suitable for microneedle perforation of the skin. The preparation of sharper needles is currently being pursued.

References


Figures