Using DLP 3D Printing for Rapid Fabrication of High Quality Molds for PDMS structures

In this research proposal, we explore how rapid prototyping methods, especially Digital Light Processing (DLP) can be used to fabricate molds for soft lithography. We will also conduct a comparative analysis on different resins while analysing and decreasing the surface roughness (R_a < 1 µm) of 3D printed molds.

Leveraging the Benefits of Rapid Prototyping

Rapid prototyping is a powerful tool that allows for fast and efficient exploration of design concepts. By using computer-aided design (CAD) software to create 3D models and then 3D printing those models as physical objects, engineers and designers can quickly iterate on ideas, test functionality, and make necessary adjustments. Soft lithography is a technique that involves using these 3D printed molds to create micro- and nano-scale structures.

The Importance of Surface Roughness in Molds

Mold Surface Roughness

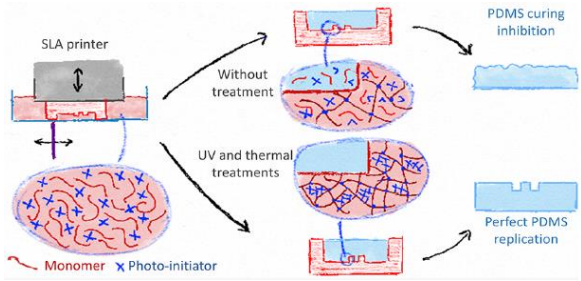
The surface roughness of a mold is the measure of the small, finely-spaced deviations from the mold surface. In the case of soft lithography, surface roughness can impact the quality of the structures that are created and also affect the surface dwell time and subsequent wetting behavior of the mold.

Surface Roughness Standards

The standard measurement of surface roughness is R_a, which is the arithmetic average of the deviations from the surface plane. It is measured in micrometers (µm) and can have a significant impact on the final product quality. Reducing surface roughness is important for a variety of reasons, including minimizing friction, improving aesthetics, and enhancing chemical resistance.

Methodology

We will use a desktop SLA 3D printer, different photopolymer resins, and a UV curing system to create the molds. We will analyze the surface roughness of the molds using a contact profilometer, which will capture the surface in micrometers. To decrease surface roughness, we will experiment with various post-processing treatments such as solvent vapor treatment and polishing.



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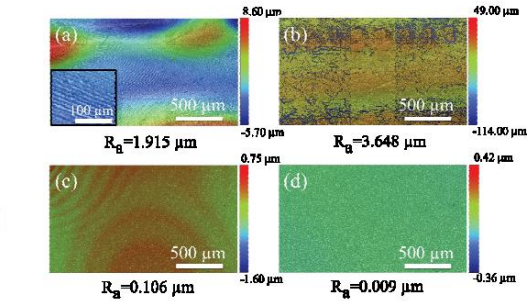

Y. Hwang, O.H. Paydar, R.N. Candler, 3D Printed Molds for Non-Planar PDMS Microfluidic Channels, Sensors and Actuators: A Physical (2015).

Expected Results and Conclusion

We anticipate that the 3D printed molds will be of high quality with good accuracy and an R_a of less than 1 µm. We also anticipate that post-processing treatments will decrease surface roughness by up to 80%.

Implications and Applications of the Research

The success of this research could lead to faster and cheaper fabrication of molds for soft lithography. It could also improve the quality of the final product and make the process more accessible to researchers who do not have access to larger manufacturing systems.

References:

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