

# Fabrication of Polymer-Based Micro devices: Formulation and Study of the Paste

N. Serra, T. Maeder, O. Gentsch, P. Ryser  
Laboratoire de Production Microtechnique, EPFL  
nathalie.serra@epfl.ch , <http://lpm.epfl.ch>

**Aim of the project: fabrication of all-polymeric biocompatible micro-devices using non-toxic and sublimable sacrificial layers**

- Requirements:
- use of **silicone** resin: it is loaded with graphite for mechanical stability
  - control of the **rheology** of the pastes needed for screen-printing process
  - **compatibility** with the organic polyol-based sublimable sacrificial paste

## Principle

- Structures defined by Organic Sacrificial Paste (OSP) based on evaporable compounds
- Fabrication of closed structures (channels, cavities...) possible due to the sublimation ability of the OSP by diffusion through the silicone over-layer.

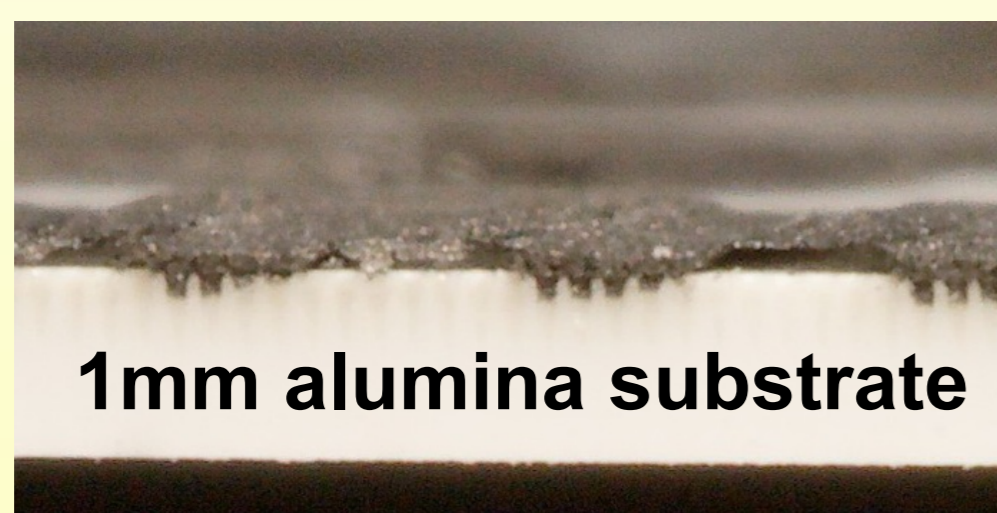
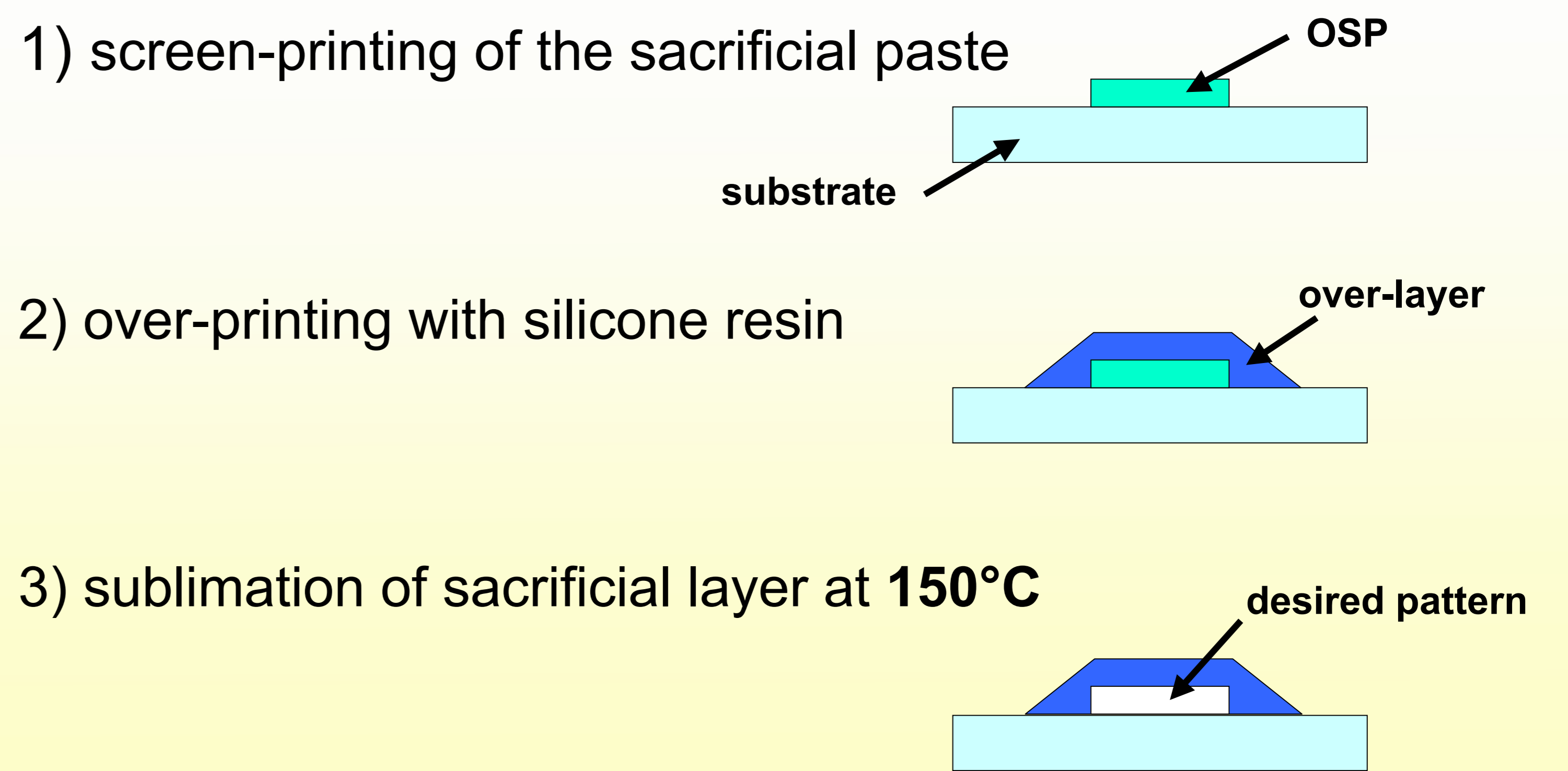


Fig.1: Cross-section of a micro-channel after sublimation of the sacrificial paste



## Formulation of the paste with solvents to control the rheology

Apolar : dodecane (A1), (R)-(+)-limonene (A3)

Polar: octanol (A2), tetraglyme (A4)

- solvents chosen regarding **miscibility** without reactions with the resin and **evaporation temperature**
- polar solvents tested for **compatibility** reasons with the OSP, which contains -OH groups

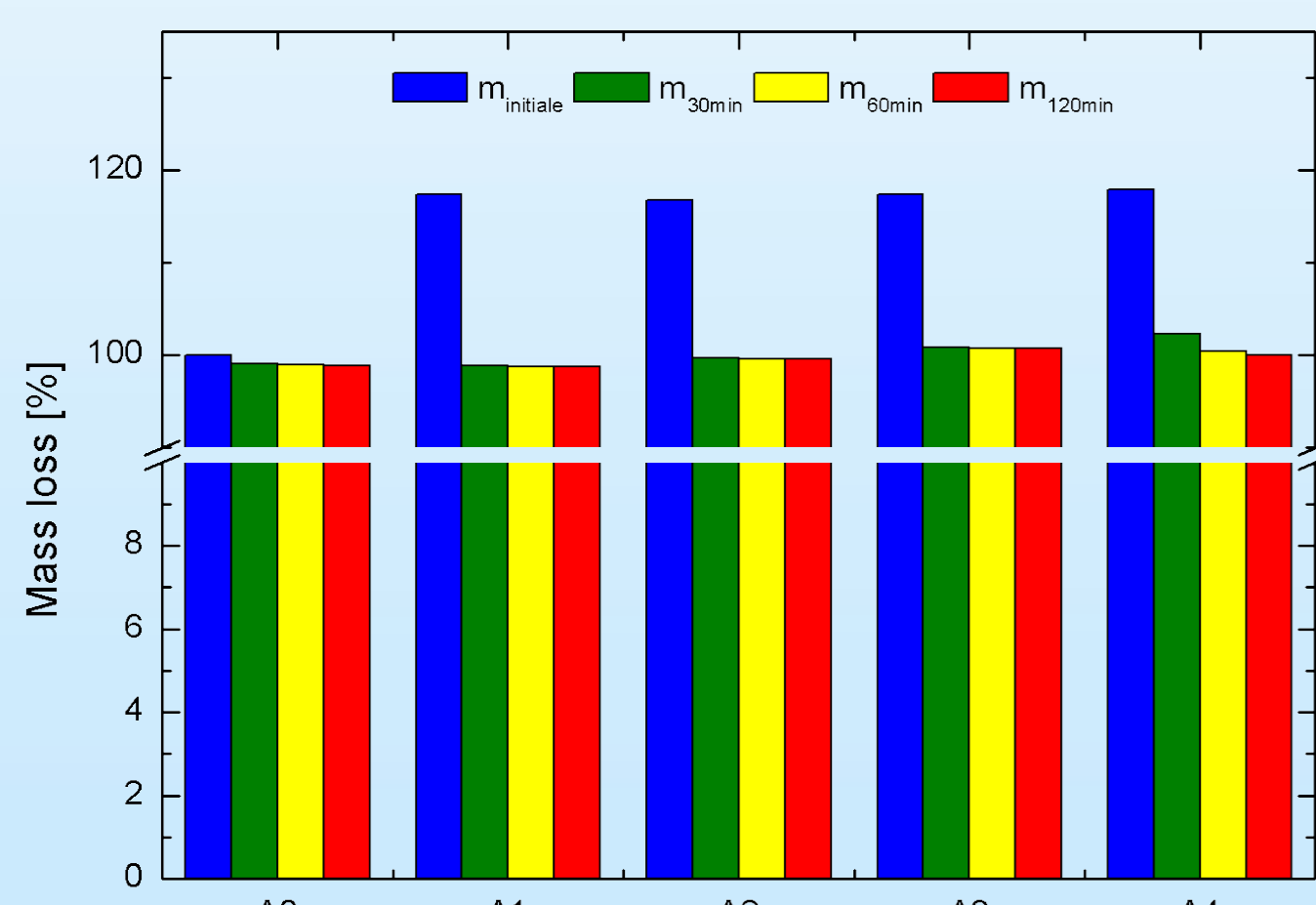


Fig.2: Relative composite mass vs. solvent in silicone with 10%vol KS4

Reference sample= A0

Mass measured at 30min, 60min and 120min during the cure of the resin (i.e. 2h @150°C)

Almost all the **solvent lost** in the first 30min

→ good candidates

Measurements of the dynamic viscosity with a rotative viscosimeter Rheomat RM180 (Mettler)

Data not available for the reference sample (excessive viscosity for the viscosimeter)

Apolar solvents have a higher solvative power, which confirms our expectations.

Polar solvents also decrease viscosity, yet remain compatible with the resin due to their long alkane chain.

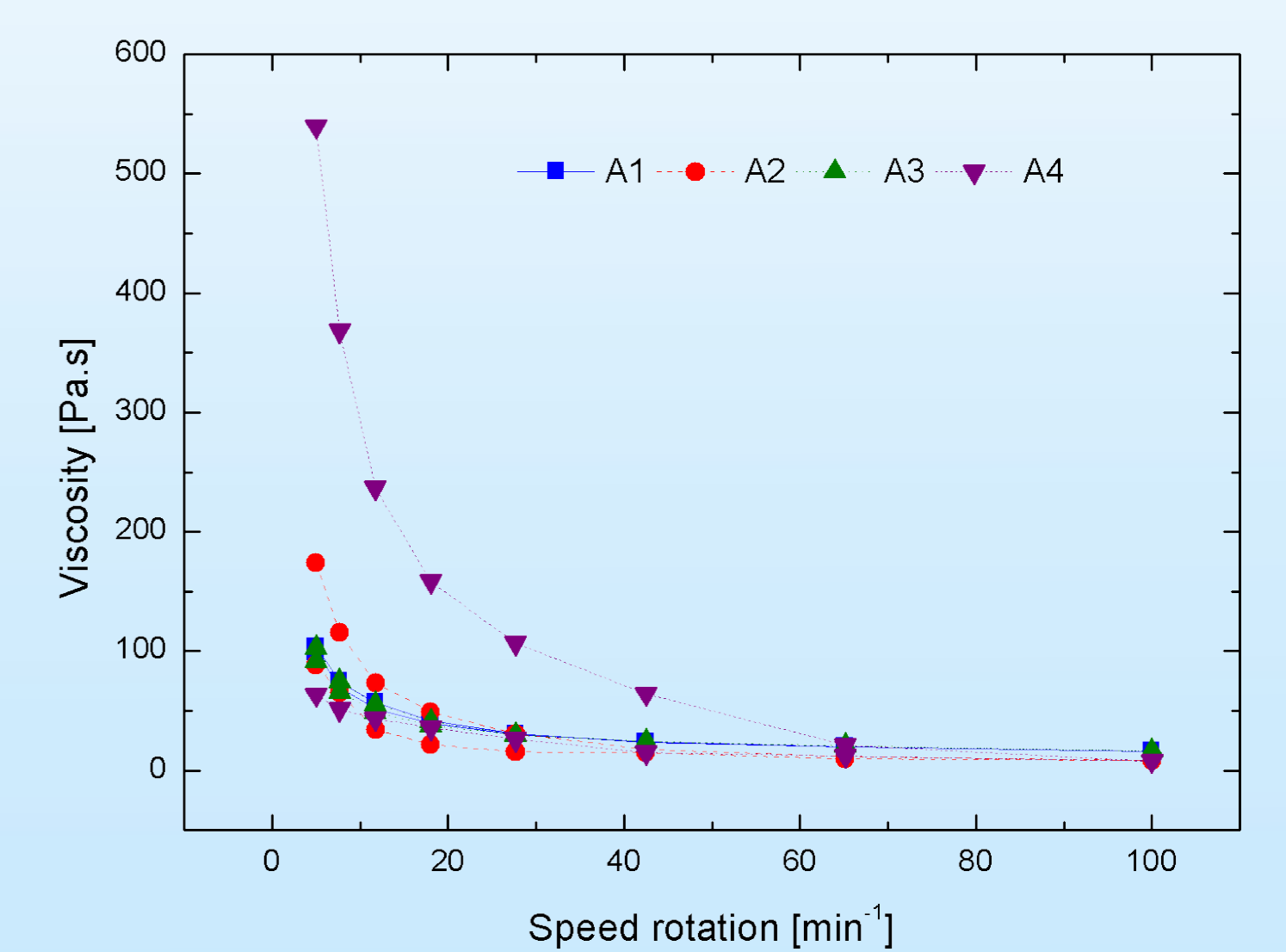


Fig.3: Viscosity measurements for the different solvents

## Micro-channel: influence of polar solvent in the formulation of the over-layer

- Use of pure dodecane and mixes of dodecane:octanol as solvents
- Maximum flow determined in each case

Table 1: Influence of the solvent formulation on the max air flow

dodecane:octanol ratio	Max. flow [NL/min]
1:0	unreliable meas.
2:1	1.7
1:1	2.8

- Without octanol, structures tend to tear away from the substrate: octanol promotes **wetting** on polyol OSPs

→ **Fabrication of all-polymeric and biocompatible micro-devices**

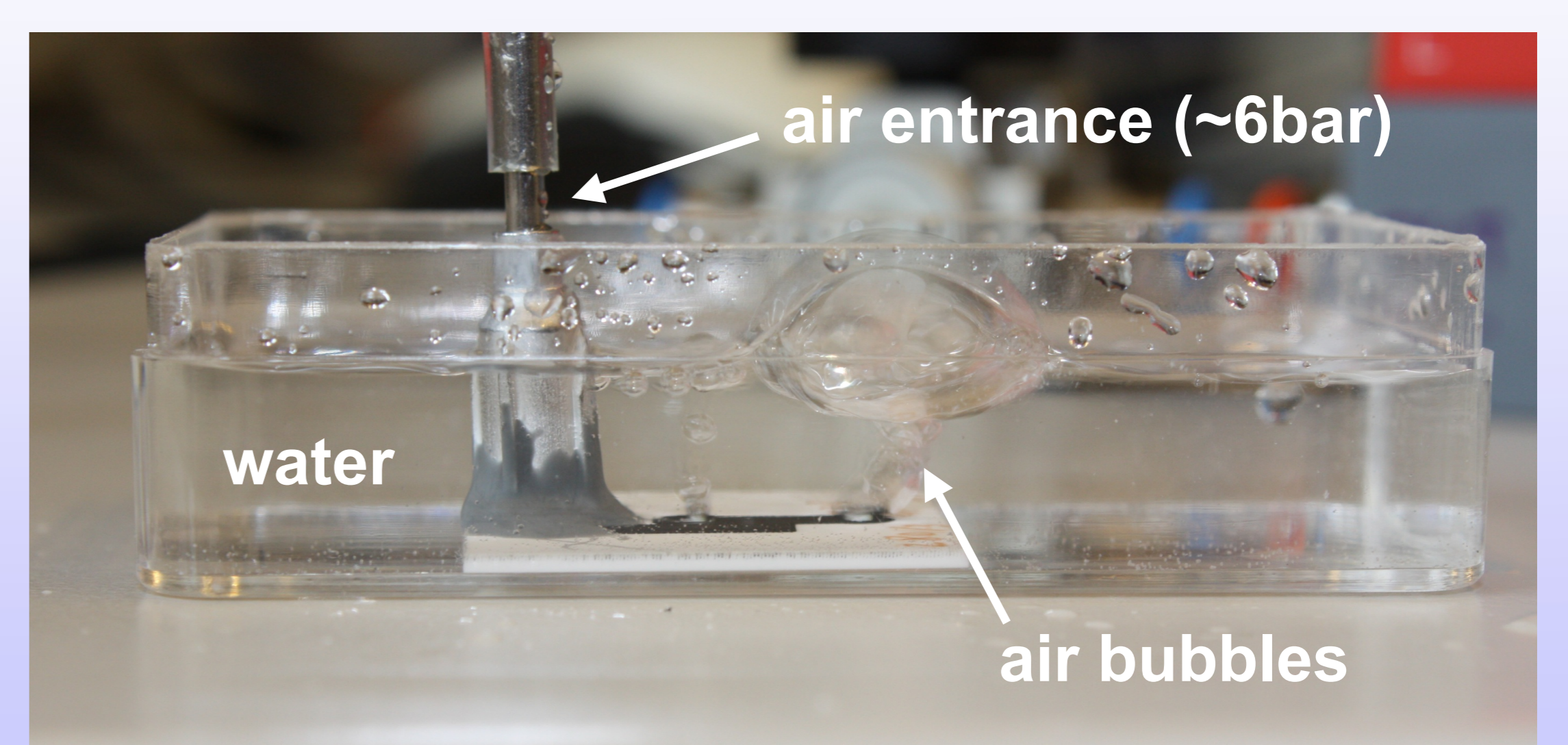


Fig.4: Microfluidic circuit with air circulating inside the channel