# Energy dissipation in Suspended Microchannel Resonators as function of channel off-axis placement

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## Abstract

- Suspended Microchannel Resonators (SMRs) enable real time analysis of fluidic samples with almost no degradation of the quality factor [1].
- Energy dissipation is a non-monotonic function of the fluid viscosity [2].
- Quality factor is highly dependent on the microfluidic channel placement with respect to the beam neutral axis [2].
- **Experimental study of the effect of the channel off-axis placement on the device's quality factor.**
- **Fabrication of SMRs with six different values of channel off-axis placement.**

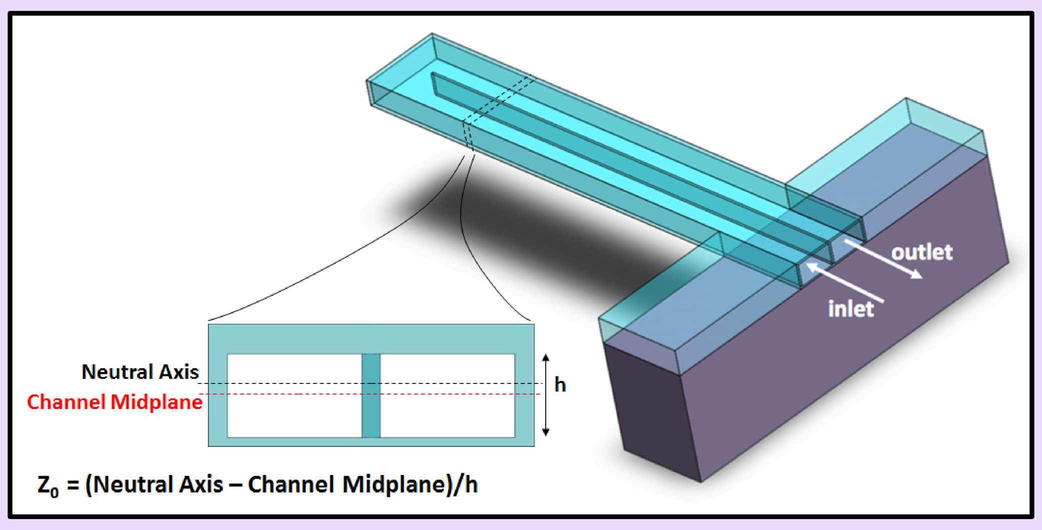


Fig. 1: Schematic of the device with the cross-section of the channel.

## Initial Considerations

- A predominant variation of the normalized quality factor occurs for values of $Z_0$ between 0 and 0.2.
- By modulating the thickness of the layer on top of the channel, it is possible to achieve the desired values of $Z_0$.

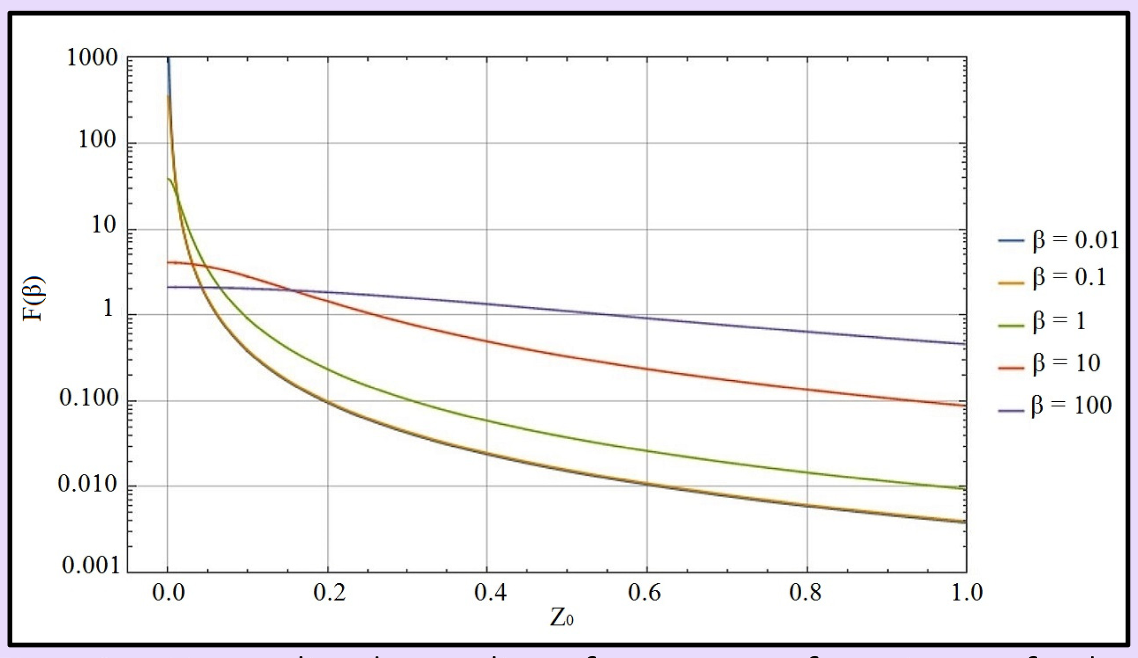


Fig. 2: Normalized quality factor as function of the normalized off-axis placement $Z_0$ for different values of Reynolds number β. Data extracted from analytical data [2].

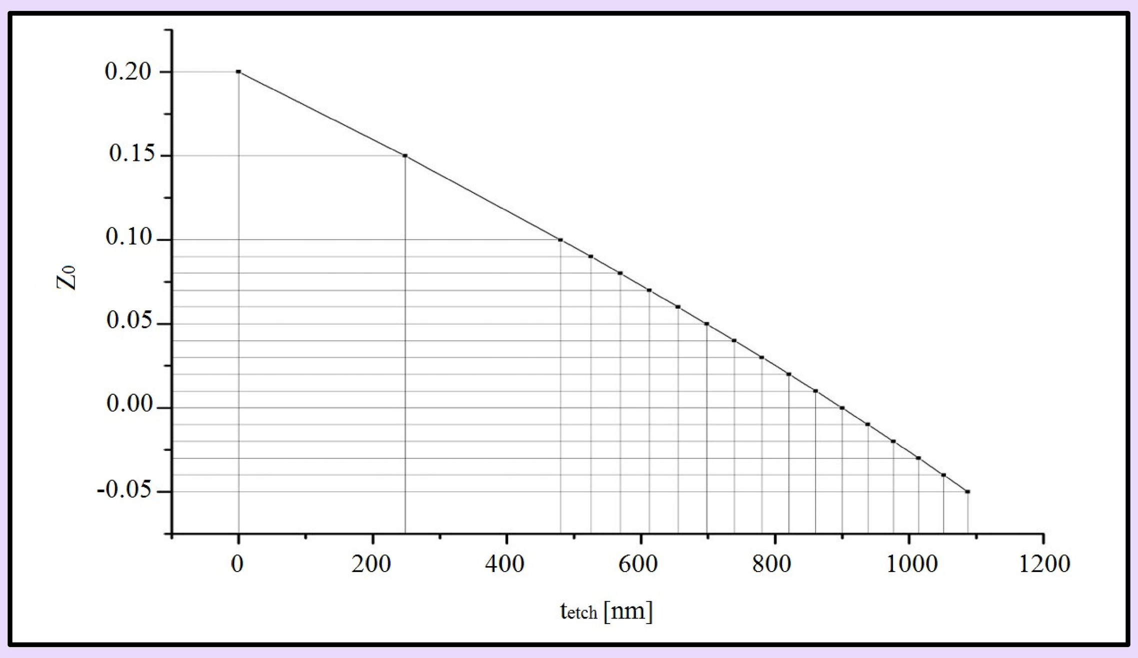


Fig. 3: Normalized off-axis placement as function of the thickness of the top layer of silicon nitride to be etched.

## Fabrication

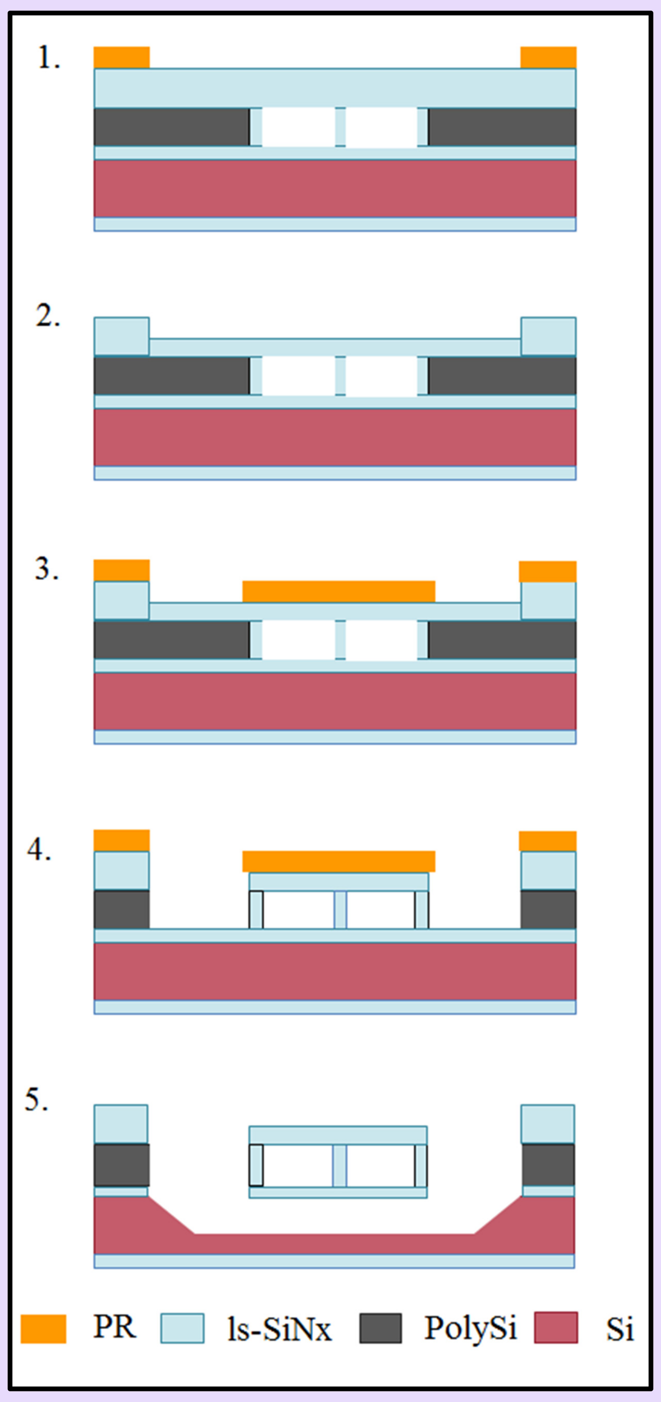


Fig. 4: Fabrication process of SMR. 1. Central window definition by photolithography, followed by wafer cleavage and PR strip. 2. Modulation of the top layer of silicon nitride by dry etching. 3. Resonator and inlets definition by photolithography. 4. Start of the resonator release process by anisotropic dry etching. 5. Resonator releasing by isotropic dry etching, and PR strip.

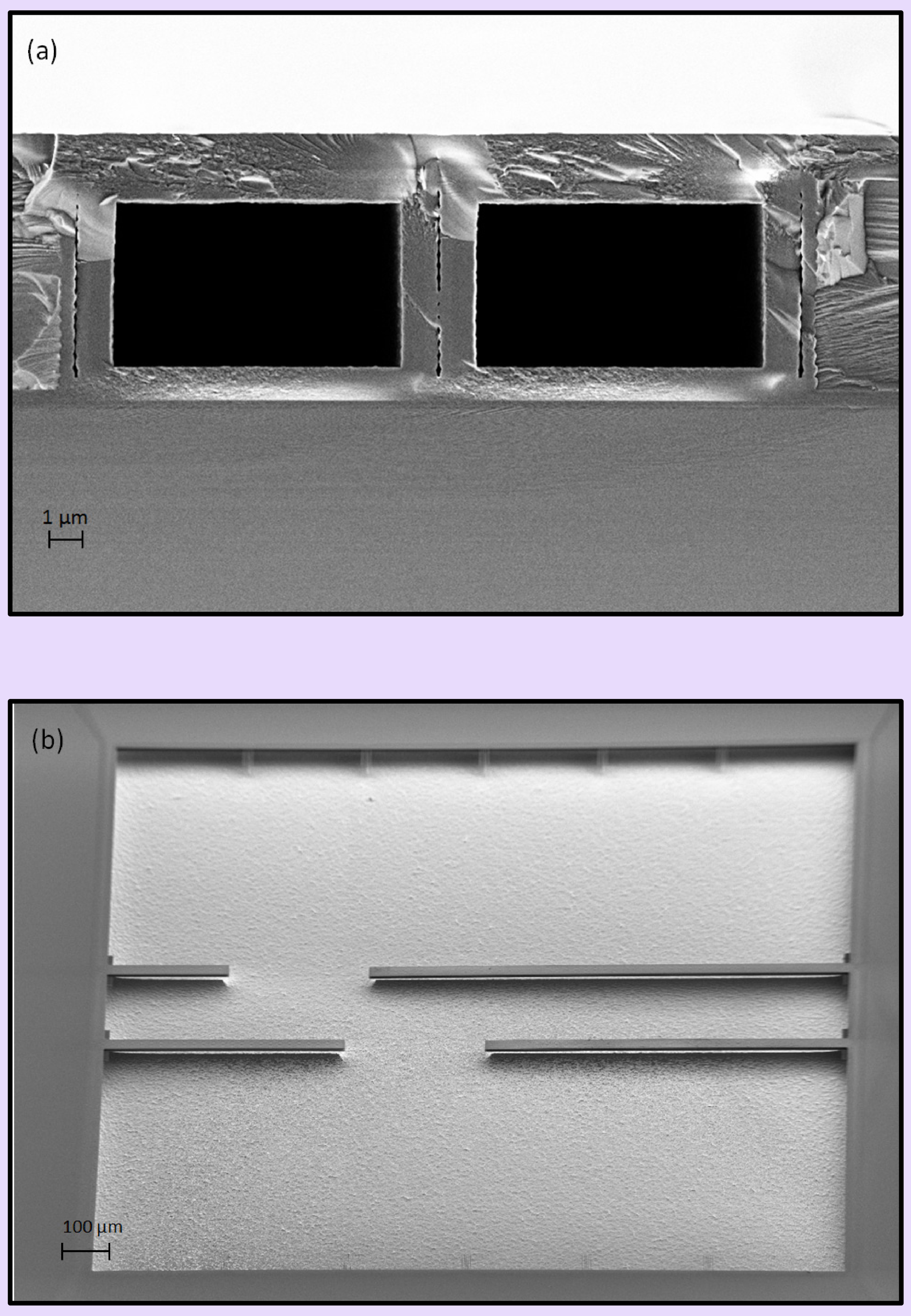


Fig. 5: (a) SEM cross-section view of a SMR before release. By modulating the thickness of silicon nitride, it was possible to achieve several values of $Z_0$. (b) SEM image of an array of released resonators up to 1000 µm in length.

## Microfluidic Setup

- Epoxy is used to glue 3D-printed microfluidic connectors on top of the inlets of the chip.
- PEEK tubing 1/16" OD is connected to the pressure sensor and syringe through fittings and glued to the connector.
- Glycerol/water mixture is used to vary the fluid viscosity.

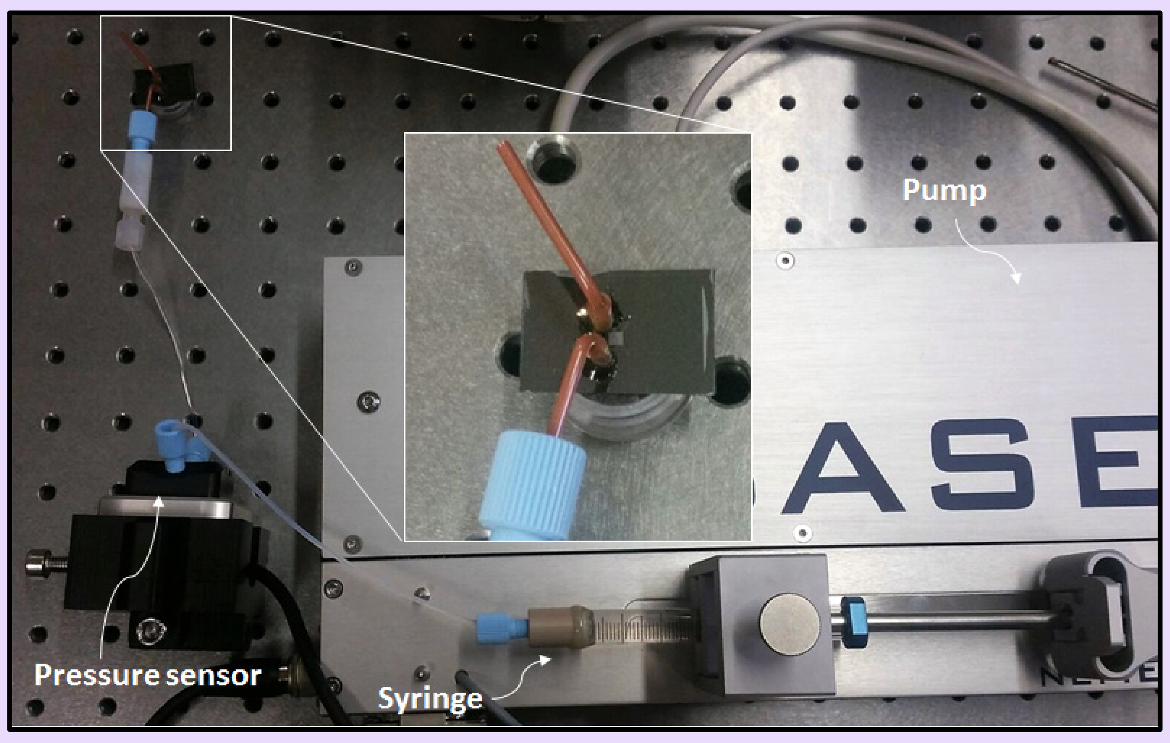


Fig. 6: Fluidic setup to fill the channels. The inset shows in detail the chip and the connectors on top of the inlets.

## Conclusions

- SMRs with six different values of $Z_0$ from -0.05 to 0.2 were fabricated.
- Microfluid setup to fill the channels with liquid was developed.
- Future work
  - Optimize the microfluidic setup;
  - Perform measurement in vacuum of Q factor and resonance frequency using a Laser Doppler Vibrometer and a piezo-shaker for readout and actuation respectively.

References
[1] T. P. Burg and S. R. Manalis, "Suspended microchannel resonators for biomolecular detection," Appl. Phys. Lett, vol. 83, no. 13, pp. 2698-2700, 2003.
[2] J. E. Sader, T. P. Burg, and S. R. Manalis, "Energy dissipation in microfluidic beam resonators," J. Fluid Mech., vol. 650, pp. 215-250, 2010.

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