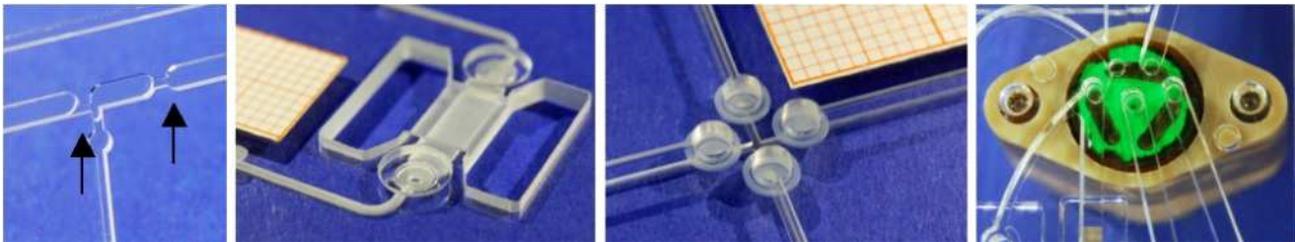


Micro-Valve Evaluation Test Bench

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For the transfer of biochemical assays into Lab-on-a-Chip (LOC) systems sophisticated valve concepts are needed due to the highly complex fluidic layouts. Often, these valve concepts also include fluid storage during shelf life and metering, separating and/or merging of fluids during the assay. Several micro-fluidic valve concepts have been developed at IMM. These micro-valves are designed for integration into fluidic polymer chips, flexible adaptation to the fluidic layout and usage on chip and consist of biocompatible materials.



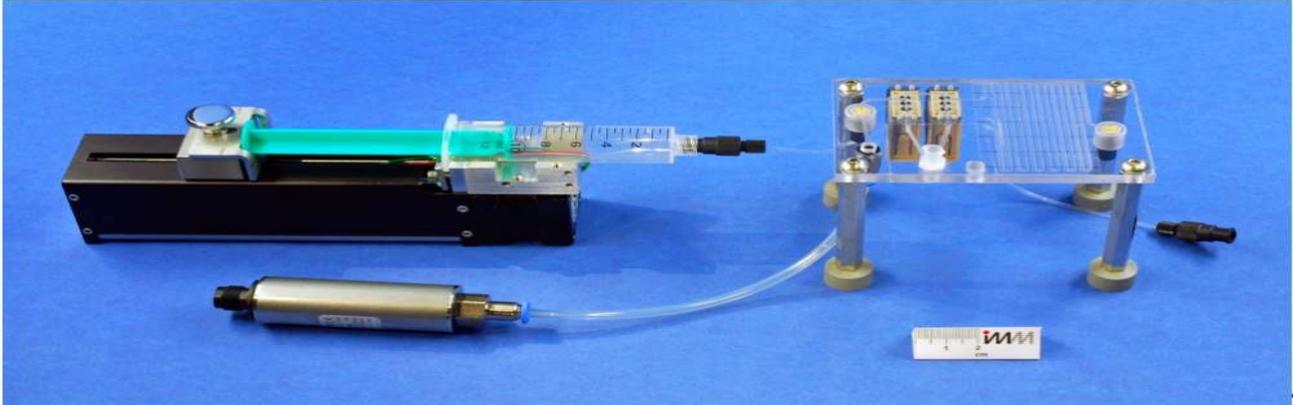
Different valves developed at IMM: Passive stop structures, passive membrane valves, pneumatic membrane valves, 6-way turning valve

The leakage rate is the most important factor for characterizing micro-valves and to evaluate fluidic control of LOC applications. Commercial available valves are mostly characterized by their response time and the maximum pressure which can be applied. However, the maximum pressure is not sufficient for characterizing novel developed micro-valves, as a small leakage can already occur at pressures of 20 mbar (2000Pa). Even small leakage volumes in the order of μl can strongly interfere with robust process control during micro-fluidic applications.

All micro-valves in LOC systems must be tested with regard to the requirements which occur during the specific assay. Since the number of design iteration loops has a strong impact on development costs, valve characterization has to concentrate mainly on one of the most important features like leakage rates according to applied pressure. The Micro-Valve Evaluation Test Bench uses the appropriate physical gas flow measurement principle in order to measure the flow rate caused by the leakage rate of a valve at constant pressure. The flow rate can be measured as the displacement of a liquid plug inside a channel with defined geometry which is situated between a pump and the valve within a certain testing period. During the measurement, the applied pressure is constantly monitored by a pressure sensor.

The design of the Micro-Valve Evaluation Test Bench aims at simple operation and reliable characterization not only of valves but of all applications that should be tested on leak tightness. The device consists of a pressure-controlled IMM-OEM-syringe pump, a pressure sensor, 3-way valves, electronics and a LabView®-operation software. Pressure is displayed graphically subject to time. The leakage rate in $\mu\text{l}/\text{min}$ is displayed when the operator enters plug displacement data

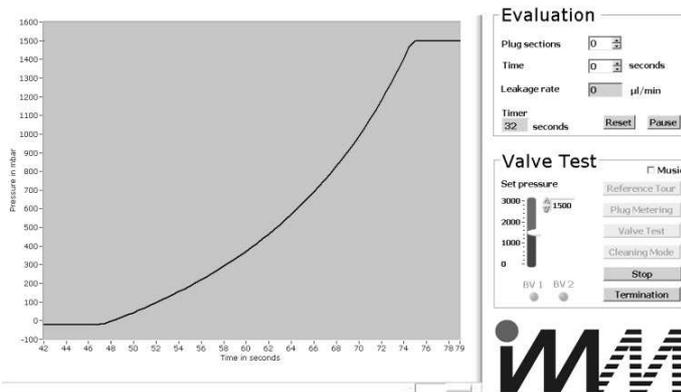
and elapsed testing time. The device uses reliable and easy removable HPLC- and Quick-Steck®-connectors. The transparent platform enables optical access and is resistant against testing media such as water, ethanol, isopropanol and different detergent-based buffers.



Basic components of the Micro-Valve Evaluation Test Bench. The connection of valves is realized with standardized HPLC® or Luer®-connectors.

Data:

- Pressure range: -500 mbar up to 3 bar (range can be changed via retooling)
- Leakage rate range: down to 1 µl/min
- Resolution of pressure detector: ±10 mbar
- Typical valve setting tests: closed against air/water-like fluids, closed restriction behind opened valve
- Dimensions of transparent platform: 66 x 100 x 5 mm



Front panel of operation software

Due to simple design principles IMM is able to easily adapt the test bench and its components to meet demands of higher pressures, different testing media and refined measurement ranges. All in all the Micro-Valve Evaluation Test Bench is a useful, easy to handle and reliable tool for the characterization of newly-developed micro-valves. It is also capable of characterizing commercial valves without their available leakage-rate data at a specific system pressure. Future testing range will feature the measuring of valve response times in the order of micro seconds.