Three DoF micro-nano-force sensor using magnetic springs and upthrust buoyancy

Research framework

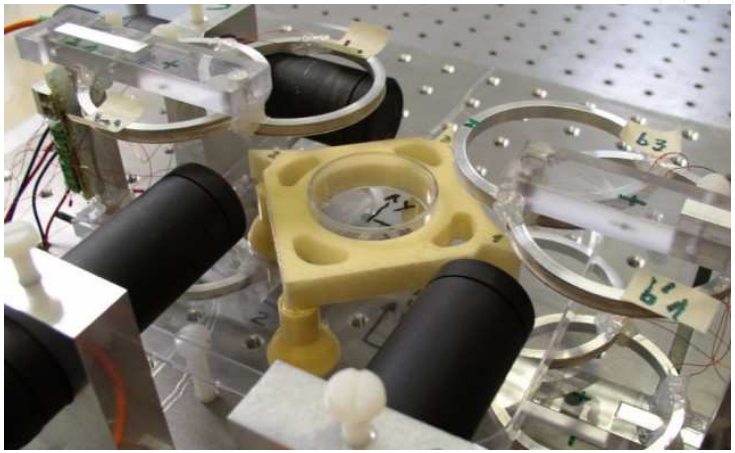
When high bandwidth in micro and nano force measurement is not mandatory, the use of rigid *macroscopic* force-displacement transducers is a possible alternative to force sensors based on elastic microstructures. Sensors using such transducer are easy to produce using conventional assembly approaches and also easy to handle thanks to the size of the transducer. The SPECIMeN group is developing such sensors characterized by high resolution and long range force measurement using passive stable *magnetic springs* resulting from the combination of attractive magnetic forces coupled with a repulsive physical principle (upthrust buoyancy).

Sensor characteristics

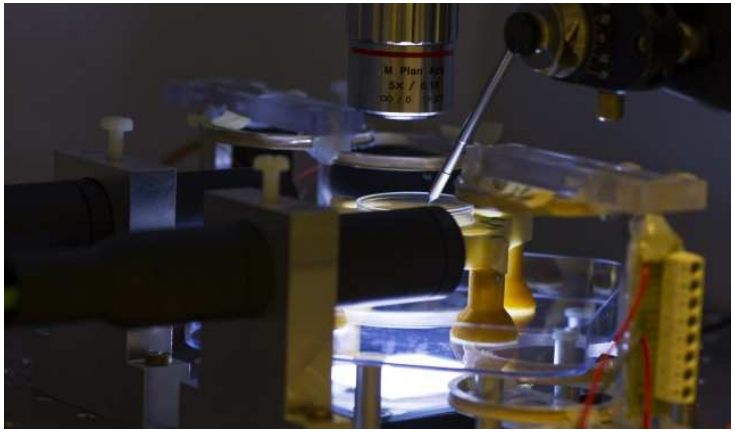
Macroscopic force-displacement transducer: floating platform (4 g).
Force measurement: F_x and F_y horizontal components
Torque measurement: C_z vertical component
Stiffness: 0.02 N/m.
Resolution: 10 to 20 nN (1)
Max range: ± 20 µN typ. (2)
Displacement bandwidth: 1 Hz typ. (3)
Max force bandwidth: 10 Hz typ. (1)
Displacement measurement: confocal chromatic sensors.
Response: under-damped second-order linear force-displacement dynamic.

(1) depends on the S/N ratio wanted on force measurements and the resolution of the displacement sensor.
(2) depends on the range measurement of the displacement sensor used.
(3) depends on the mass of the capillary tube.

Major article: A. Cherry, E. Piat, J. Abadie, Analysis of a passive microforce sensor based on magnetic springs and upthrust buoyancy, Sensors and Actuators: A Physical, 2011, 169(1):27-36.



Sensor with its floating plateform (in yellow)



Sensor used for oocyte stiffness characterization

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SPECIMeN Group

Sensing strategies, Perception and Characterization at Micro- and Nano-scales

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