Amphiphobic mushroom-like structures fabricated by direct nanoimprint lithography

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Intensive research efforts have been performed during the last years to study and realize surfaces with self-cleaning properties. However, engineering surfaces that show low affinity toward most of the low surface tension liquids like oils is not achievable unless re-entrant or overhanging structure in addition to low surface energy are provided [1].

Nanoimprint lithography (NIL) is a good alternative towards the conventional fabrication methods due to its low cost and high throughput [2]. However, despite great efforts have been made to improve the applications of NIL; it has not been demonstrated as a suitable approach to fabricate overhanging structures [3,4,5]. Here we show the potential of NIL to fabricate complex overhanging structures.

By a novel one-step controlled electroplating process we produced mushroom-like structures with controlled shape. These structures were fabricated using the template-assisted electroplating concept. We create a polymer mask with an array of cylindrical holes by means of a photolithography process over a conductive substrate for subsequently realize the electroplating process only on the opened channels of the surface. These structures were successfully replicated in a soft PDMS stamp followed by a direct UV-NIL step to replicate the them in a photocurable resist. (Figure 1). Figure 2 shows different SEM images of

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overhanging structures fabricated by direct NIL, where the precise control over the morphology of the mushroom-like structures is observed. The surface morphology, in combination with a low surface energy coating demonstrated repellency towards a wide range of low surface tensions liquids (Figure 3).

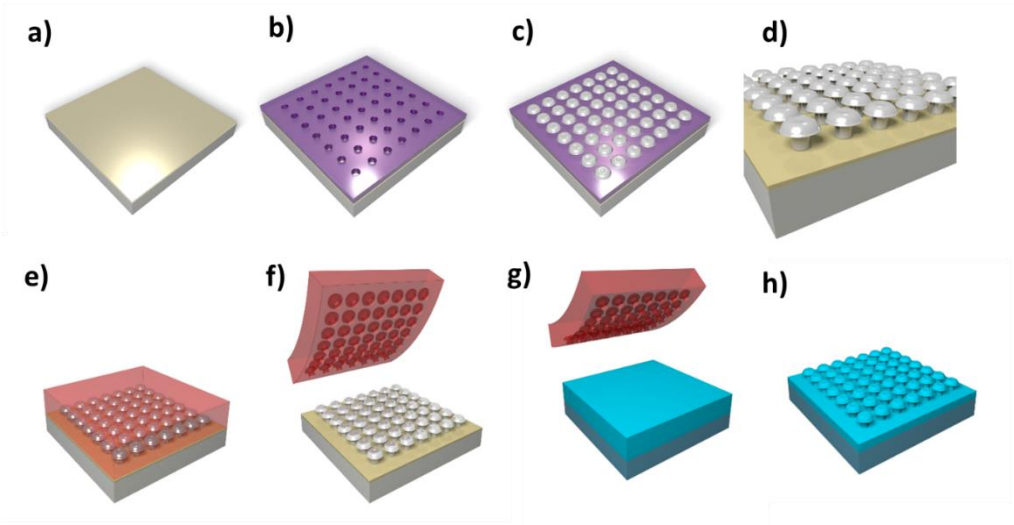

Figure 1. Schematic of the fabrication process followed to develop the polymeric mushroom-like structures. The template was fabricated on nickel by electrodeposition. A soft stamp was produced with the negative pattern. This soft stamp was used to produce mushroom-like structures by direct UV-NIL.

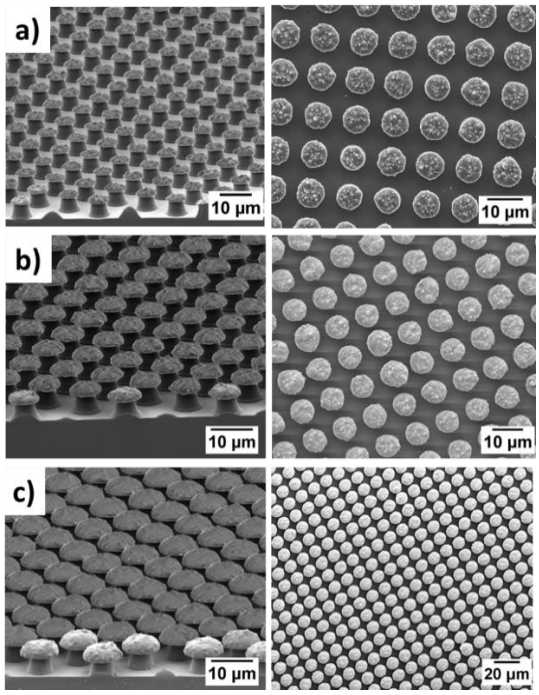

Figure 2. SEM images showing Ormocomp mushroom-like structures with different overhang degrees. a) Distance between caps of 3-3.5 µm, b) distance between caps of 2-2.5 µm and c) distance between caps of 0.8-1 µm.

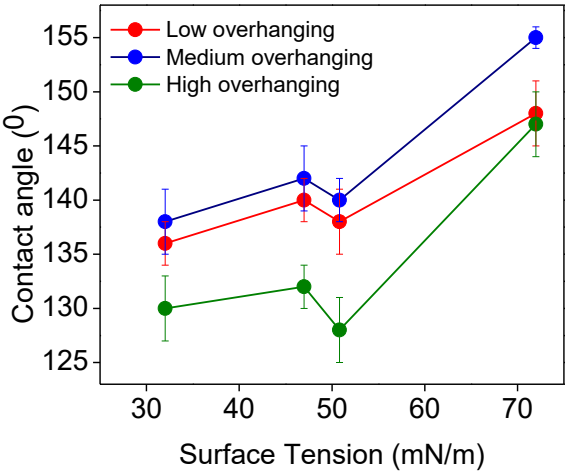

Figure 3. Graph showing the obtained contact angle values for liquids with different surface tensions.

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