Homework Micro-scale Engineering #1, Due Date: January 23, 2014

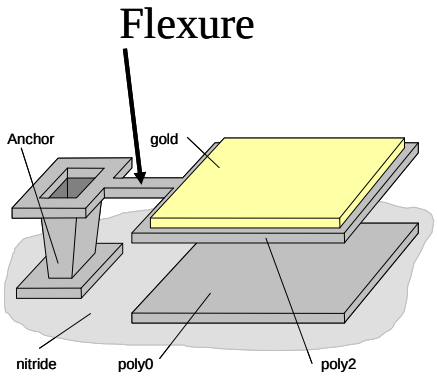
You can turn in your answers by the beginning of the class on the 23rd. Or, email its PDF or Word file to leeyc@colorado.edu before the class. There will be penalty for late submission.

1) During the Workshop #2, we discussed FinFET and 3-D packaging. Please identify one of the leading companies in FinFET technology and another one in 3-D packaging. List the URL of the reference link to justify your choice. (3 points)

Intel is a leader in FinFET technology; see a link at http://www.intel.com/content/www/us/en/silicon-innovations/intel-22nm-technology.html.

Samsung is a leader in 3D packaging; see a link at http://www.i-micronews.com/news/Samsung-3D-TSV-Packaging-Roadmap,4047.html.

2) The following micro-mirror has been analyzed during the class. We would like to increase the pull down voltage from 1.9 Volts to a level close to 5 Volts. Please change one of the dimensions of the flexure or the mirror for the increase. Justify your recommendation by simple calculations. Note: The pull down voltage does not need to be exactly at 5 Volts. As long as it is between 4 and 6 Volts, the new design is fine. (7 points)



Calculations presented in the lecture:

A plate: 250 μm x 250 μm
An air gap: 2 μm
A flexure: 40 μm x 10 μm x 0.5 μm
E = 169 GPa for the flexure
k = 169,000 MPa x 10 x $0.5^3/(4 \times 40^3)$
= 0.8 μN/μm
d = 1/3 x 2 μm = 0.7 μm
V = (2/3 x 2μm) x
SQRT [$(2x1x0.8x0.7)/(8.85E\text{-}6 \times 250^2)$]
= 1.9 V

Change the length of the flexure from 40 to 21 μm, the pull down voltage would around 5 V. Changing the length is the best design since the stiffness is related to L^3. Another choice is to change the width of the flexure.

Do not change the thickness since a designer is not allowed to change the thickness of a layer for a foundry process. Do not change the mirror area since this area is critical to the optical performance.