Vacuum-Packaged Suspended Microchannel Resonant Mass Sensor for Biomolecular Detection

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Microfabricated transducers enable the detection of biomolecules in microfluidic systems with nanoliter size sample volumes. Their integration with microfluidic sample preparation into lab-on-a-chip devices can greatly leverage experimental efforts in systems biology and pharmaceutical research by increasing analysis throughput while dramatically reducing reagent cost. Microdevices can also lead to robust and miniaturized detection systems with real-time monitoring capabilities for point-of-use applications.

We have recently fabricated, packaged, and tested a resonant mass sensor for the detection of biomolecules in a microfluidic format [1]. The transducer employs a suspended microchannel as the resonating element, thereby avoiding the problems of damping and viscous drag that normally degrade the sensitivity of resonant sensors in liquid (Figure 1). Our device differs from a vibrating tube densitometer in that the channel is very thin, which enables the detection of molecules that bind to the channel walls; this provides a path to specificity via molecular recognition by immobilized receptors. The fabrication is based on a sacrificial polysilicon process with low-stress LPCVD silicon nitride as the structural material, and the resonator is vacuum packaged on the wafer scale using glass frit bonding (Figure 2). Packaged resonators exhibit a sensitivity of 0.8 ppm/(ng•cm²) and a mechanical quality factor of up to 700. To the best of our knowledge, this quality factor is among the highest so far reported for resonant sensors with comparable surface mass sensitivity in liquid.

![Figure 1: Suspended microchannel resonator (SMR). In SMR detection, target molecules flow through a vibrating suspended microchannel and are captured by receptor molecules attached to the interior channel walls. What separates the SMR from existing resonant mass sensors is that the receptors, targets, and their aqueous environment are confined inside the resonator, while the resonator itself can oscillate at high Q in an external vacuum environment, thus yielding extraordinarily high sensitivity.](image1)

![Figure 2: Optical micrograph of a packaged cantilever resonator. The 300µm long beam contains a 1 x 20 µm microfluidic channel (a). An electrode on the glass surface above the cantilever enables electrostatic actuation (b). Glass frit conforms to the surface topography and does not collapse the thin channel in location (c) during bonding.](image2)

REFERENCES