A low-cost manufacturing method for microfluidic device based on soft-lithography technique

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Background

- Microfluidics has been widely applied to focus, separate and trap micro sized particles, and has played an increasingly important role for applications that involve single cell biology and the detection and diagnosis of diseases.
- One essential part of microfluidic applications and research is the fabrication of microfluidic devices. Traditional nanotechnology requires cleanroom and well trained personnel, which has highly increase the cost of microfluidic device fabrication process.
- This work demonstrates a low-cost and high resolution method to fabricate microfluidic devices by using soft-lithography technique. Basically, the dry film photoresist is exposed under LED light source and transparent mask is used to pattern microstructures on dry film. Briefly, a layer of dry film resist was first laminated onto a copper plate using a thermal laminator. After ultra-violet (UV) exposure through a transparency photo mask, the exposed dry film was developed, rinsed and dried to obtain the master mold. The microstructures then are replicated into Polydimethylsiloxane (PDMS) to form microfluidic channel for experimental use. This fabrication method enables microfluidic applications in biology, biomedical and medicine area without requiring cleanroom environment.

Approach

The system is based on the optical photo-lithography principle. It uses dry film photoresists, low-cost transparency photo masks, and a UV-LED light source.

In contrast to previous efforts that required stringent conditions to make small features, we demonstrate a good resolution with an inexpensive UV light source while the entire fabrication is done without a cleanroom.

Overview of the System and Fabrication Process

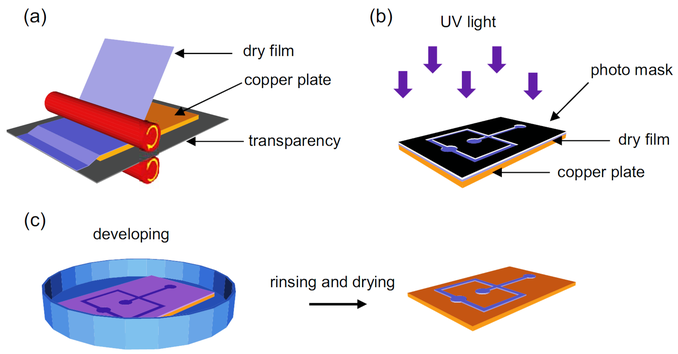


Fig. (2). Schematic of the fabrication process [1]. (a) Dry film is laminated onto a substrate (e.g. copper) with an office laminator. (b) Exposure through a photomask under a UV light source. (c) Development of the exposed dry film.

- The microfluidic device was fabricated in PDMS using a soft-lithography technique. Master molds were manufactured in a dry film photoresist (MM540, 35 µm thick, DuPont) by lithographic patterning.
- A layer of dry film resist was first laminated onto a copper plate using a thermal laminator. After ultraviolet (UV) exposure through a transparency photo mask, the exposed dry film was developed, rinsed and dried to obtain the master mold.
- PDMS base and initiator were thoroughly mixed, degassed, and then cast on the master. After curing, the PDMS replica was peeled off from the master, cut and punched, and then bonded with another thin PDMS layer after corona surface treatment.

Results

- Using this method, microfluidic and microstructure channels with rectangular cross sectional shape were fabricated.

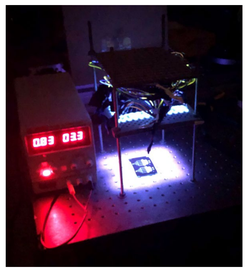


Fig. (3). The actual UV-LED light source assembly

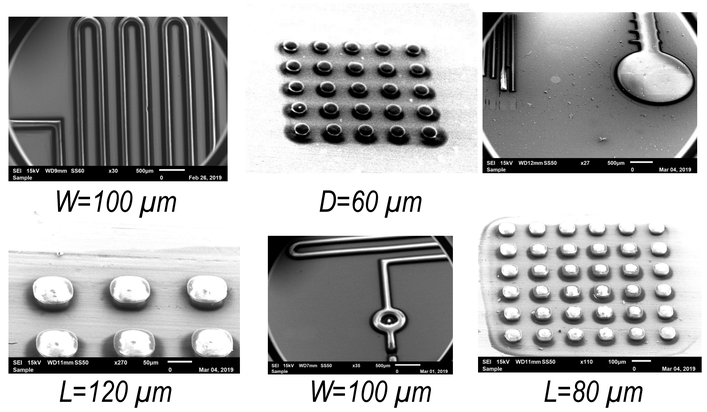


Fig. (4). The scanning electron microscopy photographs of test structures

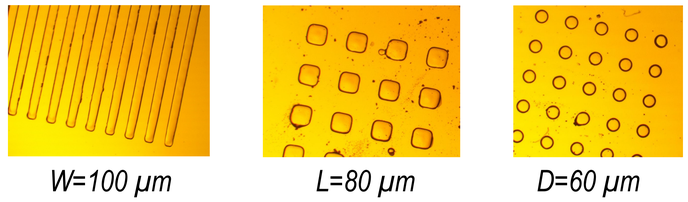


Fig. (5). 2D microscopy photographs of test structures

- In this project, we have designed and characterized a low cost lithography patterning system by combining dry film photoresist, transparency photo mask, and UV-LED exposure light. The system demonstrates the capability of manufacturing master molds in dry film with 60 µm feature resolutions.

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REFERENCES

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