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

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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.

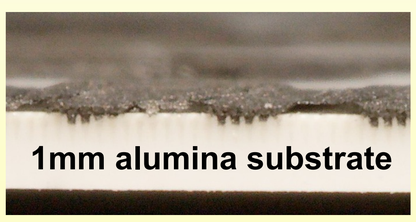
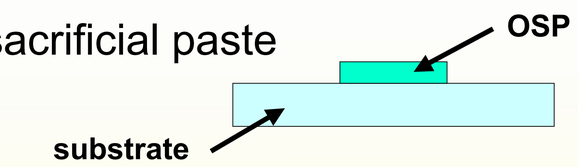
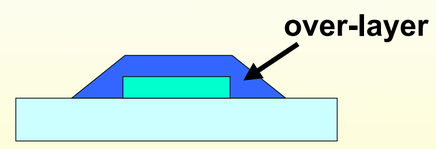


Fig.1: Cross-section of a micro-channel after sublimation of the sacrificial paste

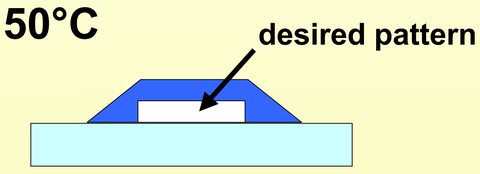
1) screen-printing of the sacrificial paste



2) over-printing with silicone resin



3) sublimation of sacrificial layer at **150°C**



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

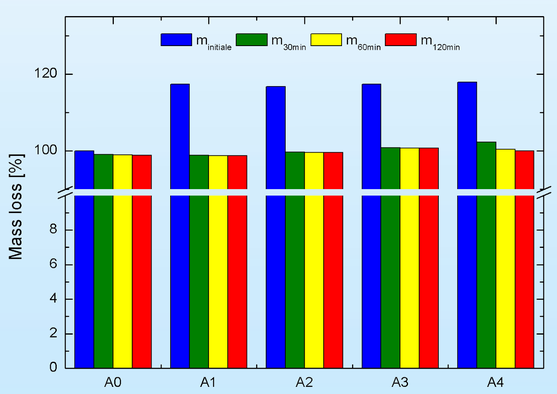


Fig.2: Relative composite mass vs. solvent in silicone with 10%vol KS4

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 alcane chain.

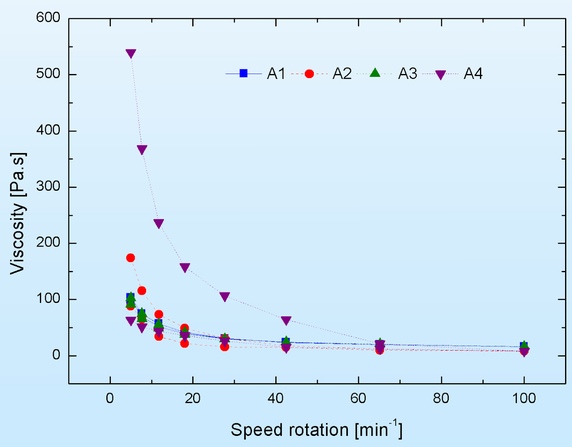


Fig.3: Viscosity measurements for the different solvents

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**

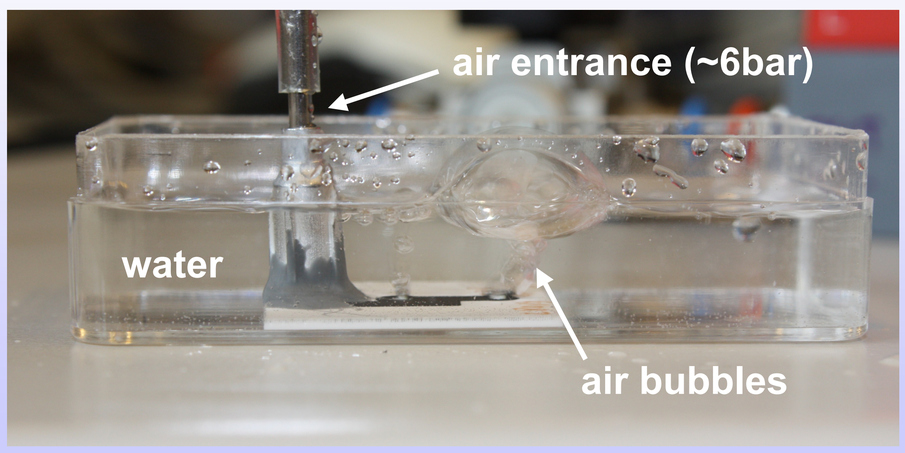


Fig.4: Microfluidic circuit with air circulating inside the channel

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