Title	Hot-embossed polymer microneedles
Authors	Verheggen, Jaap;Vazquez, Patricia;O'Mahony, Conor
Publication date	2012-05
Original Citation	Verheggen, J., Vazquez, P., O'Mahony, C. 2012. Hot-embossed polymer microneedles. Microneedles 2012, Cork, Ireland, 13-15 May 2012.
Type of publication	Conference item
Download date	2023-03-30 18:42:02
Item downloaded from	http://hdl.handle.net/10468/956

Hot-embossed polymer microneedles

J. Verheggen, P. Vazquez, C. O'Mahony

Tyndall National Institute, Cork, Ireland.

Jaap.Verheggen@Tyndall.ie

In recent years, microneedles have been developed as a method for transdermal drug and vaccine delivery, physiological signal monitoring[1] and electroporation. This research explores the possibility of replicating polymer microneedles by two-stage hot-embossing. Polymer microneedles might provide an alternative to silicon microneedles with regards to optical, mechanical and electrical properties as well as cost of fabrication. These opportunities are investigated. The method of fabrication is presented and compared to current techniques for fabricating polymer microneedles.

Hot-embossing is a polymer fabrication method that replicates a microstructured mold into a thermoset polymer that is heated above its glass transition temperature. Thermosets are cheap and are available in various modifications. Using hot-embossing, polymer microneedles with a wide range of properties can be fabricated[2]. At Tyndall, ultrasharp silicon microneedles have been developed for a range of biomedical applications. These silicon microneedles are replicated using an intermediate mold in a two-stage process as described in Figure 1. Although polymer microneedles can be fabricated directly from a silicon mold patterned with the inverse of microneedles; the two-stage process doesn't require the development of a silicon inverse mold and allows direct comparison between silicon and polymer microneedles.

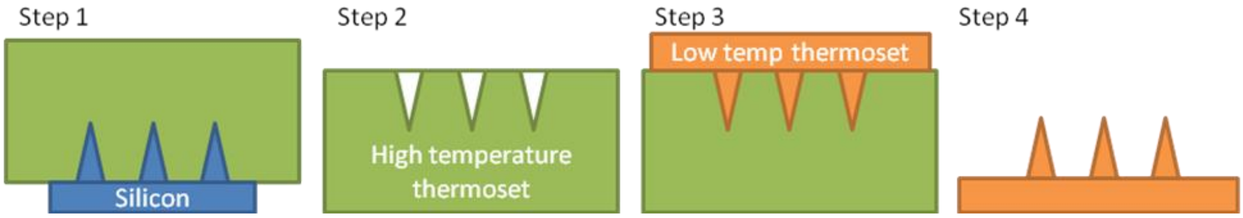

Figure 1: Fabrication process of polymer microneedels. Step 1: Emboss silicon needles into intermediate mold. Step 2: Remove the microneedles from the intermediate mold. Step 3: Emboss thermoset microneedles in intermediate mold. Step 4: Remove thermoset microneedles from the intermediate mold

Silicon microneedles are fabricated using KOH etching of silicon wafers [REF]. The silicon mould is glued to a machine tool using high temperature adhesive. The tool is loaded into the hot-embosser and is hot-embossed into the intermediate mould material. For two-stage hot-embossing, the intermediate mould needs to have an upper working temperature higher than the embossing temperature of the target microneedle polymer. PolyEthylenImine (PEI) has an upper working temperature of 170 to 200 ^{o}C and a glass transition temperature of 210 ^{o}C. This would make it suitable as an intermediate mould to fabricate many polymers such as Poly(methyl methacrylate) (PMMA), polycarbonate (PC) and polystyrene (PS). For the second stage of the process, the silicon mould is replaced with the PEI intermediate mould. This is then embossed into the low temperature polymer to form the microneedles. Figure 2 shows the inverse needle in PEI and Figure 3 shows a successfully replicated PMMA microneedle.

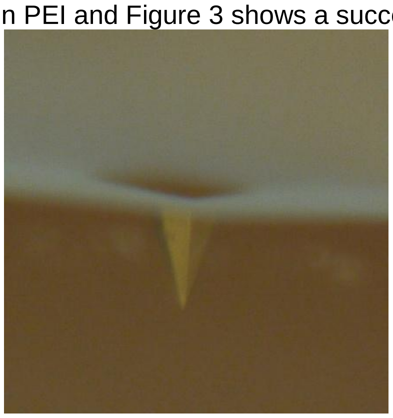

Figure 2: Microscope picture of PEI inverse microneedle.

Figure 3: Microscope picture of PMMA microneedle.

References

[1] Conor O'Mahony, Francesco Pini, Kevin G. McCarthy, Microneedle-Based Electrodes with Integrated Through-Silicon via for Biopotential Recording, Procedia Engineering, Volume 25, 2011,

[2] Matthias Worgull, Hot-embossing: Theory and technology of microreplication, William Andrew, Burlington, USA, ISBN: 978-0-8155-1579-1, 2009