

Supplementary file

Low-cost and cleanroom-free fabrication of microneedles

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SUPPLEMENTARY MATERIALS AND METHODS

Drilling methods

Three types of different drilling methods are shown in Supplementary Figure S1.

Photo curable Resin, PCL and chitosan microneedles

The objective of this paper was demonstrate a fabrication approach, we could easily extend this fabrication process to other polymers such as Resin, Polycaprolactone (PCL), Chitosan and some biocompatible photocurable polymers used in dental composites (Supplementary Figure S2).

Photo curable Resin microneedles

The following steps were taken to fabricate photo curable resin microneedles:

1. PDMS microneedle mold was prepared based on steps shown in Figure 1
2. The mold was plasma treated for 3 min
3. Photo curable resin was poured on the surface of the mold
4. The sample was vacuumed for 20 min to remove bubbles
5. The sample was exposed to UV light from bottom and top for 10 min
6. Resin microneedle patch was detached from the mold and washed with IPA and DI water

The final photo curable resin microneedles are shown in Supplementary Figure S2a.

Polycaprolactone (PCL) microneedles

The following steps were taken to fabricate PCL microneedles:

1. PDMS microneedle mold was prepared based on steps shown in Figure 1
2. The mold was plasma treated for 3 min
3. PCL was melted down in a glass beaker at 200 °C
4. Liquid PCL was poured on the surface of the mold
5. The sample was placed in a vacuum oven at 150 °C overnight to remove bubbles
6. The sample was taken out of the oven to cool down at room temperature for 3 h
7. PCL microneedle patch was detached from the mold

The final PCL microneedles are shown in Supplementary Figure S2b.

Polycaprolactone (PCL) microneedles

Similar steps as PVA microneedles were taken to fabricate Chitosan microneedles.

1. PDMS microneedle mold was prepared based on steps shown in Figure 1
2. The mold was plasma treated for 3 min
3. %5 chitosan solution (w/v) was prepared (phenol dye was also added to the solution for better visibility)
4. The solution was poured on the surface of the mold
5. The sample was vacuumed for 5 days to concentrate the solution and removing the bubbles
6. The sample was placed in a hot plate at 40 °C for 5 h
7. Chitosan microneedle patch was detached from the mold

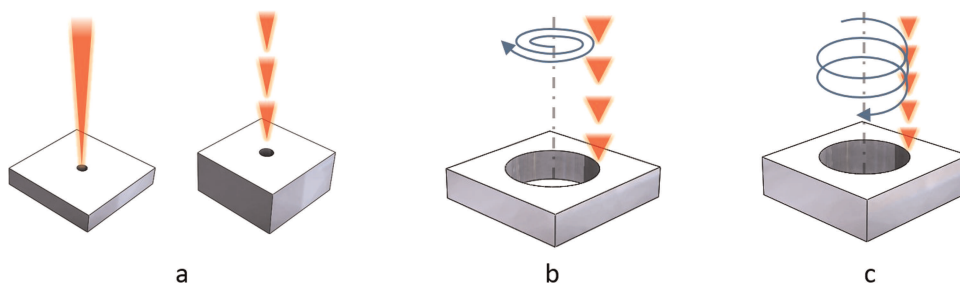


Figure 1 Methods of laser drilling (a) single shot drilling (b) trepanning (c) helical drilling.

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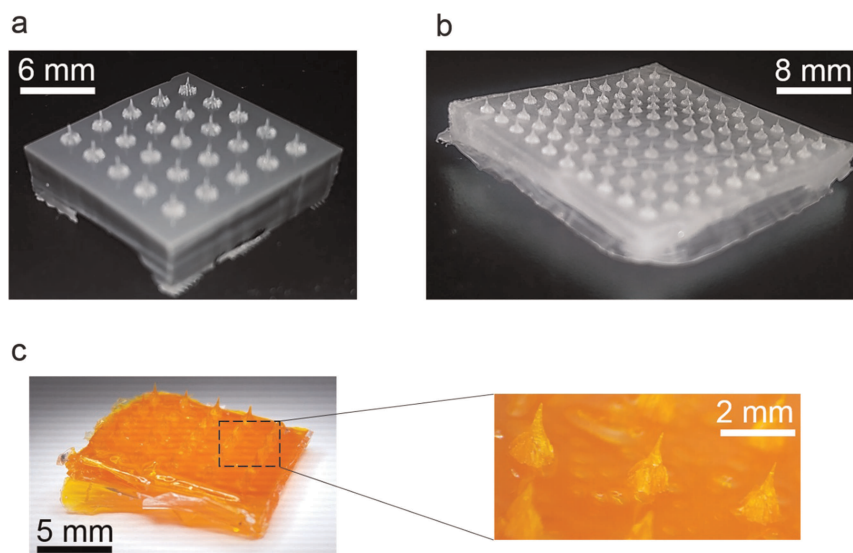


Figure 2 Microneedles made from (a) photo curable resin (b) PCL (c) Chitosan.

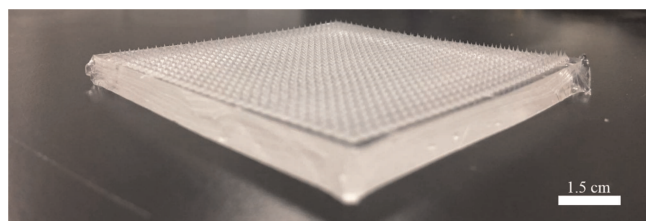


Figure 3 A microneedle patch of $6 \times 6 \text{ cm}^2$.

$6 \times 6 \text{ cm}^2$ microneedle patch

The COL technique merely requires a CO_2 laser cutting system to make the molds. Theoretically the only factor that limits the dimensions of the mold fabrication is the dimensions of the working platform of the laser. The working platform of the laser cutting system we use is $16'' \times 12''$ and the usual commercial microneedle patch size is about $30\text{--}40 \text{ cm}^2$ therefore it is very easy to fabricate a microneedle patch with a common patch size. To make this point, we fabricated a $6 \times 6 \text{ cm}^2$ patch which includes 1122 needles. The patch is shown in the Supplementary Figure S2.

The final Chitosan microneedles are shown in Supplementary Figure S2c.