µ-CP3.0 - GeSiM platform to create micro fluidic devices by µ-contact-printing and nano-imprint-lithography

Howitz,S.; Baudisch,F.; He,J. GeSiM mbH, 01454 Großerkmannsdorf, Bautzner Landstraße 45, e-mail address of the corresponding author howitz@gesim.de

In the GeSiM presentation the "µ-CP 3.0" platform, which is a device for micro-contact printing (µCP) and nano-imprint lithography (NIL) shall be presented. Both technologies can be observed as key technologies to fabricate and to functionalize micro-fluidics. The "µ-CP 3.0" platform is the first device for research and technology development, which contains both of the following two techniques in one device, a general view is visible in figure 1:

- *Micro contact printing (µCP)*: While stamp inking the PDMS-stamp is soaked with the sample, dried, and then inked stamp transfers the sample by contact printing onto a flat surface
- *Nanoimprint lithography (NIL)*: In contrast to µCP, NIL produces three-dimensional structures. The PDMS stamp is not inked, but instead pressed dry into a thin layer of polymer that has been softened by heating. After cooling to room temperature, the stamp is gently removed and the resulting structure can be preserved by illuminating and hence cross linking with UV light.

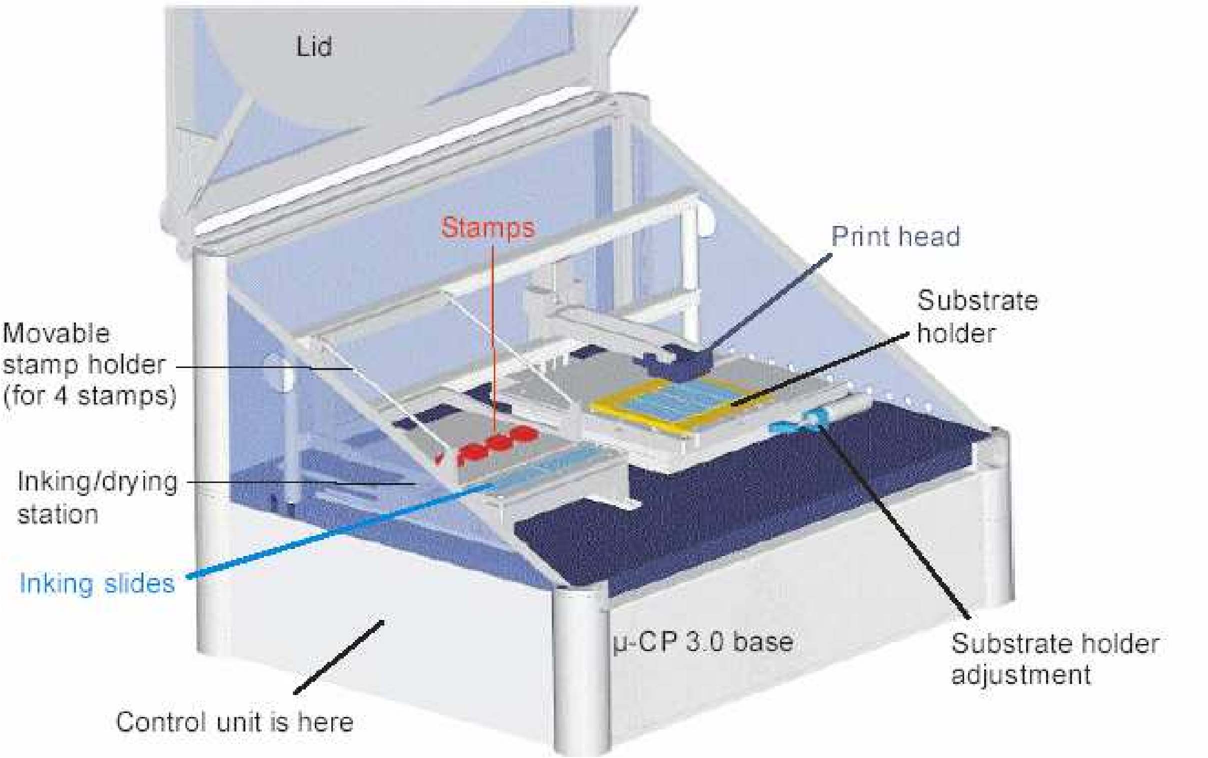

Fig.1: Schematic view of the basic unit of the µ-CP3.0 platform

The new feature of "µ-CP 3.0" platform is a deformable micro-patterned PDMS membrane that is spanned across a polycarbonate stamp frame. This stamp frame is firmly attached to the stamp holder of the Z-drive so that the entire structure is gas-tight. When the gas pressure inside the print head rises, the membrane is bulged out, like a balloon. For printing, this "balloon" is slowly moved towards the substrate until the entire membrane is in contact with the surface. The bulging guarantees a very even contact of the stamp with the surface and hence very regular printed structures. In addition, the gas pressure can be varied and modulates printing. One should always optimise this and other printing parameters (such as Z-level, speed of Z-movement and contact time) until an ideal transfer has been achieved.

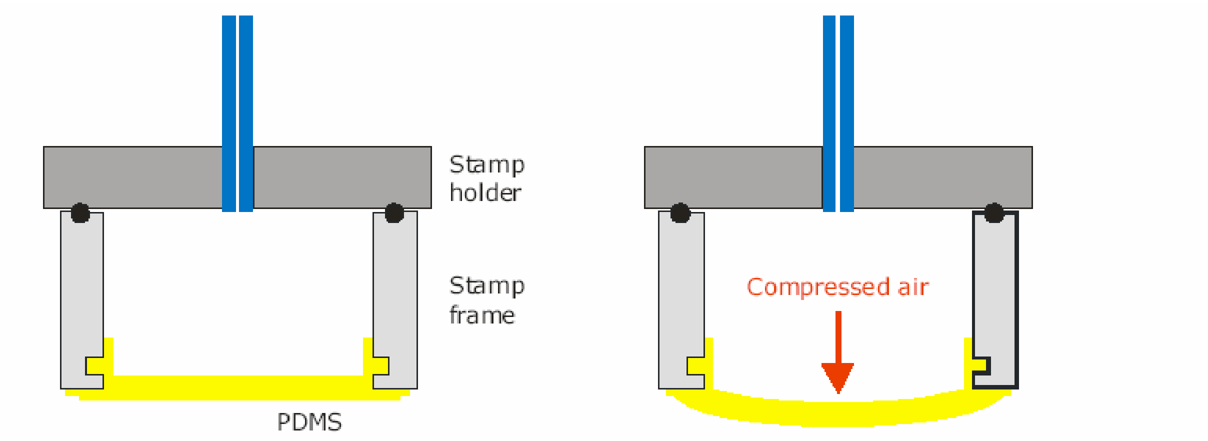

Fig.2: GeSiM's new stamp concept. The PDMS diaphragm (yellow), firmly attached to the stamp frame, is bulged out by increasing the air pressure inside the print head (right) [1]

This system has a degree of automation that is sufficient to generate micro- and nano-structured patterns with high quality, reproducibility and positional accuracy. In addition to patterns created with the standard stamp size of 1 by 1cm², one can also print with up-scaled stamps of 2 by 2cm² or downscaled stamps of 0.5 by 0.5cm². An interesting capability is the printing of multiple arrays by more the one stamps on one substrate with precise alignment of stamp and substrate in between. With this method chessboard-like larger patterns or patterns of several substances either side by side or on top of each other can be created. Figure 3-left shows one example of printing two samples on one surface sequentially. In figure 3-right an example is shown, where an extra cellular matrix protein on glass was printed. The motivation was to adhere cells in a pre-patterned way after cell cultivation of L929 mouse fibroblastes with the pre-printed glass slides.

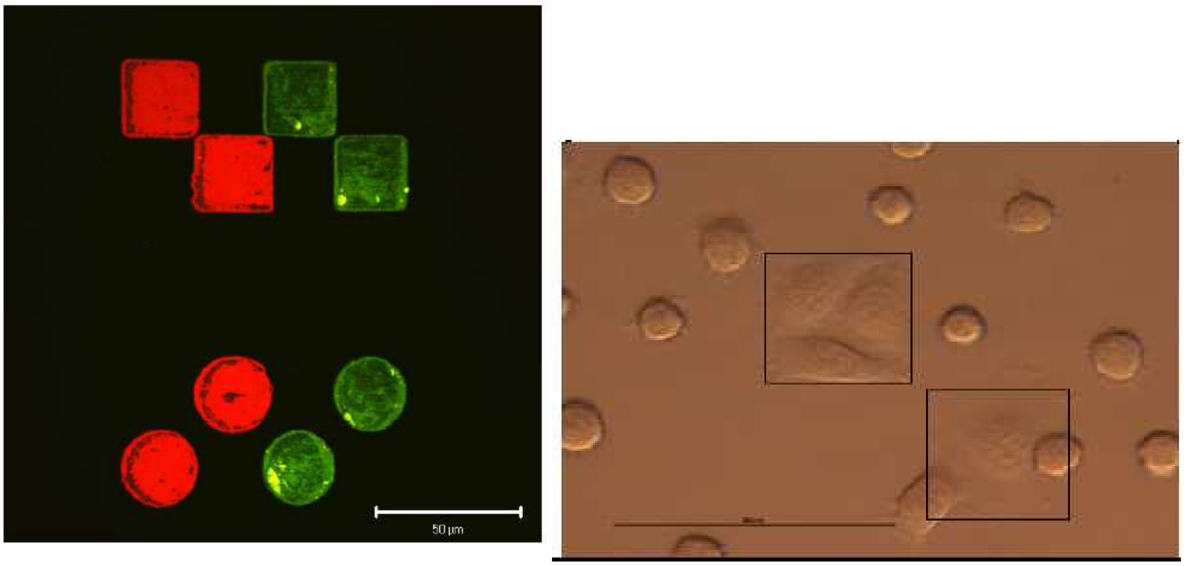

Fig. 3: *left* fluoreszine and rhodamine print on 1x1cm², feature size 25µm [2] , *right* print of extra cellular matrix protein on glass surfaces and later L929 mouse fibroblastes are cultivated [3]

Dependently of the used polymer for NIL-technology, 3D-patterns can be created by thermal NIL or by thermal-UV-NIL, two rough process flow charts are visible in figure 4.

Thermal NIL-Process	=	NOA 63 UV-Glue Dispensing	+	Imprint of the PDMS-Stamp in wet Resist	+	UV-Curing at RT		
Thermal-UV NIL-Process	=	SU8 UV-Resist Spin Coating	+	Imprint of the PDMS-Stamp at 100℃	+	Cooling down to RT	+	UV-Curing at RT

Fig. 4: Process sequences of two NIL-technologies using UV-glue or UV-resist, both technologies can used with the platform µ-CP3.0

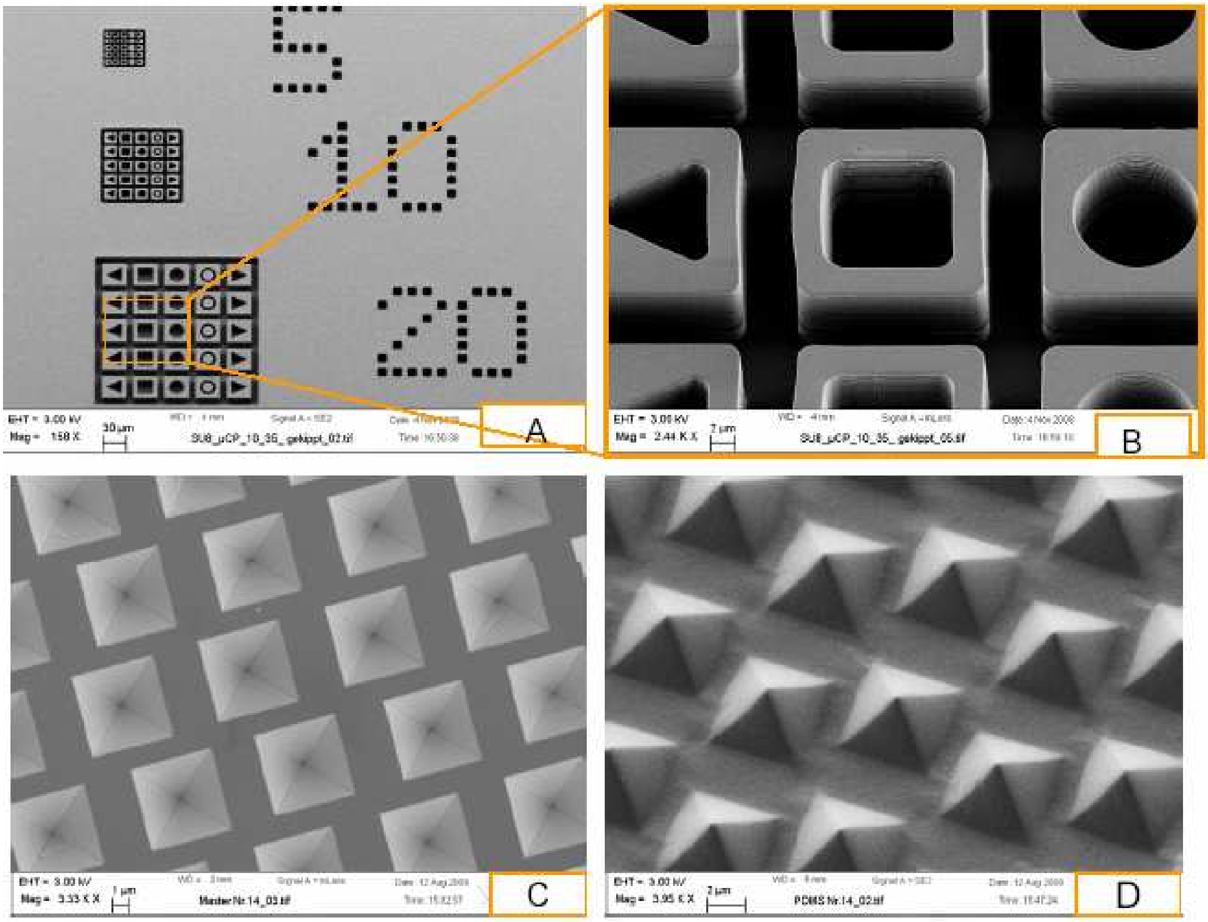

Fig. 5*:* *5-A and 5-B:* examples of a 3D-NIL pattern in SU8, *5-C:* a wet etched silicon master with pyramidal grooves, *5-D:* PDMS-stamp surface

The motivation of this presentation is to give a survey of possible applications and examples which show the flexibility of all main components of the platform µ-CP3.0. We will do this focussing on micro- and nano-fluidic applications, material research applications and biotech applications. A journey to the process-validation-module, which is an accessories of the platform µ-CP3.0, will show the possibility to use our PDMS-stamp concept directly under the optical control of an inverse fluorescence microscope.

References:

[1]Verfahren und Vorrichtung zur Übertragung von Mikro- oder Nanostrukturen durch Kontaktstempeln, Deutsche Patentnmeldung, 23.Juni 2008, No. 112008001634.8.

[2] Gast, F.-U., Zimmermann, H., Fiedler, S., Howitz, S. (2008) Functionalization of cell chips by non-contact piezo dispensing and automated microcontact printing. msb 2008, Freie Universität Berlin, March 9-13, 2008 (lecture)

[3] Howitz, S., Baudisch, F., Gast, F.-U, Gepp, M.M. (2009) µ-CP3.0: A new instrument platform to stamp functional 2D and 3D structures in the micro- and nanometer range. Poster p66, Eight International NNT'09 Conference (Nanoimprint and Nanoprint Technology), November 11-13, 2009, San Jose, California, USA