

EE245 Probe Station Lab

The purpose of this lab is to experience using a microprobe station to test and destroy some polysilicon MEMS structures.

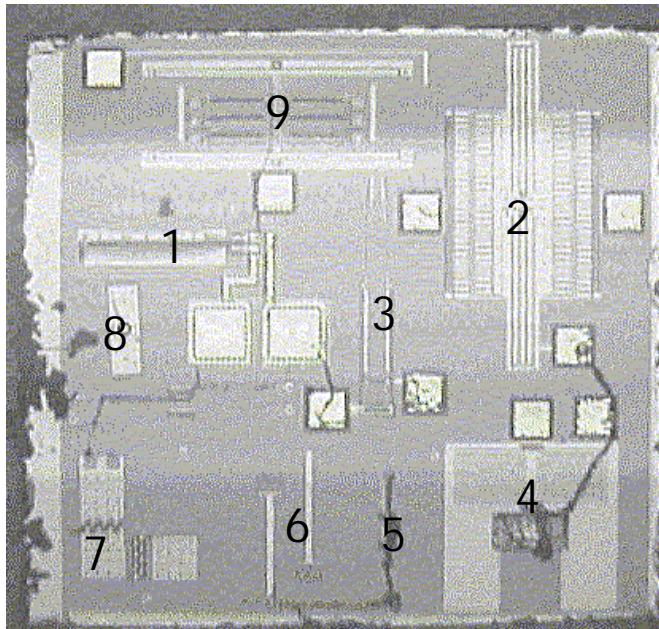
Equipment: (Should be provided to you by lab instructor)

Double-stick tape
Tweezers
2 Banana cables
2 Banana – mini-banana cables
2 Probe tips
BNC-banana adapter
Function Generator
High-Power Supply

The EE245 Lab Chip

A die shot of the EE245 chip is shown below. It contains the following structures:

1. Thermal actuator
2. Comb drive
3. Thermal tweezer
4. Scratch-drive actuator
5. Slider
6. Strain gauges
7. Fold-up cube
8. Pin joint
9. Pull-in structure



Procedure: In the allotted time (90 minutes), perform as many of the following tests as you can. Do not spend too much time on any one structure. The lab assistant will assist you with getting your chip onto the stage and showing you how to use the equipment.

Thermal Actuators – Actuate the thermal actuator and thermal tweezers.

1. Connect the negative and ground terminals on the power supply to one of the probes. Connect the positive terminal to another probe.
2. Turn the voltage and current limit on the power supply down to zero.
3. Locate the thermal actuator on your test chip and move the probes into position above its two pads.

4. Carefully touch the probe tips down to the two pads. When you see the probe tip scoot forward as you are dialing it down, it has touched the surface.
5. Turn up the voltage knob a little. The “Constant Current” LED should come on. Turn the voltage knob a couple revolutions more.
6. Slowly turn up the current on the power supply, 1mA at a time. Record the voltage at each point, and estimate the deflection of the actuator. At what current does the actuator deform permanently? At what current does the actuator start to glow? At what current does the actuator fail?
7. Turn the current down to zero and raise the probes.
8. Find the thermal tweezers on the test chip and touch the probes down to the two pads.
9. Turn up the current to actuate the tweezers. At what current do the tweezer tips close together?
10. Turn the current down to zero and raise the probes.

Comb Drive – Resonate the comb drive

1. Connect the BNC-banana adapter to the output of the function generator.
2. Connect the negative and ground terminals of the power supply to the ground terminal on the BNC-banana adapter.
3. Connect the other terminal on the adapter to one probe. Connect the positive terminal on the power supply to another probe.
4. Set the voltage on the power supply to 25V. Set the amplitude of the function generator to 10Vp-p. Set the frequency to 1kHz and the waveform to sine wave.
5. Find the comb drive on your chip, and position the probes above it.
6. Touch the probe connected to the power supply to the pad connected to the structure and groundplane.
7. Touch the probe connected to the function generator to the pad connected to one of the drive combs.
8. Slowly sweep the frequency up. Find the resonant frequency of the structure.
9. Estimate the maximum amplitude you can get using these voltages.
10. Play with the bias voltage and ac amplitude to see how these affect the amplitude of motion.
11. [Optional] Estimate the Q of the structure.
12. Raise the probes and shut off the function generator and power supply.

Pull-in Structure – Find the pull-in voltage of a parallel-plate structure.

1. Make connections to the power supply as in experiment 1. Turn the current limit down to 2 mA and the voltage down to zero.
2. Locate the pull-in structure on the chip and position the probes above it.
3. Touch one probe to either pad.
4. Slowly raise the voltage on the power supply. Observe the deflection of the structure if you can.
5. Continue raising the voltage until you find the pull-in voltage of the structure.
6. Lower the voltage to zero. Does the structure return to its original position?
7. Raise the probes.

Hinge and pin-joint structures

1. Locate the slider structure. Push the slider back and forth with a probe.
2. Locate the pin joint structure. Rotate the rectangular piece about its hub.
3. Locate the fold-up cube. Has part of the cube self-assembled? Attempt to assemble the rest of the cube with a probe.

Appetite for destruction

1. Locate any structure that you have not yet destroyed, and destroy it with a probe. Experiment with different ways to blow things up real good. I personally recommend moving the stage without lifting the probes and touching the back of a probe tip.

Report

Each group should compile a *BRIEF* report summarizing what you did. There is no specific format that I want you to use. Just use the following “Dos and Don’ts.” Reports will be due one week after you complete your lab.

DO briefly summarize what you were and were not able to do with the test chip.

DO show plots or charts of any data you may have collected.

DO some additional analysis or calculations if you are curious, e.g. figuring how hot the thermal actuator must have been to glow.

DON’T write an objective, introduction, conclusion or any such extraneous sections.

DON’T repeat the instructions on this sheet.

DON’T write down the operating procedures for equipment that I already know how to use.

DON’T exceed two pages.

Written by Patrick Riehl, 11-4-99