Electronic Supplementary Material (ESI) for Lab on a Chip

An embedded microchannel in a MEMS plate resonator for ultrasensitive mass sensing in liquid

V. Agache,[a‡*] G. Blanco-Gomez,[a‡*] F. Baleras,[a] P. Caillat[a]

[a] *CEA-LETI/Minatec, DTBS, F- 38054 Grenoble, France. Tel:+33 (0) 474 382 653 E-mail: vincent.agache@cea.fr, gerald.blanco-gomez@cea.fr*

‡ These authors contributed equally to this work

Supplementary materials

A Fabrication process flow

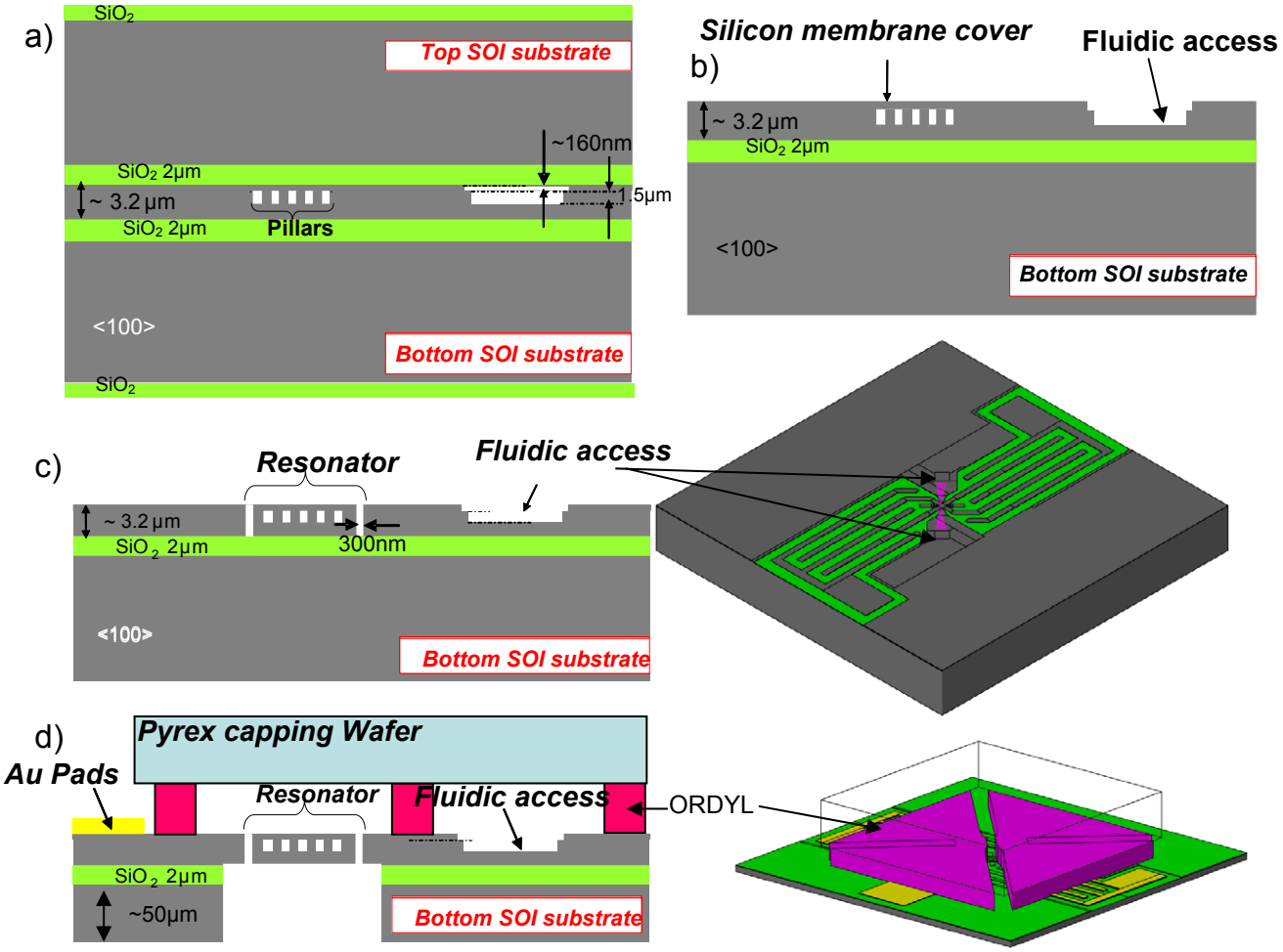

Fig. S1 Illustrations of the hollow plate resonator fabrication process flow (from (a) to (d)).

B Fluidic Filling procedure

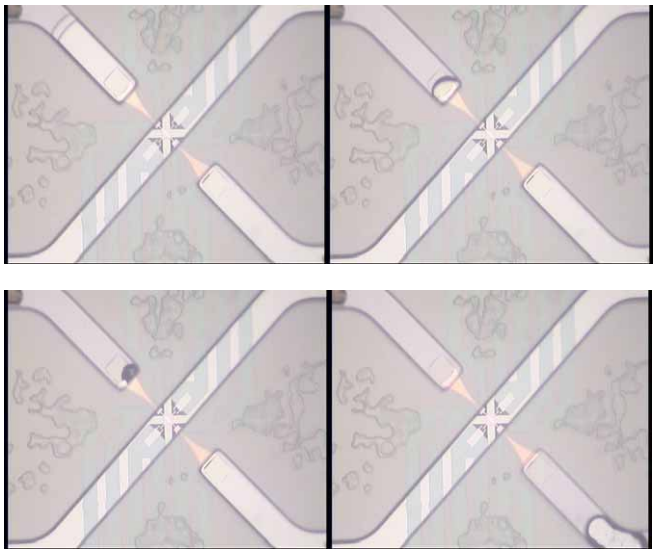

Fig. S2 Sequential (from top left to bottom right) snapshots depicting the chip fluidic filling procedure for a typical device with an embedded channel on resonator.

C Frequency stability analysis through Allan Variance extraction

Frequency stability responses of several square plate resonators were first studied for different applied DC bias voltages (from 60 V to 140 V) in an open-loop configuration. A frequency closed to the resonance was synthesised using an Agilent Signal Generator N5181A, phase fluctuations were recorded during 45 minutes taking values within the linear region of the phase as a function of the frequency (Fig. S3a) rendering an equivalent frequency fluctuations map (Fig. S3b). The Allan deviation was then computed considering overlapping samples as a function of the averaging time (Fig. S3c). As the DC bias voltage V_{DC} was increased, the actuation electrostatic force went up to follow $F = \frac{\partial C}{\partial x} V_{DC} V_{AC}$. With C, the transduction capacitance defined across the gap 300 nm between the drive electrodes and the resonator, when V_{AC} is the AC excitation amplitude. Although the fluctuations should decrease as V_{DC} increases, we observed that the highest value of $V_{DC,}$ adds up to the resonator

frequency instability (from 100 to 140 V) as the layer of 30nm thick silicon dioxide used as an insulator within the structure may progressively break down.

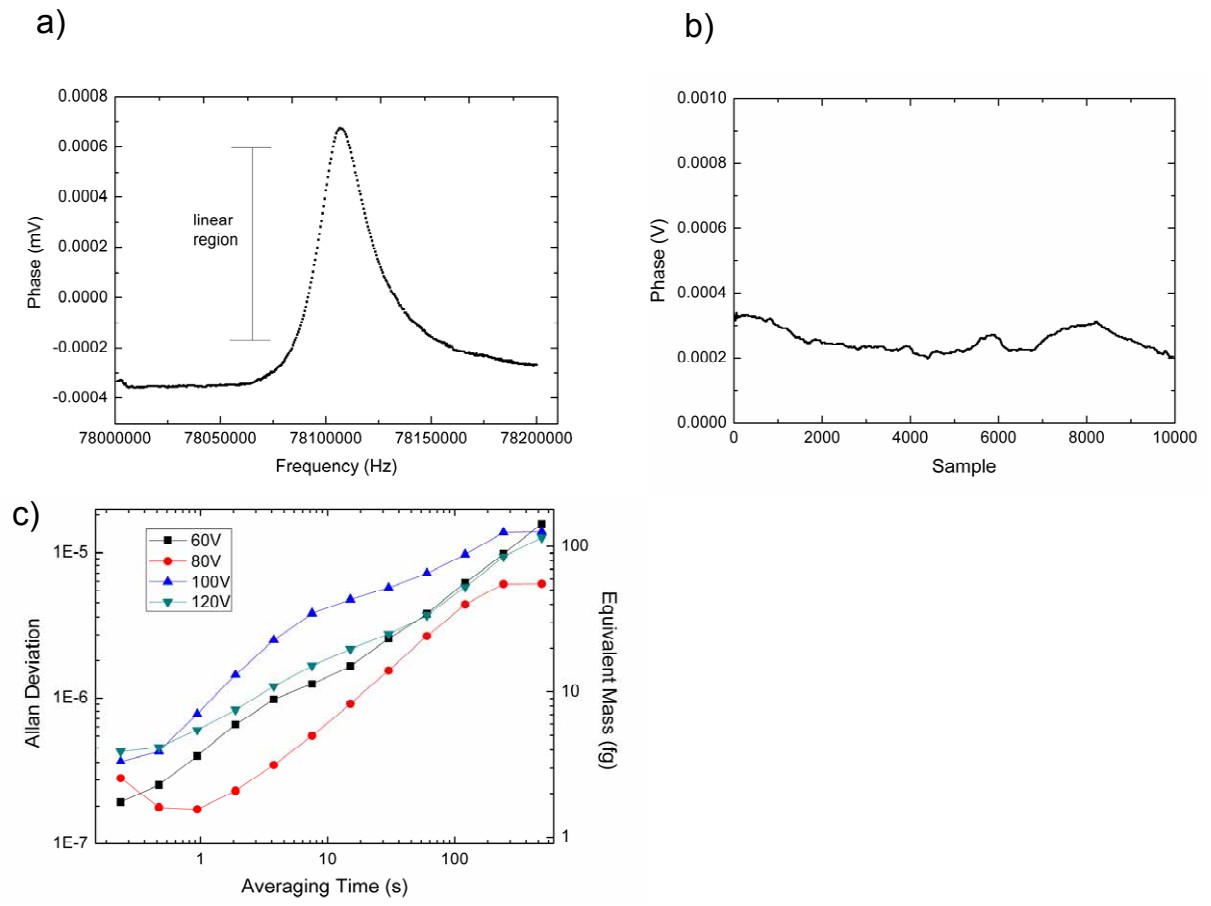

Fig. S3 (a) Transmission S_{21} phase raw signal as a function of the frequency. (b) Raw data logged for the phase channel when a fixed frequency was set spanning over 45 minutes. (c) Allan deviation and mass resolution as a function of the averaging time computed with overlapping samples for DC bias voltages of 60 V, 80 V, 100 V and 120 V, logged at an averaging time of 250 ms for 45 minutes (ca. 10^4 samples). The minimum of Allan deviation together with the resonator effective mass governed the mass resolution.