Injection moulding hollow microneedles using laser ablated moulds

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Abstract

Traditional needles, known as hypodermic needles, are used in clinical practice to deliver vaccines or medication across the skin into the blood stream. Although such needles are very frequently used, they are known to induce discomfort to the patient, carry the risk of infections, and require trained medical staff. A possible alternative to hypodermic needles are microneedles. These are microscale invasive devices, usually arranged in an array, designed to by-pass the human stratum corneum skin barrier. The length of the needles ranges from 50 µm – 2000 µm and when penetrated in the skin, they can deliver vaccines, antibodies or other drugs to the human body, or collect interstitial fluid or blood through the transdermal route.

In a recent work, we demonstrated a methodology to produce solid polymer microneedles using laser ablated moulds in an injection moulding process [1]. We were able to create cone-shaped microneedles with tip radii < 20 µm. Although these solid microneedles can offer numerous advantages compared to the known conventional hypodermic needles, their application area is limited because they cannot be used to collect fluids and they can only deliver a small amount of drugs. Hollow microneedles however, have a huge potential as they can both inject and extract a larger amount of fluid.

In this study, a novel method for producing hollow polymer microneedles using laser ablated moulds in an injection moulding process is presented. This femtosecond laser method utilises a cross-hatching strategy with internal scan-free areas for the creation of the microneedle cavities. Afterwards, these microneedle cavities are replicated in a polymer injection moulding process to create bevel-shaped

hollow microneedles. We are able to create hollow microneedles with a length of 1000 µm, a base diameter of 400 µm, and a lumen of 100 µm, as shown in Figure 1.

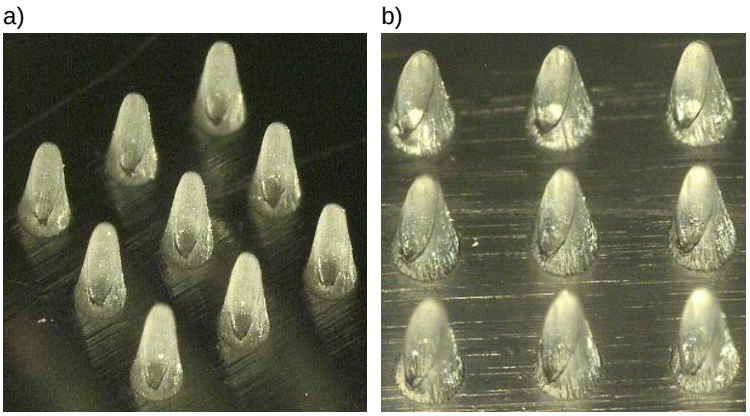

Figure 1: Two microscopic images of an injection moulded hollow polymer microneedle array in (a) front view and (b) side view.

References

[1] Evens T, Malek O, Castagne S, Seveno D, Van Bael A. A novel method for producing solid polymer microneedles using laser ablated moulds in an injection moulding process. Manuf Lett 2020;24:29–32. https://doi.org/10.1016/j.mfglet.2020.03.009.