Micromachined Quartz Resonators
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Motivation
1. Short decay length
2. High sensitivity
3. Multi pixels

\[ f_0 = \sqrt{\frac{C_{66}}{\rho_s}} \]

\[ t_q = \text{quartz thickness} \]

\[ \rho_s = 2.648 \text{ g cm}^{-3} \]

\[ C_{66} = 2.947 \times 10^{11} \text{g cm}^{-1} \text{S}^{-2} \]

Viscoelastic film study

Fabrication
a) 100mm thick AT-cut quartz
b) Patterned 10mm thick nickel layer
c) ICP etching of 75mm quartz
d) Nickel hard mask strip
e,f) Back side and front side electrode patterning

Packaged device in liquid test cell

Admittance characteristics of the 8-pixels in a resonator array

Device characterization

Sensitivity calibration
for 4-pixels

\[ \Delta f (\text{in Air}) = -24.08 \text{ kHz} \text{ After DTSSP Adsorption} \]

\[ \Delta f (\text{in Avidin Solution with respect to Air}) = -41.41 \text{ kHz} \]

\[ \Delta f (\text{in Avidin Solution with respect to DTSSP}) = -76.40 \text{ kHz} \]

In-situ two modes measurement of fibrinogen isotherm adsorption

\[ \ln([\text{Concentration Fibrinogen (pmole/l)}]) \]

Ln[Concentration Fibrinogen (pmole/l)]
4 6 8 10 12 14 16
Frequency Shift (Hz)
0 5000 10000 15000 20000 25000 30000 35000

1 st overtone
3rd overtone
curve fit for 1st overtone
curve fit for 3rd overtone

Nearby pixel isolation

\[ \sim 30 \text{dB} \]

Packaged device in liquid test cell

Viscoelastic medium

Protein
Cell
Bacteria
Polymer

Fluid

Semi-Infinite Newtonian fluid

Thin, rigid no slip condition

Mass

Snaps

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