Experimental setup and o-ring based µfluidic interface for suspended microchannel resonators

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1. Abstract

- Existing solutions for suspended microchannel resonators packaging[1,2]
  - Fluidic delivery (back-side) : PDMS or o-ring sealing
  - Vacuum encapsulation (front-side) : glass capping or o-ring sealing
- Our suspended microchannel resonators have inlets and outlets on the **front-side**
  - Fluidic delivery and vacuum must coexist : complete solution based on o-rings
  - Need for an intermediary connector, prototyped via stereolithography 3D printing, between the chip and the external equipment
- We developed a setup for temperature control and fluidic delivery

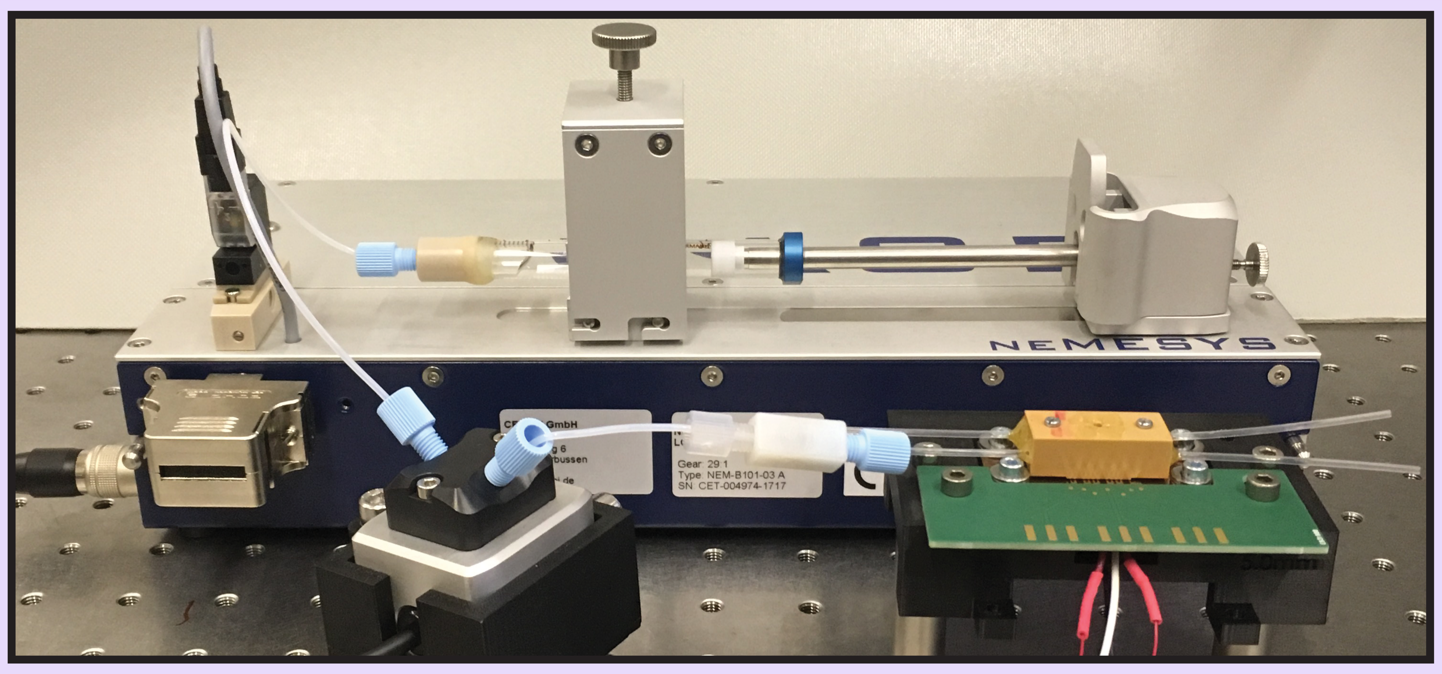


Fig. 1: Experimental setup for delivery of fluids to the SMRs.

2. Microfluidic interface concept

Chip sealing : o-rings + connector

- Four small "microfluidic o-rings" (dimensions 0.35x0.4mm)
- One larger "vacuum o-ring" (dimensions 8x1mm)
- Connector ensuring sealing and interaction with external fluidic equipment

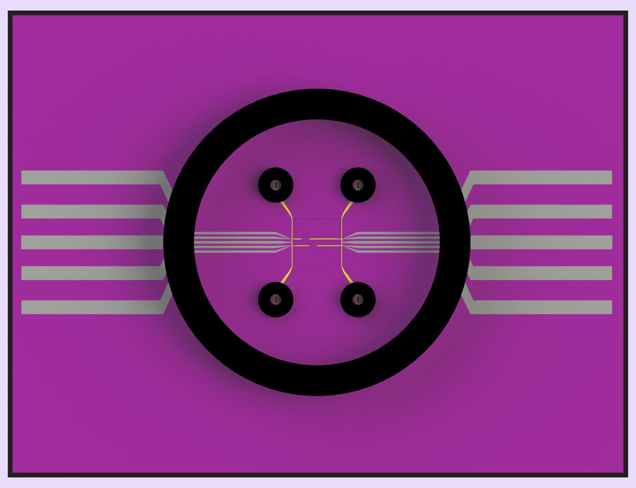


Fig. 2: Schematic representation of an SMR chip (20x15mm) with the locations of the microfluidic and vacuum o-rings on top.

3. Connectors

- Realized by 3D printing (*envisionTEC Prefactory 4 Mini XL*, material RC70)
- Fluidic channels (min. diameter 0.5mm)
- Central opening serving as access point for optical detection of the resonators and vacuum chamber
- Through holes for alignment with chip under microscope
- Tubes and top glass covers for sealing the through holes are glued with epoxy

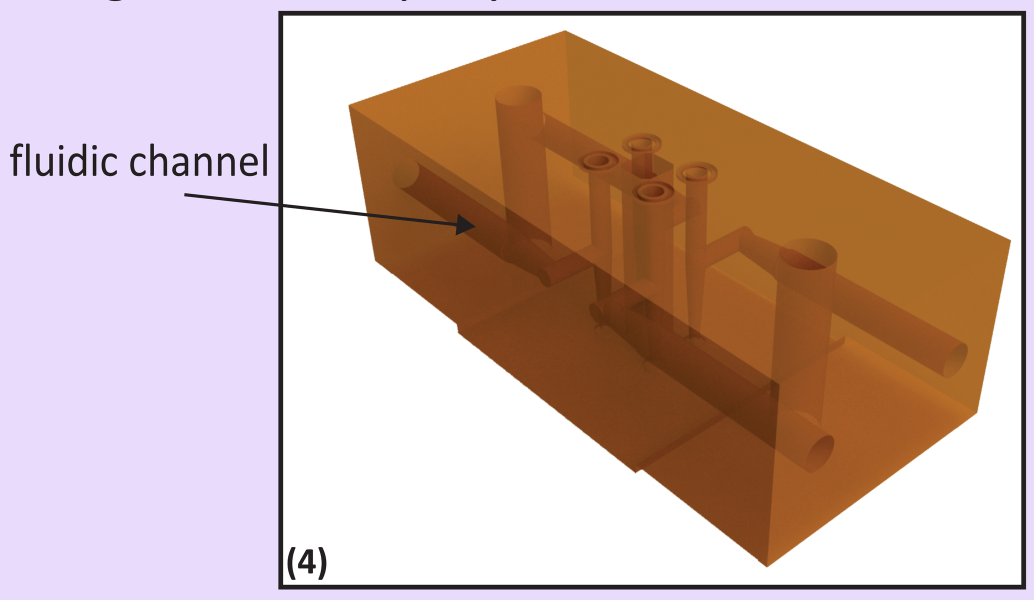
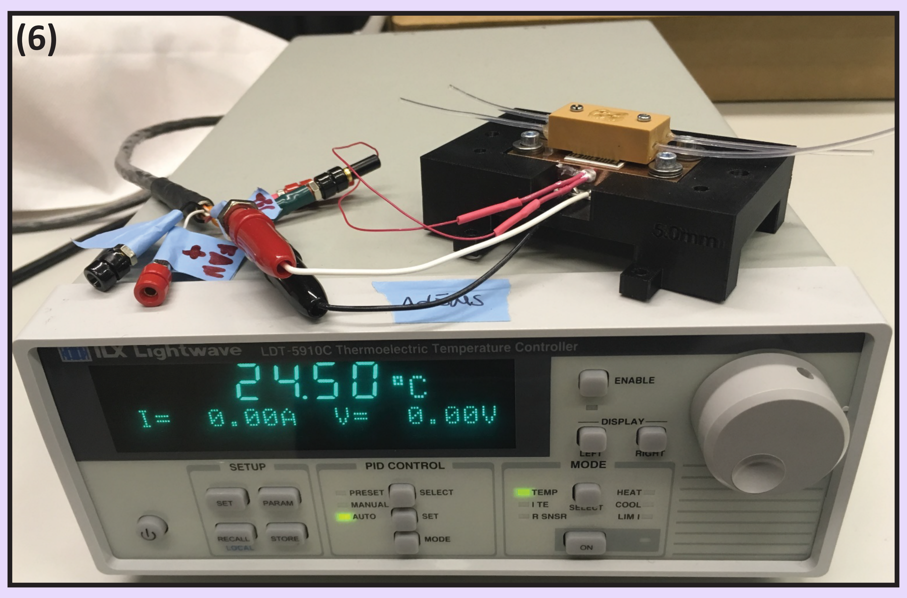


Fig. 3: Connector ready for assembly, with glass covers and tubes glue.
Fig. 4: Schematic view of the connector, exhibiting the through holes.

4. Complete setup

- **Temperature control**
  - TTC (*Newport Corporation*)
  - Peltier module
  - Thermistor
- **Fluidic delivery**
  - Fluids are delivered with a neMESYS syringe pump (*CETONI GmbH*)
- **Integrated electrical actuation**
  - PCB wire-bonded to the chip electrodes
- **Optical detection**
  - Laser Doppler Vibrometer



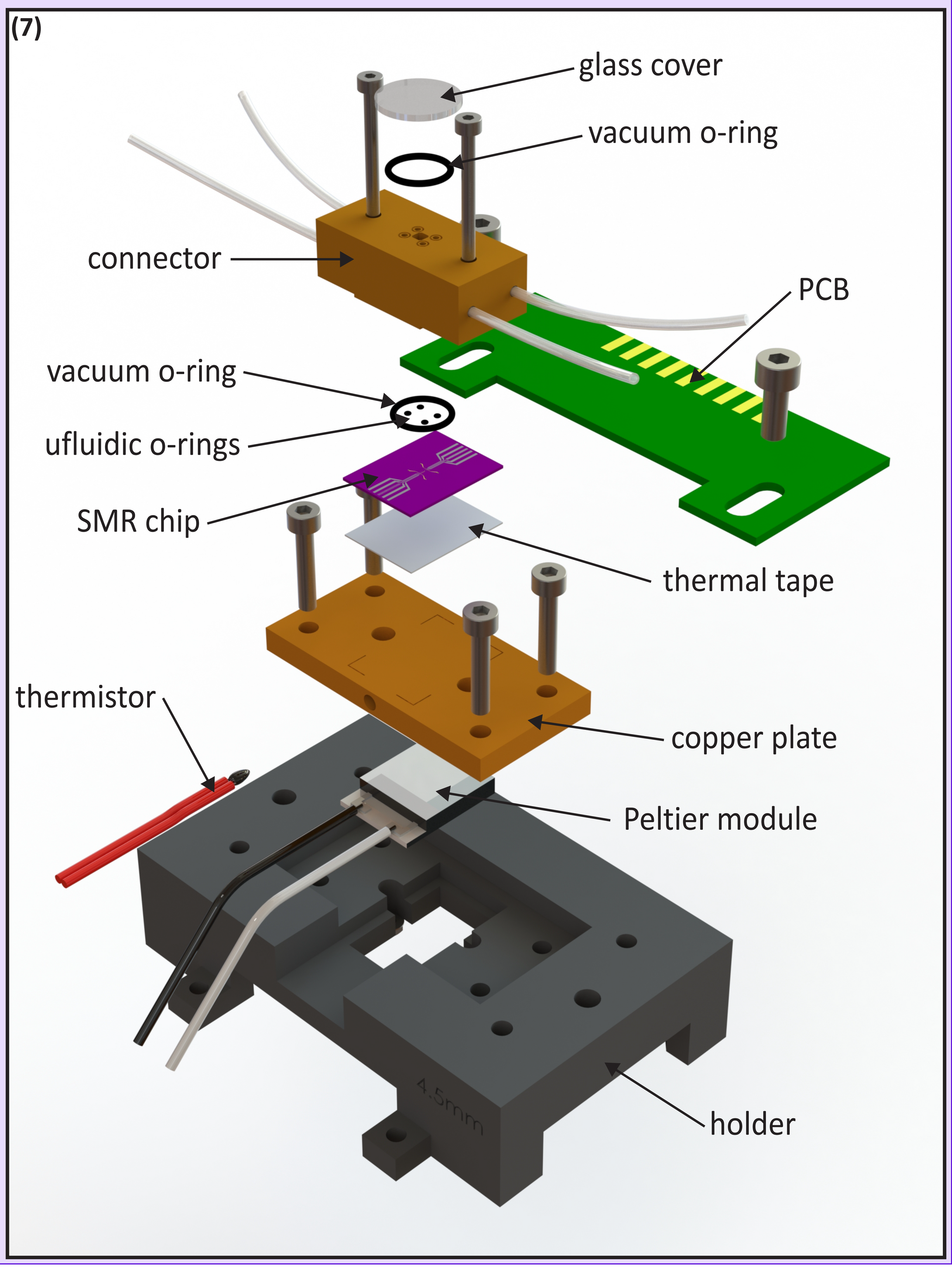


Fig. 6: Assembled SMR chip interfaced with a copper plate connected to the Newport TTC through the Peltier module and a thermistor. The copper plate is ensuring good thermal conductivity between the Peltier module and the chip.

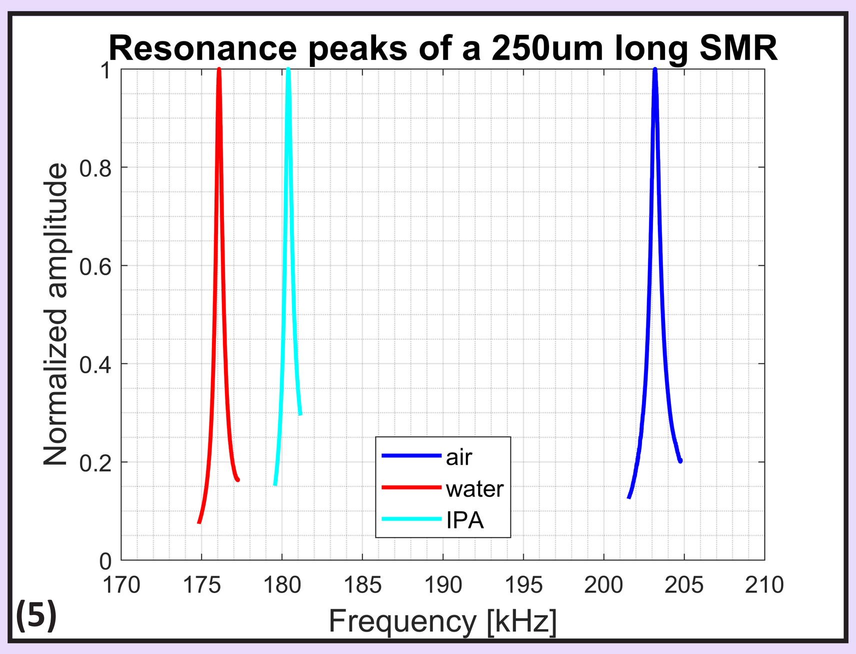
Fig. 7: Exploded view of the complete setup for actuation, temperature control and microfluidic interface of the suspended microchannel resonators.

5. Measurements

$$f_{fluid} = f_0 \frac{1}{\sqrt{1 + \frac{\delta m}{m_0}}}$$

Fluid	Theory		Experiments	
	f_r [kHz]	$\Delta f / f_0$	f_r [kHz]	$\Delta f / f_0$
Air (f_0)	236,79	-	203,21	-
Water	195,40	17,48%	176,11	13,34%
IPA	202,36	14,54%	180,43	11,21%

Fig. 5: Normalized peaks of resonance measured on a 250um long cantilever SMR filled with air, water and IPA.



6. Conclusions

- We demonstrated an entirely o-ring based interface concept for delivering fluids to SMRs chips, controlling the temperature, and enabling integrated electrical actuation
- The measurements perfomed on the SMRs are in agreement with the theoretical values

References

[1] T.P. Burg et al., "Vacuum-Packaged Suspended Microchannel Resonant Mass Sensor for Biomolecular Detection" Journal of Microelectromechanical Systems, vol. 15, no. 6, pp. 1466-1476, 2006.
[2] M.F. Khan, "Microchannel resonators to characterize liquid samples" (PhD thesis), DTU, 2012.

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The authors would like to thank SNSF for the funding provided via the project PP00P2 144695.