The manufacture of micropillars with high depth-to-width ratio, and the comparison between two typical materials

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This paper demonstrates a new method in manufacturing micropillars with a relative high depth-to-width ratio, compared with former works. As is known that micropillars enjoy a wide range of applications in the field of biology and chemistry, such as cancer drug screening, the auto-formation of artificial vessels, and so forth, the strict demand for high depth-to-width ratio haven’t effectively settled in conventional MEMS technology. Also considering other means, for instance, through the stereolithographic printing process is of high cost, we propose a rapid way that combined the laser drilling as well as molding to realize the whole procedure¹. And we will discuss the diverseness of two materials, PMMA (Poly(methylmethacrylate) and PDMS (polydimethylsiloxane), in fabricating the micropillars. Some simulations contribute to our deeper comprehension of the pillar structure, which mainly lie in strain behavior.

We used CO2 laser system to ablate the substrates, which resulted in PMMA or PDMS mould in single hole drilling mode (Fig1 (a)). Then, in order to prevent the materials from tightly bonding with each other, we coated a layer of silane preserving for 3 hours (Fig1 (b)). Next, we transfused PDMS (as well as PMMA) onto the surface of the microwell-structure that served as the die (Fig1 (c)). After detaching the two parts, we obtained the array of micropillars with high depth-to-width ratio (Fig1 (d)).

For the sake of quantizing the relationship between the power of laser and the depth, diameter of the mould, we adopted 5 different powers of laser, and catch images of the mould profile that can describe the configuration of micropillars (Fig2 (a)). The tendency presents ascending orientation with the increase of laser’s power, and the depth-to-width ratio is also in constant augment from intuitively view (Fig2 (b)). As we exerted the laser of 10W, the molded result of micropillar illustrate superb character in high depth-to-width ratio (Fig2 (c)).

Observing from top view, the array of micropillars as well as its mould (Fig3 (a)), we can apparently figure out that owing to the prototyping technique of fabricating mould would manufacture higher depth-to-width ratio wells than common etching, and the micropillars not only exhibit excellent character in uniform, but could also realize abundant number. Therefore, this method efficaciously expresses excellent outcome ranging from time, and energy saving, to low cost.

We also run some simulation works in order to reveal the intensive property of micropillars, and the model’s dimension, features of material, and surroundings are all resemble with the actual micropillars. We separately applied 10, 20, and 30 pressures on the upper surface of micropillars. Solving the model with proper external effect after meshing, we can uncover the carrying capability of micropillars, and we can also approximately estimate the maximum bearing capability of the structure.

In summary, we present efficient methods in manufacturing plentiful of micropillars array with high depth-to-width ratio, and discussed the differences between two suitable materials. The subsequent simulation works are conducive to ulteriorly optimizing parameters that varies with sundry of situations.

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References
