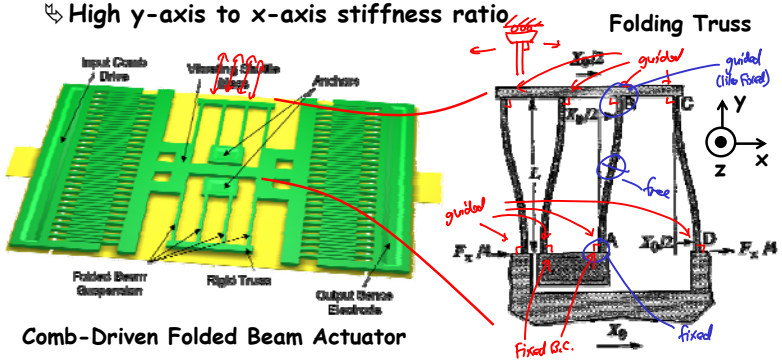
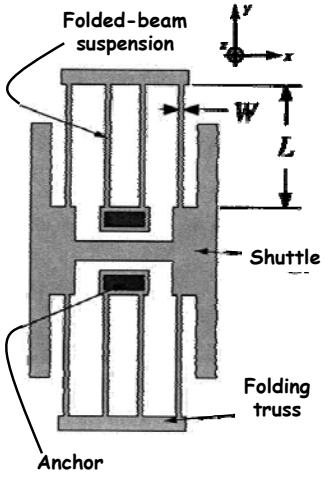
Folded-Beam Suspension

- Use of folded-beam suspension brings many benefits
  - Stress relief: folding truss is free to move in y-direction, so beams can expand and contract more readily to relieve stress
  - High y-axis to x-axis stiffness ratio



Comb-Driven Folded Beam Actuator

Folded-Beam Stiffness Ratios



- In the x-direction:

$$k_x = \frac{24EI_z}{L^3}$$

- In the z-direction:
  - Same flexure and boundary conditions

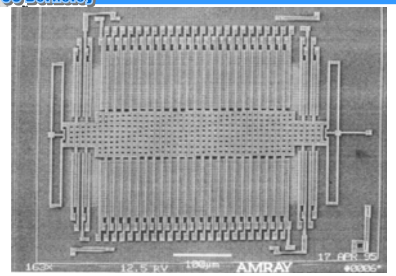
$$k_z = \frac{24EI_x}{L^3}$$

- In the y-direction:

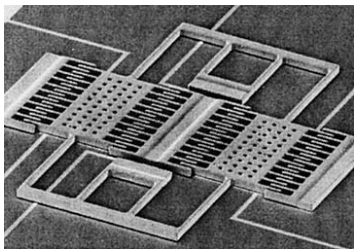
[See Senturia, §9.2] $k_y = \frac{8EWh}{L}$

- Thus: $\frac{k_y}{k_x} = 4\left(\frac{L}{W}\right)^2$ Much stiffer in y-direction!

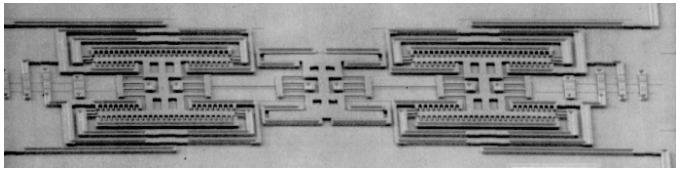
Folded-Beam Suspensions Permeate MEMS



Accelerometer [ADXL-05, Analog Devices]



Gyroscope [Draper Labs.]



Micromechanical Filter [K. Wang, Univ. of Michigan]

Folded-Beam Suspensions Permeate MEMS

- Below: Micro-Oven Controlled Folded-Beam Resonator