Paper 9 – Discussion

ME-426 – Micro/Nanomechanical Devices

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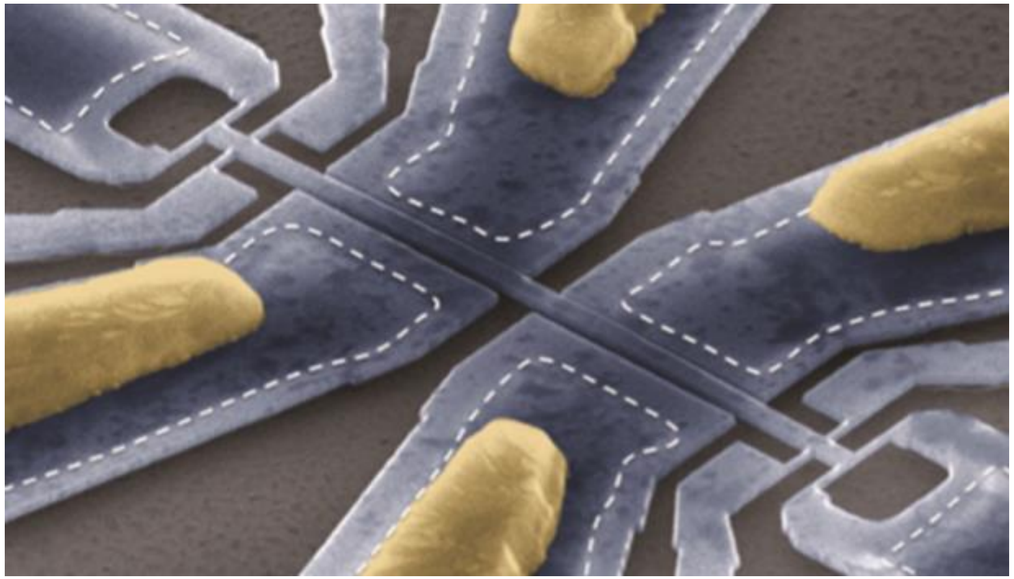
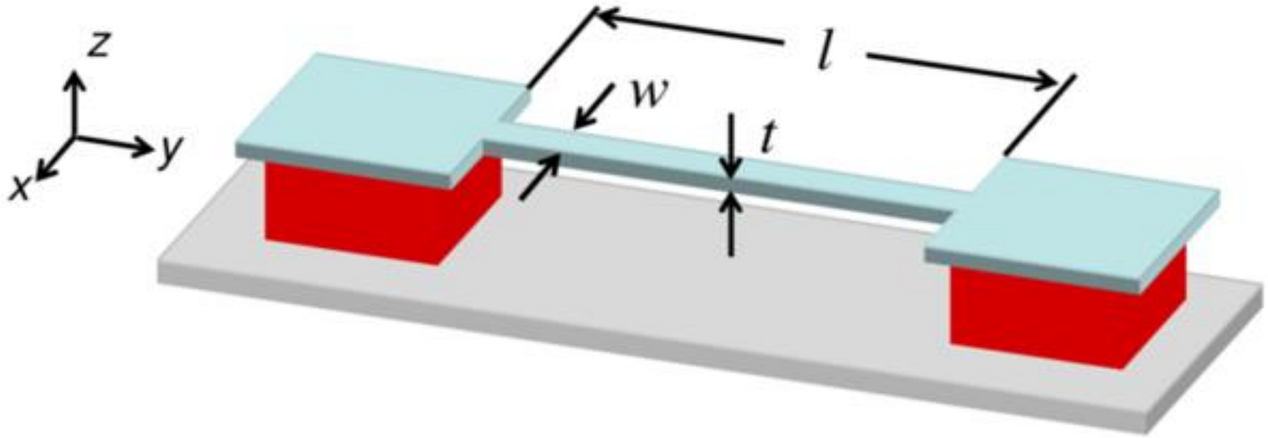
Questions

- What do they try to do with these devices?
- How are the devices made?
- How are the devices actuated and detected? Why this shape?
- Why do we need 2 modes for the detection?
- Why do we need that G is invertible?
- How do we deposit things on top?
- Can particles aggregate? How do we know it is not more than 1 landing?
- What is the resolution?
- Why the noise in the position is larger than in the mass for smaller masses?
- What are Monte Carlo?
- How are the plots for the results generated?

Discussion



Discussion



$$\frac{\delta f_n}{f_n} = -\frac{\delta m}{M}\frac{\phi_n(a)^2}{\alpha_n}$$

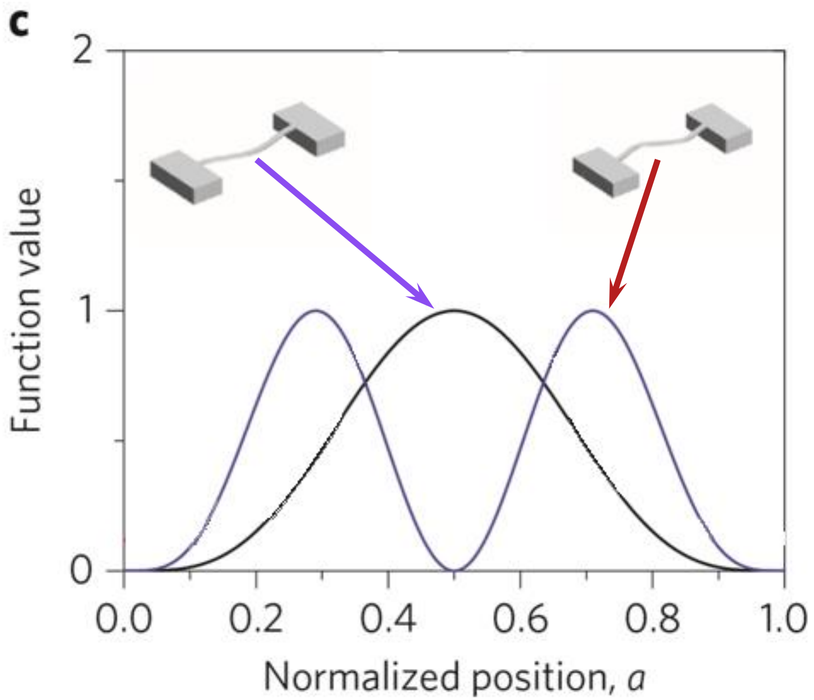
Discussion

$$\frac{\delta f_1}{f_1} = \frac{\delta m}{m.\alpha_1}.\phi_1^2(a)$$

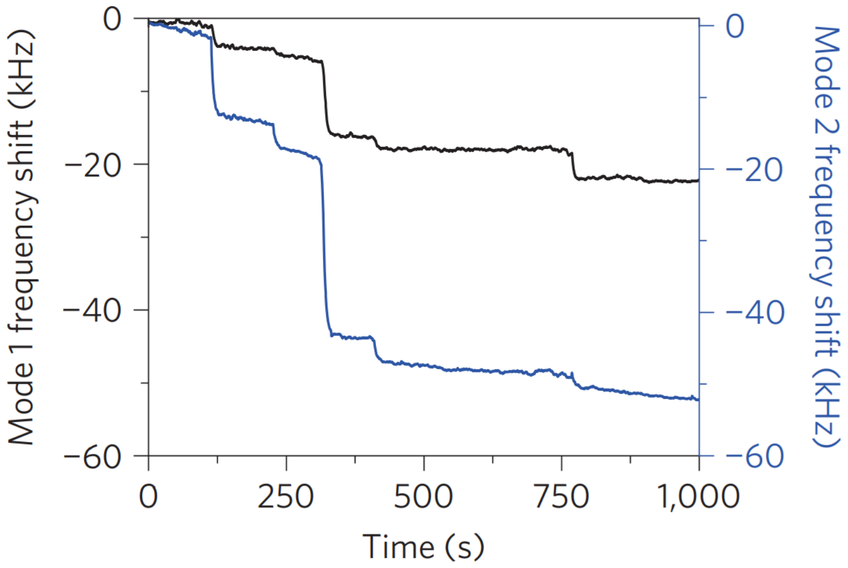
$$\frac{\delta f_2}{f_2} = \frac{\delta m}{m.\alpha_2}.\phi_2^2(a)$$

$$G(a) = \frac{\phi_1^2(a)}{\phi_2^2(a)}$$

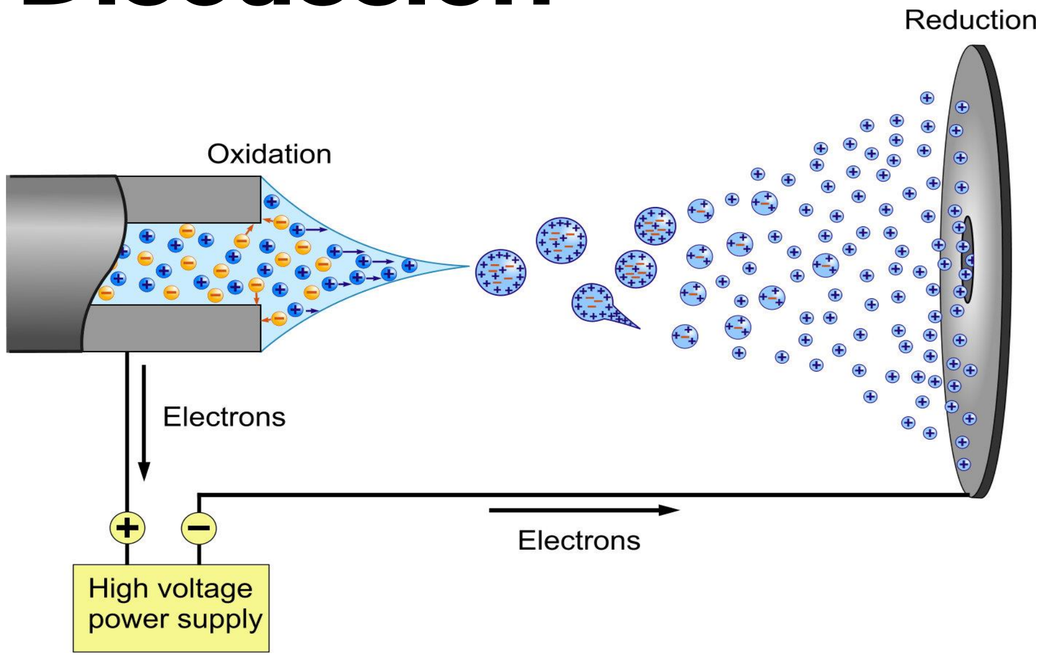
$$a = G^{-1}(a)$$

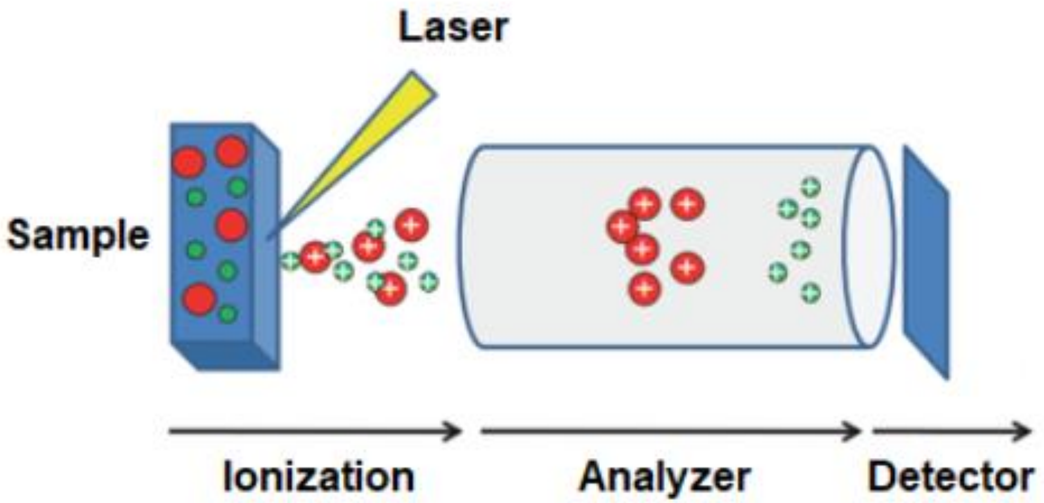


Discussion

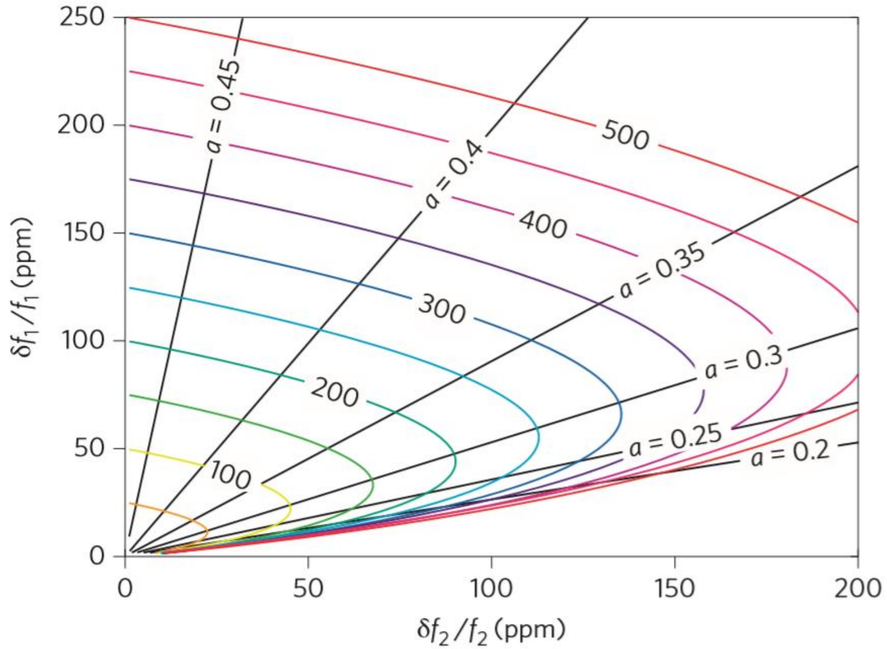

Mode 1 frequency shift (kHz)
0
−20
−40
−60
Mode 2 frequency shift (kHz)
0
−20
−40
−60
0
250
500
750
1,000
Time (s)

Discussion

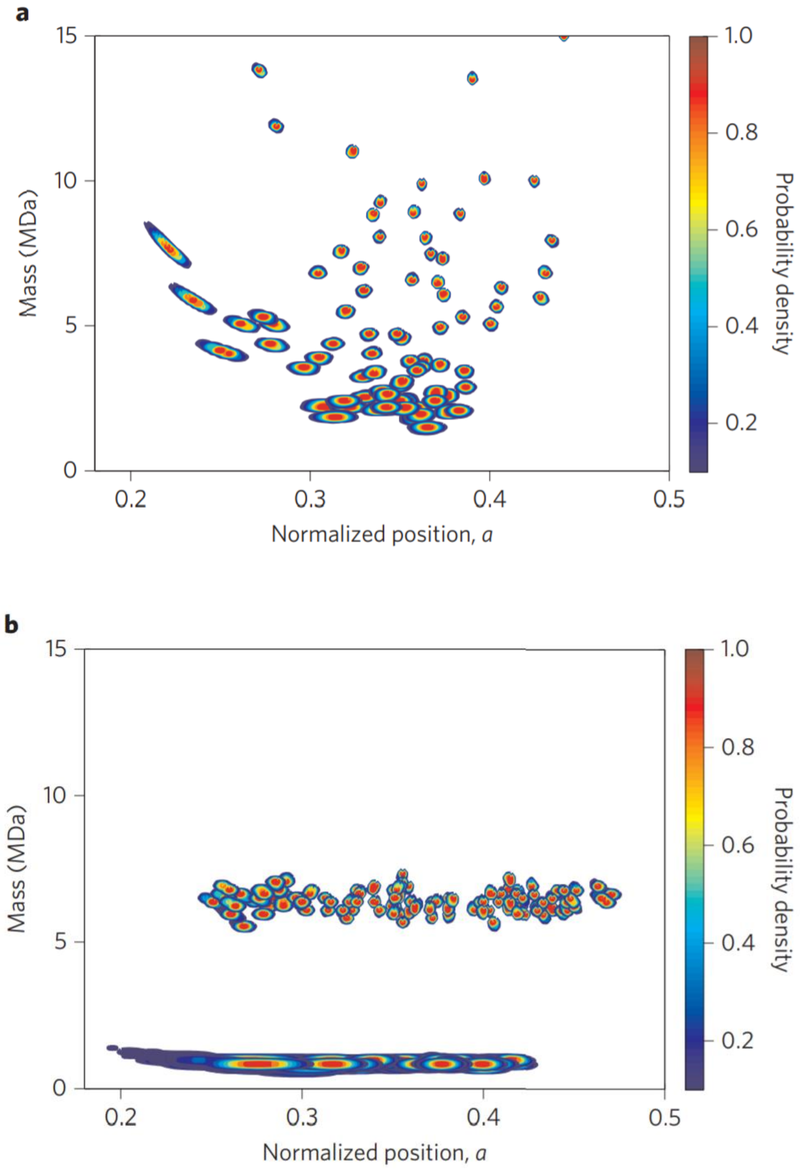

Reduction
Oxidation
Electrons
Electrons
High voltage
power supply


Laser
Sample
Ionization
Analyzer
Detector

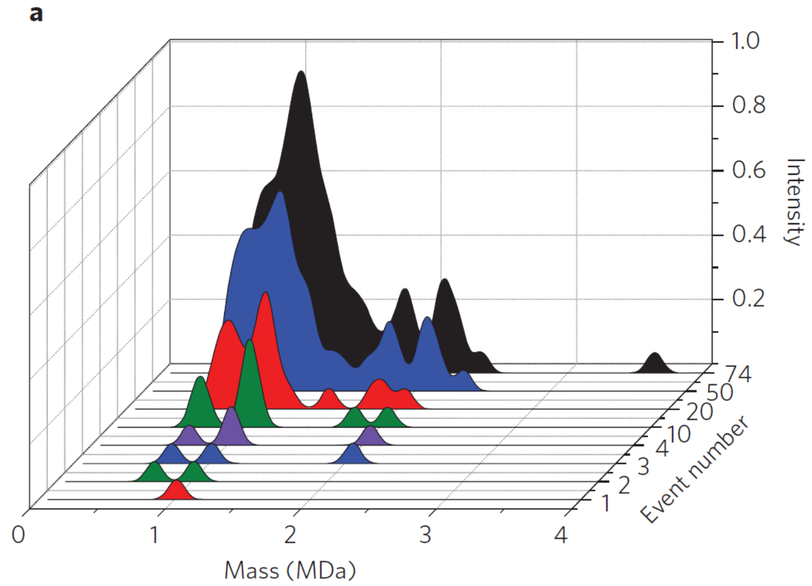
Discussion


250
200
150
100
50
0
0
50
100
150
200
$\delta f_1 / f_1$ (ppm)
$\delta f_2 / f_2$ (ppm)
a = 0.45
a = 0.4
a = 0.35
a = 0.3
a = 0.25
a = 0.2
500
400
300
200
100

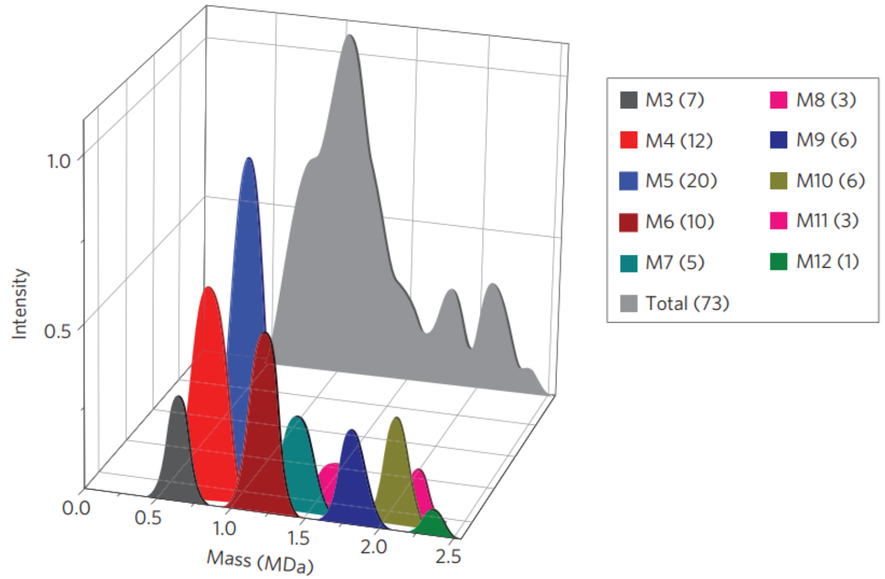
Discussion

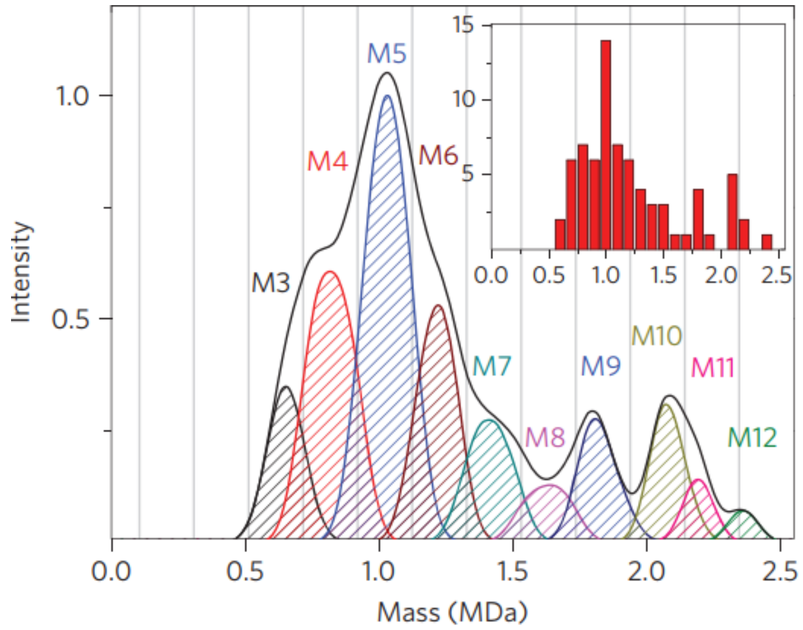

a
15
10
5
0
Mass (MDa)
0.2
0.3
0.4
0.5
Normalized position, a
1.0
0.8
0.6
0.4
0.2
Probability density
b
15
10
5
0
Mass (MDa)
0.2
0.3
0.4
0.5
Normalized position, a
1.0
0.8
0.6
0.4
0.2
Probability density

Discussion


a
1.0
0.8
0.6
0.4
0.2
Intensity
74
50
20
10
4
3
2
1
Event number
0
1
2
3
4
Mass (MDa)

Discussion


M3 (7)
M4 (12)
M5 (20)
M6 (10)
M7 (5)
Total (73)
M8 (3)
M9 (6)
M10 (6)
M11 (3)
M12 (1)
Intensity
1.0
0.5
0.0
0.5
1.0
1.5
2.0
2.5
Mass (MDa)


M5
M4
M6
M3
M7
M9
M10
M11
M8
M12
15
10
5
0.0
0.5
1.0
1.5
2.0
2.5
Intensity
1.0
0.5
0.0
0.5
1.0
1.5
2.0
2.5
Mass (MDa)