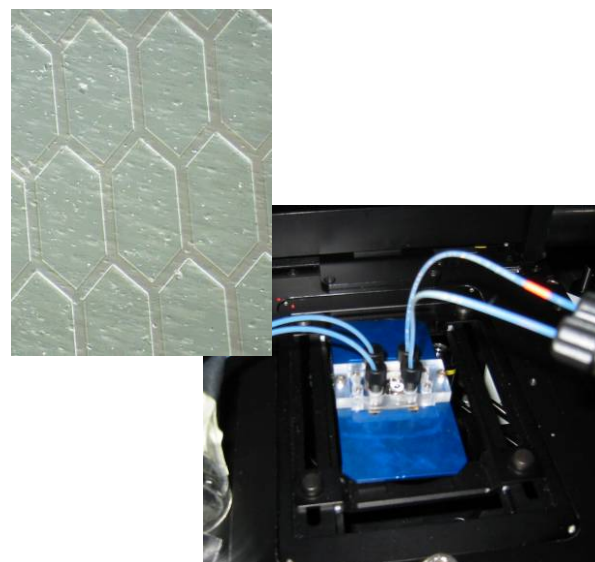


Further Applications

Our customers and collaborators have realized the following projects (selection):

- Study of multi-color fluorescing particles (e.g., bacteria) in a focused stream using fluorescence correlation spectroscopy
- Generation of lateral concentration gradients in microchannels with a honeycomb-like gradient mixer (right picture)
- Nanostructuring through manipulation of single bio-polymers (e.g. DNA and motor proteins) in hydrodynamic flow fields
- Surface plasmon resonance (SPR)



Parts List (Partial)

Article No.	Article	Remark
A040-018	Mechanical support (holder), standard	holds the flow cell and places it near the objective for the external connection to electrodes on the chip adapter to the microscope (Zeiss, Olympus, Leica)
A040-019	Mechanical support mit printed circuit board	
A070-600	Working plate for inverted microscope	
A050-007	MicCell fluid processor, 1-channel syringe pump	1 syringe pump and 1 distribution valve in the box
A050-006	MicCell fluid processor, 1-ch. SP "extension kit"	1 extra syringe pump, for installation
A050-005	MicCell fluid processor, 4 channels	4 SP or 3 pumps and 1 distribution valve in the box
A110-019	Distribution valve "Smart-Valve," 1-4 port	with 1 inlet, 4 outlets, for installation
A070-089	MicCell software, standard version	software and manual for S-, T-, and K-channel
A040-030	Silicon master, flat, structure height < 50 µm	all chips from one 4" silicon wafer, Teflon-coated
A040-031	Silicon master, flat, structure height 50 - 150 µm	all chips from one 4" silicon wafer, Teflon-coated
A040-033	MicCell PDMS casting station, complete	casting station + 1 liter PDMS Sylgard 184 + curing agent, instructions, 4 channel spacers
A040-080	Hydrogel microvalve PV5, PEEK housing	external housing, with 1/16" fittings (UNF 1/4-28)
A040-100	Hydrogel microinjector PV6, PEEK housing	integrated within standard 1/16" fitting (UNF 1/4-28)
A040-101	Hydrogel microvalve PV6, "naked" chip	spare part for A040-100
A040-083	MicCell sample carrier	to insert intransparent samples into the MicCell
A040-105	MicCell PDMS channel plate, recycled	molded PDMS channel plate, ready to use, including PMMA lid with 4 female inlets (UNF 1/4-28)
A040-106	MicCell PDMS channel plate, new	molded PDMS channel plate, ready to use (s. above)
A040-107	MicCell PDMS channel plate for sample carrier	movable PEEK sample carrier
A040-026	MicCell glass channel plate, pre-drilled, SiR *	1 batch, cut from a 4" glass wafer, customized channel
A040-044	Coverslip, 150 µm thick, glass, arbitrary size	1 batch, cut from a 4" glass wafer
A040-034	Coverslip, 150 µm thick, ITO-coated (100 nm)	8 standard coverslips 22x22 mm, completely coated
A040-102	Coverslip, 150 µm thick, with platinum electrodes	1 batch, cut from a 4" glass wafer, design on request
A040-103	Coverslip, 150 µm thick, with ITO electrodes	1 batch, cut from a 4" glass wafer, design on request
A040-027	Coverslip, 150 µm, with Pt electrodes and SiR *	1 batch, cut from a 4" glass wafer, design on request
A040-104	Coverslip, 150 µm, w. SiO ₂ -passivated Pt electr.	1 batch, cut from a 4" glass wafer, design on request

Additional components upon request

* SiR: gasket from silicon rubber, screen-printed

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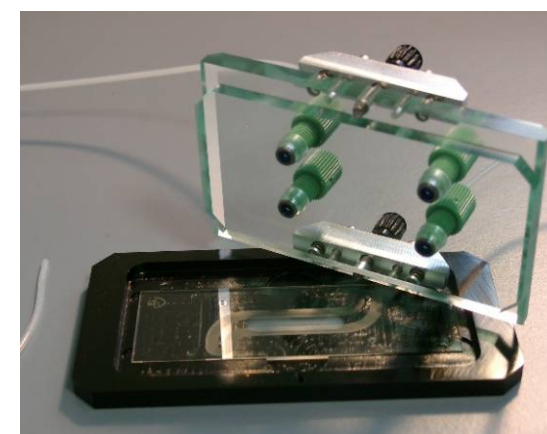
MicCell™



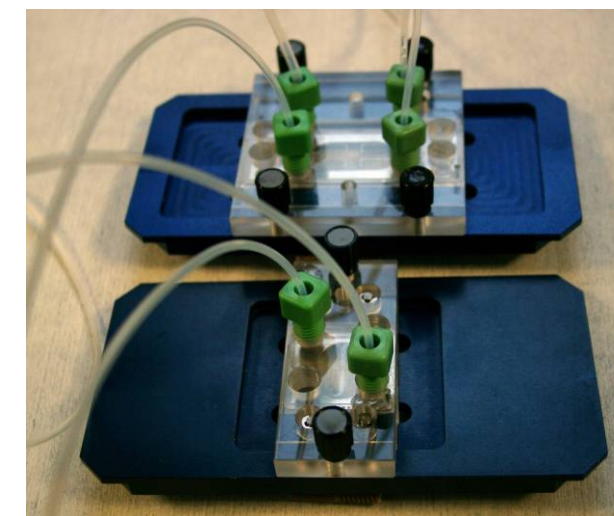
Special Designs (Selection)

Large Coverslip

If the channel system is larger than a standard coverslip (22 x 22 mm), the MicCell must be arranged differently, as shown in these examples.



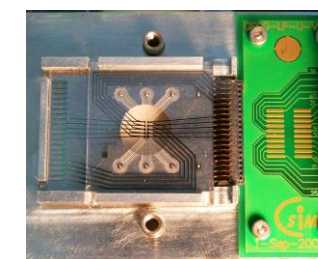
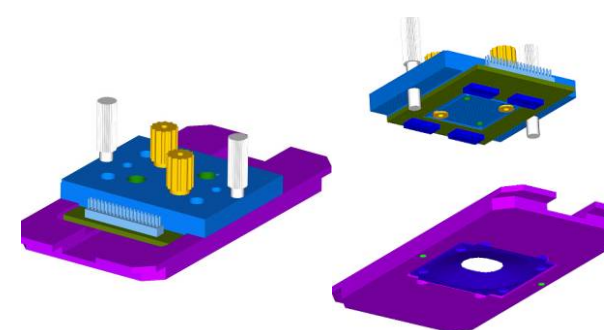
Coverslip 50 x 22 x 0,15 mm, mounted on top of a glass-polymer channel system having the size of a slide.



PDMS channel systems with two different coverslip sizes: 22 x 50 x 0.15 mm and 22 x 22 x 0.15 mm

Microelectrodes for Heating and Sensing

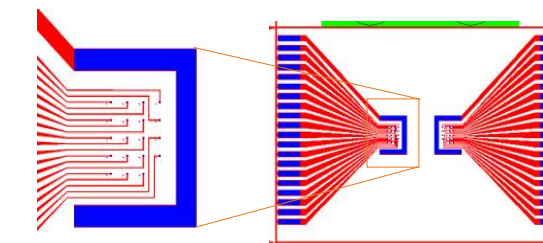
They are structured on glass (e.g. the coverslip), contacted in the assembled MicCell via spring contacts, and connected on a printed circuit board (green) to sockets. If no PDMS is used, electrodes can be placed on both the top and the bottom side of the channels.



Examples shown were performed in cooperation with Fraunhofer-IBMT, Berlin, and Max-Planck Institute for Polymer Research, Mainz, Germany.

Microelectrode Arrays

To measure signals of muscle or nerve cells, these cells can be grown on coverslips containing microelectrode arrays (layout: see bottom picture) and mount these into a flow-through channel. The flow system shown can process electrical potentials while the cells are being inspected under the microscope.



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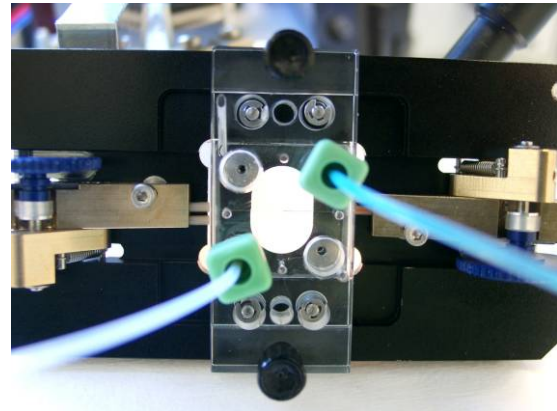
Laser Manipulation of Cells in the Flow

A so-called optical tweezer can be used to manipulate suspended cells. Such an optical tweezer can be arranged perpendicular to the flow cell, but also parallel to it, i.e. within the channel layer. In this latter case, a narrow channel to guide the optical fiber must be present.

We have devised a flow cell in which single-mode optical fibers are exactly positioned in a PDMS channel that has same the size as the fiber. Despite the flexibility of the PDMS, one can achieve an accuracy of a few micrometers, as the optical fibers are guided into the channel by a mechanical feeder (see pictures on the right).

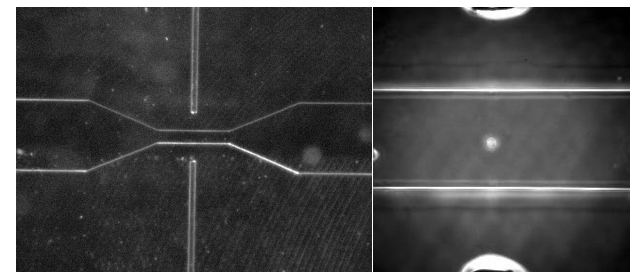
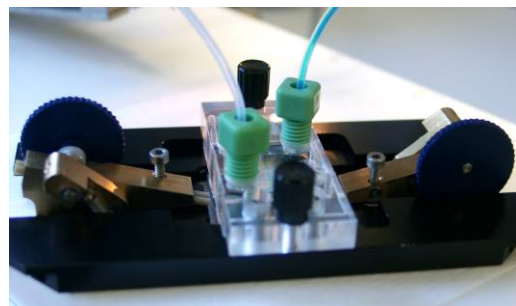
This technique could be used to build a microfluidic "optical stretcher". This is a novel optical trap that catches a suspended cell between two divergent, counterpropagating laser beams. By raising the laser power, the trapped cell can be extended by the two beams. This works only, however, when the two optical fibers are aligned to at least 3 μm .

The deformability of a cell correlates with its developmental stage: non-differentiated cells are softer than



differentiated ones. This constitutes a quick method to detect cancer or stem cells. Aside from the pure diagnosis, a sorting of cells according to their flexibility and so an efficient enrichment of, e.g., stem cells from tissues is conceivable.

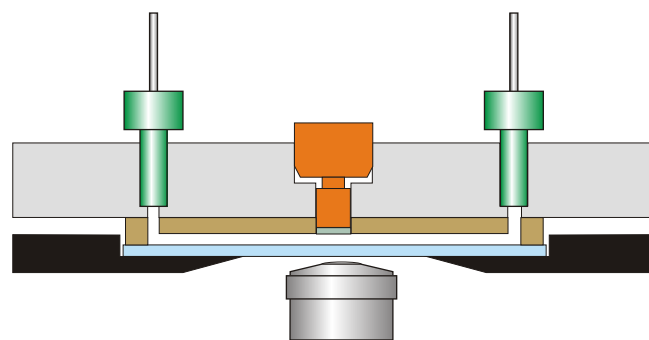
This is an ongoing project with the University of Leipzig, but its future application is likely.



Examination of Intransparent Objects: the Sample Carrier

The MicCell channel is translucent and thus allows sample illumination from the rear side. Opaque objects can be introduced into the channels by a pivotable sample carrier (orange in the schematic drawing on the right), e.g., for material testing.

GeSiM offers such a flowthrough cell that can hold objects up to a size of 2,5 x 2,5 mm in the channel. As sample and sample holder are intransparent, the sample must be illuminated from the objective side, i.e., along the optical path. The specialty: the specimen can be rotated a full 360° around the optical axis of the microscope, such that objects can be exposed to the flow at an arbitrary angle.



Hydrogel Microvalve

Liquids can be introduced into the flow channel via a microvalve. This contains hydrogel particles that expand (by hydration) more than ten-fold when the temperature drops below 34 °C and thus close the channel up to a pressure of approx. 6000 hPa (6 bar). Warming above this transition temperature opens the valve in seconds, allowing the aspiration of substances into the main channel.

Two valve setups exist:

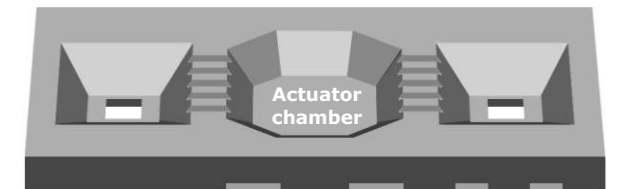
- the standard setup (PV5) where the liquid flows through silicon channels. It is mounted in an extra housing (PEEK standard box, sealed by O-rings, with UNF 1/4-28 fittings, dead volume ca. 5 μl) that is inserted into the inlet tube.
- the PV6 valve where the liquid flows through small holes that were etched through the silicon layers. This setup allows smaller dead volumes.

The PV6 can be built into a standard fitting that is screwed into the flow cell. This requires an additional channel inlet. Versions with several hydrogel valve are possible (see pictures on the right).

In addition, hydrogel slabs can be photopolymerized directly inside the microchannels using customized photomasks, resulting in valves with almost no dead volume. This method is a bit complex and expensive, so please ask us.

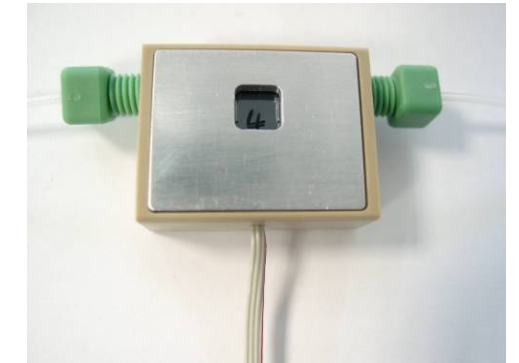
Spezifikationen of the Actuator

- Polymerized from purified *N*-isopropyl acrylamide (PNIPAAm)
- Standard phase transition around 34 °C (can be varied), more than ten-fold volume increase upon cooling ("normally closed valve")
- Needs aqueous solutions, but tolerates
 - < 15 % methanol, ethanol, and acetone
 - < 5 % 1-propanol
 - > 75 % methanol and 1-propanol
- Heating power max. 250 mW at 3.5 - 5 V
- Minimal switching time ca. 1 - 3 seconds; if Peltier cooling is used, the same time is also used for closing
- Watertight up to a pressure of more than 5 bar (5000 hPa)

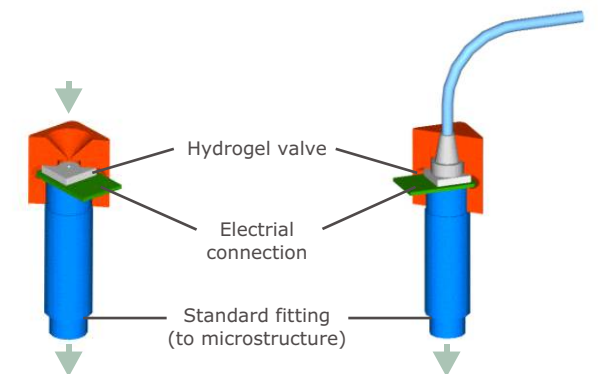


Heater + T-sensor

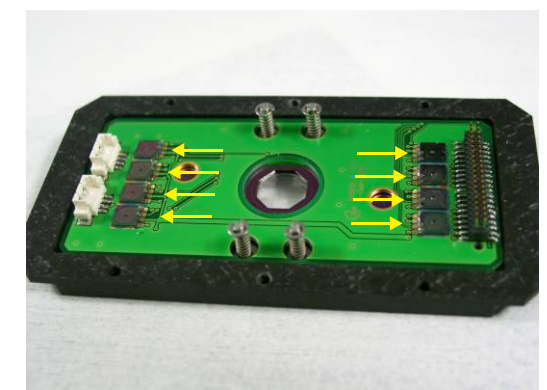
Standard hydrogel valve setup (schematic) with in- and outlet and an actuator chamber filled with hydrogel particles



Standard hydrogel valve (PV5) in the housing



Hydrogel particle actuator (PV6) in standard UNF fitting with a small dead volume. left: injector for manual sample addition via a microfunnel, right: automatic sample injection through PEEK capillary (inner diameter 25 - 762 μm).



Hydrodynamic flow chamber with eight hydrogel valves (arrows) to generate a number of different flow directions (in collaboration with the University of Technology Dresden and Namos GmbH, Dresden)