Supplementary Material (ESI) for Lab on a Chip
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Rapid and low cost prototyping of microstructures in polydimethylsiloxane (PDMS) by direct UV-lithography

Supporting Information

Experimental

Preparation of Polydimethylsiloxane (PDMS)

For the described experiments with polydimethylsiloxane, the Sylgard 184 elastomer kit (Dow Corning, US) was used. The elastomer was prepared according to the manufacturer's instructions by thoroughly mixing the two precursors in a ratio of 10:1. Silicone samples with several millimetres thickness were obtained by pouring the PDMS into a polystyrene Petri dish. To remove air bubbles, the mixture was degassed under vacuum for 5 min. Thin films with distinct thicknesses were produced by spin coating the mixture onto cover slips and varying spin times and speed [1]. The samples were allowed to cure for at least 4 h at 60 °C.

Direct VUV-lithography and pattern development

The patterns were produced by first irradiating the PDMS substrates through a chromium/quartz photomask with a low pressure mercury lamp (15 W NNQ, Heraeus Noblelight, Germany) at a distance of 10 cm corresponding to surface power densities of 150–200 µW cm^{-2} at 185 nm. The energy doses were calculated from the duration of UV exposure and the surface power density measured with a UV power meter (Hamamatsu Photonics, Japan). The latent pattern in the irradiated substrates was immediately developed with a solution of 1 M NaOH and ethanol (mixed in a ratio of 1:1 v/v) at RT either by gently shaking the samples for 45–60 min or by sonication with ultrasound for 10–20 min. The determination of structural depth, surface roughness, edge steepness as well as the measurements of film thicknesses were performed with a 3D violet laser scanning microscope (VK-9700, Keyence, Japan) and scanning electron microscopy.

Microcontact printing

The µCP of bovine serum albumin (BSA) labelled with fluorescein isothiocyanate (FITC) was performed following established protocols [2]. In brief, the stamp was hydrophilized by irradiating with VUV (flood exposure). A solution of 1 mg/ml FITC-BSA in phosphate buffered saline (PBS) was pipetted onto the PDMS and incubated in the dark for 5 min. After removal of the drop, the sample was dried in a nitrogen stream and directly placed on a cleaned glass cover slip for 1 min.

Pattern transfer using micromoulding in capillaries (MIMIC)

The mould for MIMIC was fabricated by irradiating a PDMS substrate through a chromium quartz mask with a line and space pattern. A network of crossing channels was generated by a second exposure with the mask rotated 90°. After development, this stamp was placed on a PDMS substrate hydrophilized by UV irradiation. The channels filled due to capillary action with a 0.1 M solution of fluorescein dissolved in a mixture of 80% ethanol and 20% 1 M NaOH. After drying at 60°C over night, the mould was carefully lifted off. The dried fluorescein structures with thickness ranging between 4–6 µm served as a mask blocking the UV light. Developing removed the irradiated silicone as well as the temporary mask.

Cell culture

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HeLa cells (obtained from German Collection of Microorganisms and Cell Cultures GmbH – DSMZ) were cultivated in Quantum 101 medium (PAA, Germany) supplemented with Penicillin/Streptomycin (PAA, Germany) in cell culture flasks. At confluency, the cells were detached with Trypsin/EDTA. Cell cavities were prepared by spin coating 3–5 µm thick PDMS films onto cover slips and irradiating the cured PDMS layer through a mask with approx. 5 J/cm^2. After developing the irradiated structures, the samples were washed twice with PBS. Cells were seeded onto the substrate at a concentration of about 15,000 cm^{-2} and incubated for 24 h at 37°C and with 5% CO_2. For examination with a fluorescence microscope, the actin filaments of the cells and cell nuclei were stained. Staining of the actin filaments was performed with Alexa-Fluor-488-labelled phalloidin (Molecular Probes, U.S.), following the manufacturer's instructions. For nuclei staining, the phalloidin containing solution was supplemented with DAPI (0.1 µg/ml). After washing with PBS and deionised water, the samples were mounted with Fluorescence Mounting Medium (Dako, U.S.) and examined with a fluorescence microscope (Axiovert 200M, Zeiss, Germany).

Soft embossing

The soft mould was fabricated by exposing a 1 mm thick PDMS film (diameter 36 mm) with VUV through a chromium quartz mask. The film was developed as described above. In a heatable press, the PDMS mould was replicated into a 50 µm thick polymethylmethacrylate film (Goodfellow Ltd., UK) at 160 °C and with a pressure of approx. 7 MPa.

References

1. *J. H. Koschwanez, R. H. Carlson and D. R. Meldrum, PLoS ONE, 2009, **4**, e4572.*
2. *K. Shen, J. Qi and L. C. Kam, J. Vis. Exp., 2008.*