Journal Name

Cite this: DOI: 10.1039/c0xx00000x

www.rsc.org/xxxxxx

ARTICLE TYPE

Self-Powered One-Touch Blood Extraction System: Novel Polymer-Capped Hollow Microneedle Integrated with Pre-Vacuum Actuator

Cheng Guo Li, Manita Dangol, Chang Yeol Lee, Mingyu Jang and Hyungil Jung*

Received (in XXX, XXX) Xth XXXXXXXXX 20XX, Accepted Xth XXXXXXXXX 20XX
DOI: 10.1039/b000000x

Supplementary Information

Fabrication of the optimized hollow microneedle: The SU-8 2050 negative photoresist (MicroChem, USA) was spin-coated onto a flat glass panel at spin speeds of 1500 μm (coating thickness was about 120 μm), placed on a 120 °C hot plate for 5 min, and cooled to room temperature. The photoresist was then placed in contact with a prepared pillar with a 300-μm diameter, and drawing lithography was performed at a drawing rate of 10 μm s^{-1} for 6 min at 60 °C to produce a high-aspect-ratio microstructure solid mold of 3600 μm. This photoresist was cured for 30 min at room temperature to solidify the polymeric bridge. The microneedle was separated from the frame by increasing the drawing speed to 700 μm s^{-1} to fabricate a microneedle solid mold with an approximate height of 1800 μm and tip diameter of 60 μm. The hollow metallic microneedles were fabricated by nickel electroplating onto the solid mold with a silver layer that was deposited by Tollen's reaction. The nickel electroplating was performed in a 52 °C nickel bath for 150 min with a constant current density of 2.8 mA cm^{-2} to obtain metallic microneedles with a 35-μm wall thickness. The 15° tip angle was treated at the tip of each nickel microneedle by laser (K2 Laser System, Korea) and the solid mold was removed with SU-8 Remover (MicroChem, USA) to complete the hollow microneedle.

Figure S1

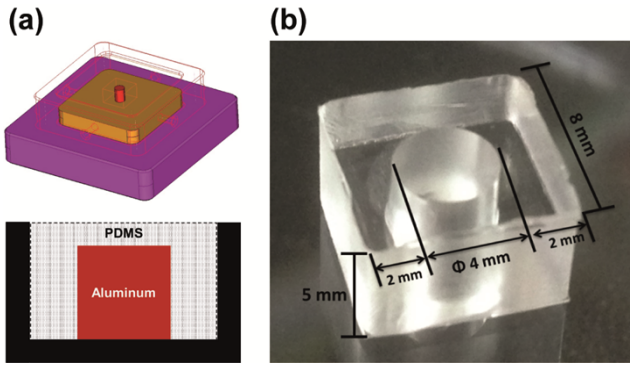

Fig. S1 (a) PDMS chamber molding using the aluminum master; (b) Chamber structure with length and width of 8 mm and a height of 5 mm containing a cylindrical chamber with a diameter of 4 mm and height of 4 mm.

Figure S2

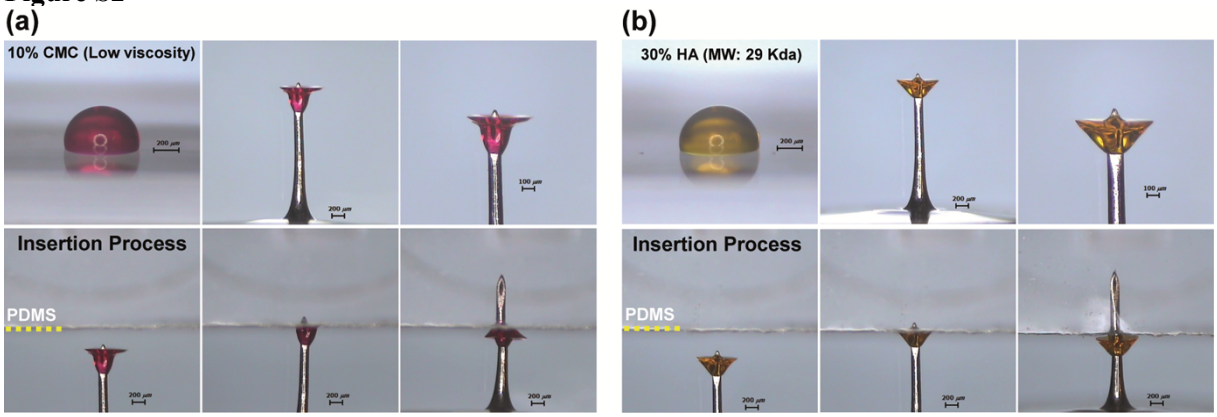

Fig. S2 The hollow microneedles capped with viscous CMC (10%, w/v) and HA (30%, w/v) polymer solutions using the micron-scale capping method to form exposed-tip structures. (a) The hollow microneedle capped with viscous CMC (10%, w/v) polymer solution containing pink dye, and the polymer cap separation process; (b) The hollow microneedle capped with viscous HA (30%, w/v) polymer solution containing yellow dye, and the polymer cap separation process.

Figure S3

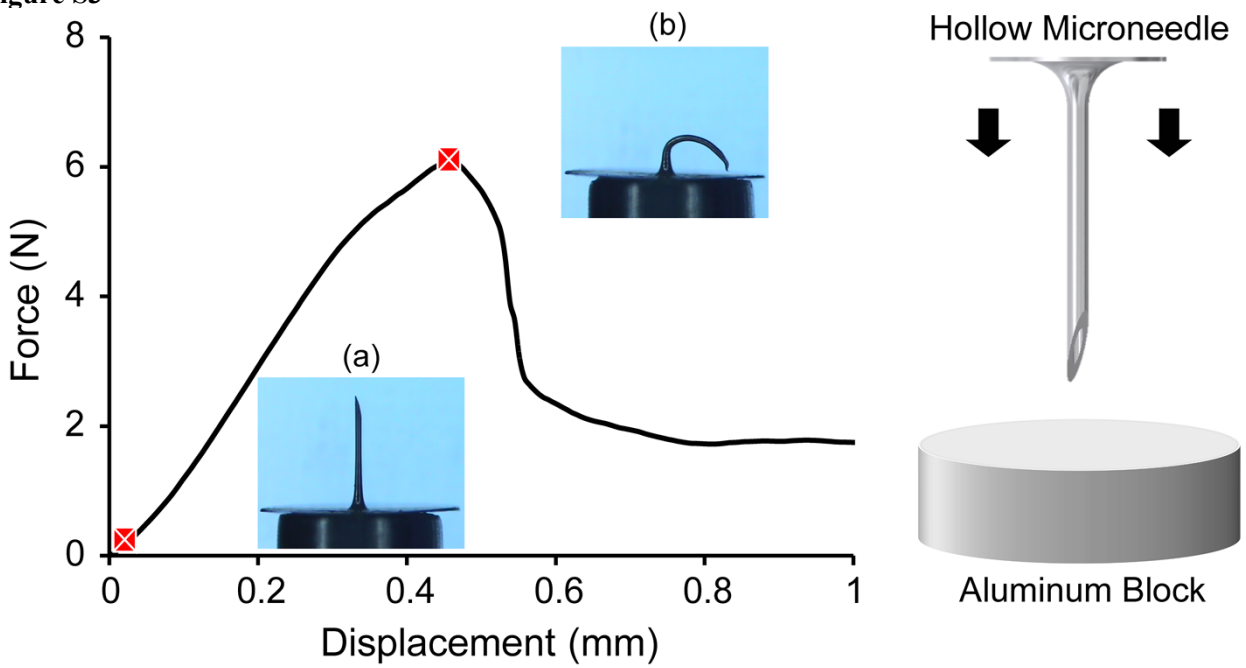

Fig. S3 A schematic illustration of the fracture force measurements of the hollow microneedles (fracture was identified by a sudden drop in force). The fracture force data was collected by driving microneedles against an aluminum block. The image of the microneedle was shown before (a) and after (b) fracture force measurements.

Supporting Videos:

Supporting video 1: *In vitro* delayed distilled water extraction process via polymer-coated hollow microneedle.
Filename: Delayed water extraction.wmv (Video clip: 8.09 MB)

Supporting video 2: *In vitro* rapid-response distilled water extraction process via exposed-tip polymer-capped hollow microneedle.
Filename: Rapid-response water extraction.wmv (Video clip: 1.34 MB)

Supporting video 3: Pre-vacuum activated system for *in vivo* blood extraction process via exposed-tip polymer-capped hollow microneedle.
Filename: Pre-vacuum activated system for in vivo blood extraction.wmv (Video clip: 1.88 MB)

Supporting video 4: Pre-vacuum inactivated system for *in vivo* blood extraction process via exposed-tip polymer-capped hollow microneedle.
Filename: Pre-vacuum inactivated system for in vivo blood extraction.wmv (Video clip: 2.24 MB)