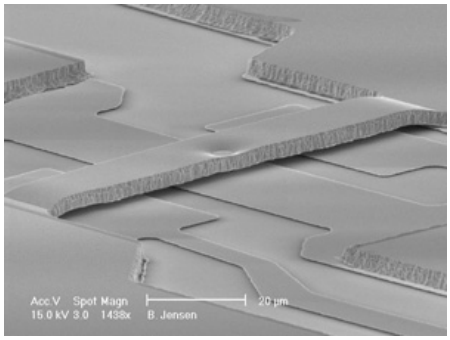
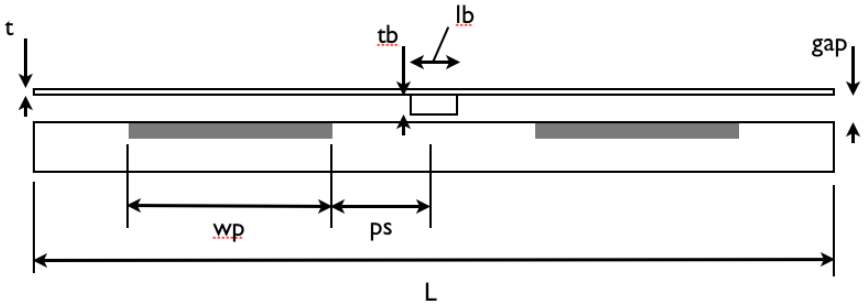
Lab 6 ME/ECE 550

Force Analysis of MEMS Contact Switch

Introduction:

MEMS switches have applications in radio-frequency circuits, commonly known as RF MEMS. RF MEMS switches have both advantages and drawbacks. These switches are electrostatically actuated which requires little power to operate. But, the actuation speed, 2-40 μs, may be too slow for some systems. Two types of MEMS switches are capacitive and contact. In this lab you will look at a MEMS contact switch that is electrostatically actuated. You will determine the contact force of the switch under different applied voltages.





Procedure:

You will model a MEMS contact switch using SOLID95 elements in ANSYS. This model will build on all of the techniques you have been developing. You are expected to build the model using a batch file. The steps you will need to complete are outlined below. Several new commands that are necessary to complete this analysis are also described below.

Step:

- Define parameters
- Create 2 volumes
- Glue volumes together
- Create contact area (WPOFFS, BLC5)
- Define material properties
- Mesh volumes
- Create contact pair (see the end of lab description for this tutorial)
- Create electrostatic field elements (EMTGEN)
- Specify boundary conditions (DOF, VOLT)
- Solve non-linear solution (40, 60, 30)
- Output needed results(*GET, *DIM, VWRITE)

Commands:

-BLC5: can be used to create 3 dimensional blocks. By setting the block thickness to zero, this command will create 2D areas.

-WPOFFS: this command is used to offset the working plane. Used in combination with the BLC5 command, an area can be created at a location offset from the origin.

-*DIM: Used to define an array.

Deliverables:

You will turn in a professional memo that shows and discusses the results you obtained from the model. In particular, make note of the voltage when contact occurs. This will include the plots and pictures that are requested below. Additionally, you are expected to discuss at least two advantages and two disadvantages of MEMS switches that aren't mentioned above.

Other items to include in your memo:

- Picture of the deflected structure at its final state.
- Plot of voltage vs. contact force

Parameter	**Symbol**	**Value**
Length of the beam	L	300 microns
Thickness of the beam	t	0.5 microns
Length of the contact block	lb	20 microns
Thickness of the contact block	tb	gap*(2/3)
Initial gap	gap	2 microns
Distance from center to pad	ps	L/8
Width of capacitive pad	wp	L/4
Width of the beam	w	40 microns
Applied Voltage	voltage	16 Volts
Young's Modulus	E	69000 MPa
Element Size	esz	5
Coefficient of friction	Cf	0.16

CREATE CONTACT PAIR (Use GUI)

To create the contact constraints you will use the contact wizard in the Graphical User Interface (GUI). After you complete the creation of the contact pair, you will copy the required lines from the log file and insert them into your batch file. To create the contact pair place an '/EOF' command right after where the volumes are meshed. Then complete the following steps.

Preprocessor -> Modeling -> Create -> Contact Pair
Select the button in the upper left-hand corner of the window that pops up

A new window will pop up that looks like the one on the right.
Make sure you make the target type 'rigid'. The 'target' area is the area you created with the BLC5 command.
Click ' Pick Target' and then input the target area number into the next box.
Click 'Apply'. Click 'Next'

Next you will need to pick the 'contact'.
The contact is the area that is moving into the 'target'.
Set contact element type as 'node to surface'
Click 'Pick Contact' and then input the contact area number into the next box.
Click 'Apply'. Click 'Next'

Finally, click optional settings.
Set stiffness matrix to 'Unsymmetric'.
Set the Friction Coefficient to '0.16'.

Click 'OK'. Click 'Create'. Click 'Finish'.
Copy the Contact Pair log file lines into your batch file.