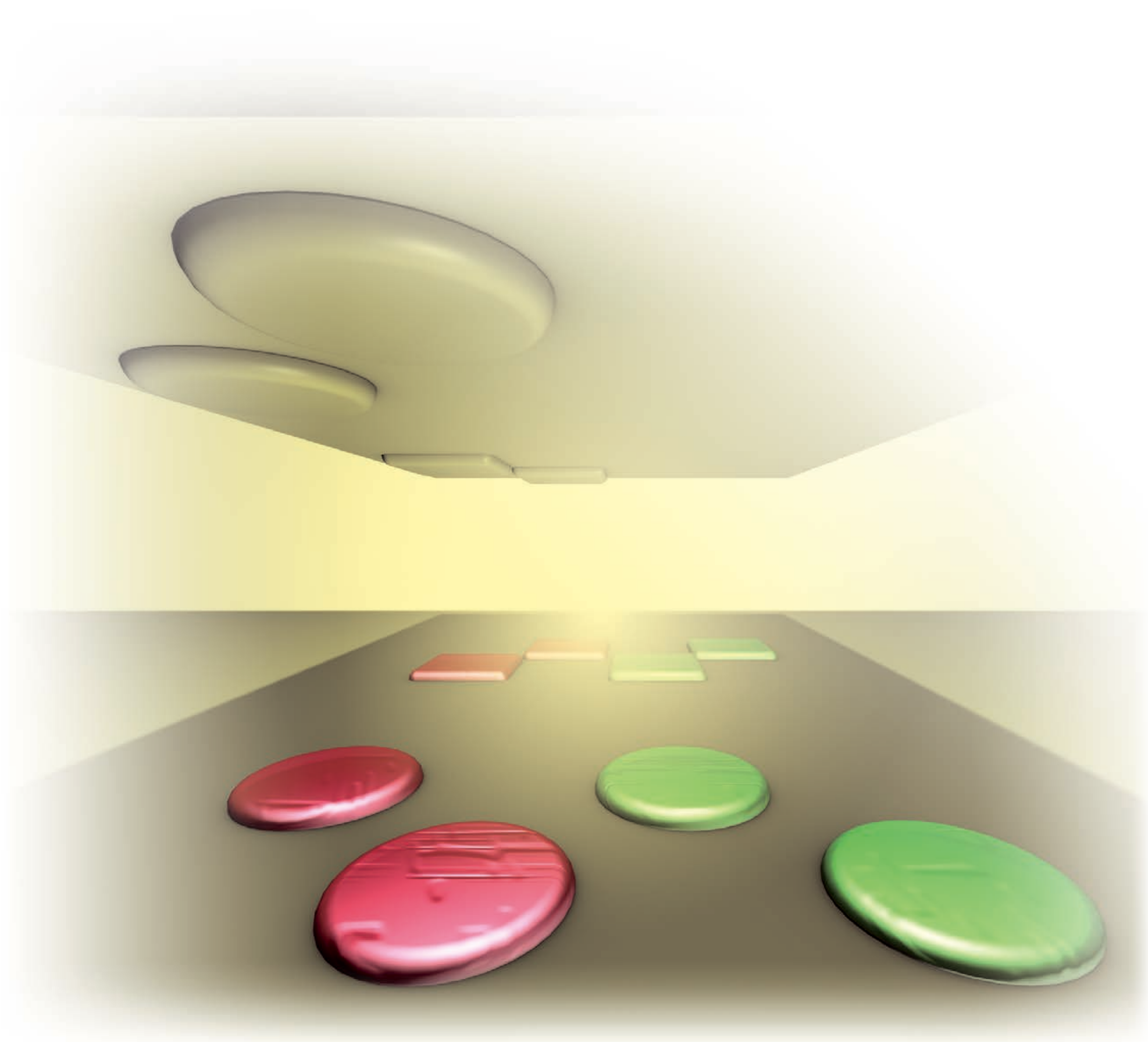
µContact Printers

Instruments for Microcontact Printing and NIL

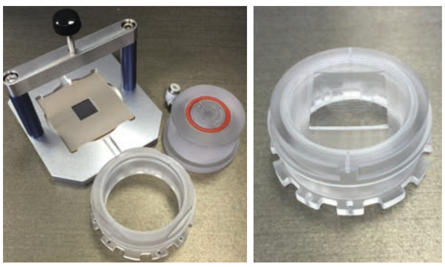


GESIM

The Making of Micro- and Nanostructures in 2D ...

Few simple techniques exist to produce tiny patterns on a surface. One method, microarray spotting (e.g. with the GeSiM Nano-Plotter) generates a resolution of approx. 100 µm. Microcontact printing (µCP) does work on the nanoscale: a soft polymer like PDMS (silicone) is cast on a micro- or nanostructured master; the resulting stamp is soaked in sample and pressed onto a surface, thus transferring molecules from the protruding areas.

Chemicals, biomolecules, nanoparticles, beads and cells can be printed, which is why µCP is getting popular in the life sciences, e.g. to study the influence of structured matrix proteins or growth factors on growth, differentiation and movement of cells.



Stamp casting station (left) and ready to use stamp membrane in stamp frame

... and 3D

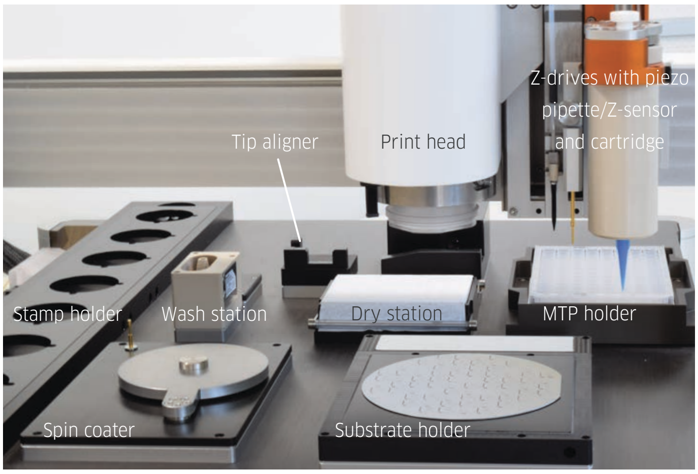
Nanoimprint lithography (NIL) has become a hot topic in microelectronics and cell biology. Here the entire stamp structure is replicated in a soft polymer at elevated temperature and fixed by cooling or UV cross-linking.

µCP *and* NIL are easily performed on the fully automatic GeSiM µContactPrinter 4.1, taking the risk out of both methods. Smaller structures can be tiled together via step & repeat, especially when using “double-side patterning” with a silicon mask in the stamp. For higher throughput, the larger µCP 4.2 exists.

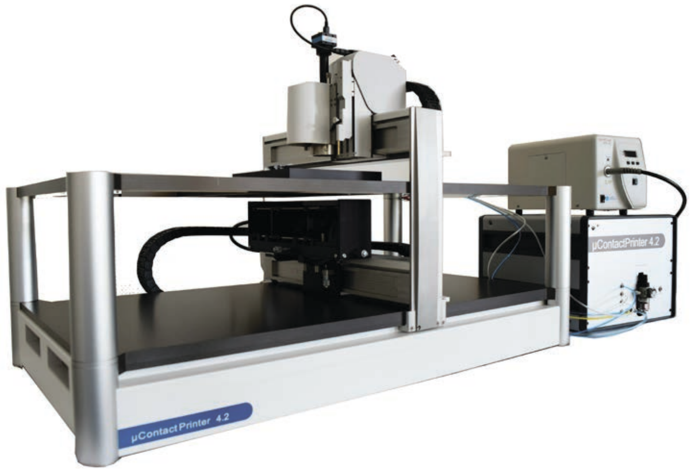
Stamping Procedure

A casting station for stamp moulding is included. Customized, teflonised silicon masters with structures as small as 100 nm can be ordered from GeSiM. Other stamp materials can be used as well, e.g. the stiffer PFPE for structures < 500 nm with high aspect ratio. The printing runs automatically:

1. *Stamp loading*: The stamp frame with the stamp membrane is picked up from the stamp holder by the print head.
2. *Sample preparation*: Liquid is pipetted onto a 5 cm (2”) wafer, followed by spin coating.
3. *Inking*: For sample uptake, the stamp is pressed onto the semi-dry wafer in a time-controlled manner. Prior stamp drying is thus not necessary.
4. *Stamping*:
   - The stamp can move in XYZ *and* rotate
   - A microscope built into the print head is used for manual or automatic alignment of stamp and substrate
   - Controlled inflation of the polymer stamp before and during printing
   - Pressure increase after surface contact is possible, especially for NIL
   - Options for NIL: temperature-controlled substrate holder, UV illumination for curing, “double-side patterning” using a silicon aperture for accurate structuring of the shape of the imprinted polymer by UV curing.



µCP 4.1 workstations: rack for stamps, spin coater for inking (with stamp height sensor), substrate holder with vacuum fixation, tool for tip alignment, turnable print head, plus ink-jet dispenser, Z-sensor and cartridge holder. Wash/dry stations, MTP holder and stroboscope (behind dry station) are for ink-jet dispensing.



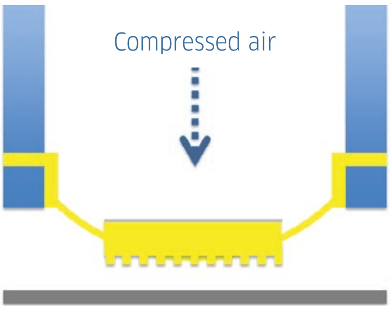
µCP 4.2 (two-level instrument) with fast linear motor in X-direction; the lower Y-axis normally contains a UV collimator for homogeneous irradiation. The flexible design of the µCP platform allows complete reconfiguration.

Two Fully Automatic Systems

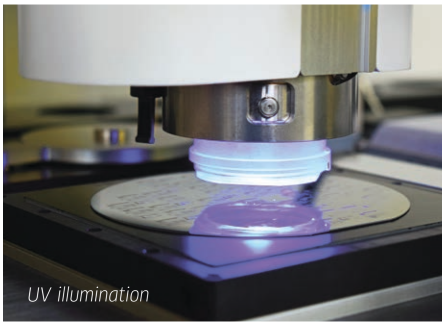
- The **µContactPrinter 4.1 (µCP 4.1)** is a small robotic platform with automatic inking pad preparation and numerous options, for research and small-scale production.
- The larger **µContactPrinter 4.2 (µCP 4.2)** comes with linear motor and a UV collimator on the lower level, for research and medium-scale production.

Properties, µCP 4.1

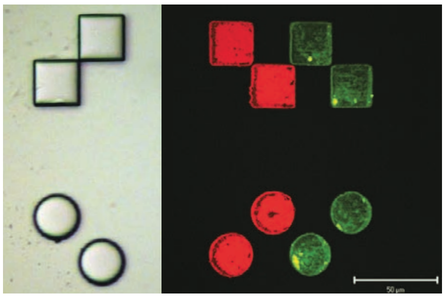
- XYZ robotics, belt-driven
- Repeating accuracy of mechanics < 5 µm
- Individually controlled multi-Z-drives with various tools, stamping unit and cartridge/ powder/piezo/capillary dispensers, etc.
- Stamp drive: automatic pickup of stamp holder from rack, head turnable by ±5°
- Stamp diameters: 5, 10, 15, 20 mm (max.), and customized
- Substrate holder: wafer size (10 cm / 4"), vacuum fixation, with ceramic heater / air-cooling
- Sensors for stamp *Z*-position, substrate *Z*-height, and positions of dispenser tips
- Microscope in print head, background illumination, automatic image processing to find and align fiducial marks
- Liquid handling by capillary dispenser (for µl volumes) and/or piezoelectric ink-jet dispenser (for nl volumes)
- Microplate holder, cooled / heated by external recirculation thermostat
- UV source with optical fibre for NIL
- Extras: cartridge holder for adhesive printing (as in GeSiM BioScaffolder), powder dispenser for µg quantities, microfluidic flow-through stamp for "negative" print, "double-side patterning" stamps and casting station
- Windows control software, pre-configured on computer
- Periphery: 115 or 230 V AC, compressed air or nitrogen (max. 1 MPa), vacuum if needed
- Requirements: filtered compressed air or nitrogen (max. 1 MPa), vacuum if needed, 115 – 240 V AC, enclosure or fume hood or biological safety cabinet



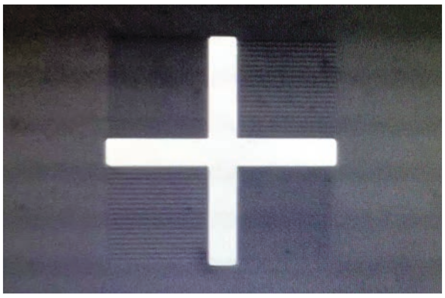
GeSiM µCP principle. The stamp membrane in its frame is bulged out when contacting the surface, resulting in defined pressure and even transfer.



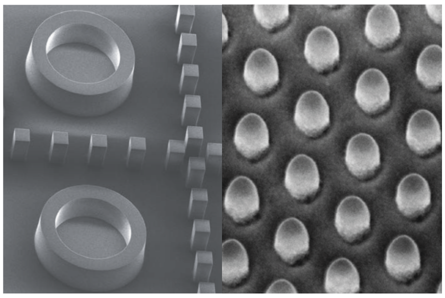
UV illumination



Microcontact printing: left, PDMS stamp; right, fluorescein- and rhodamine-labelled fibronectin pads, printed side by side on glass. Bar: 50 µm.



Crosshairs on a chip, aligned (X/Y/Z/angle) with complementary structure on stamp



Nanoimprinting experiments: nanoimprinted picowells, 250 µm diameter (left), and 200 nm wide pillars of a plasmonic sensor

GESIM µContactPrinter 4.1/4.2

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Specifications subject to change without notice

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