Enhancement of Electrostatic Comb drive design for MEMS

Microelectronics
Asian Institute of Technology

Puttachat Khuntontong1, Nitin Afzulpurkar1, Adisorn Tuantranont2

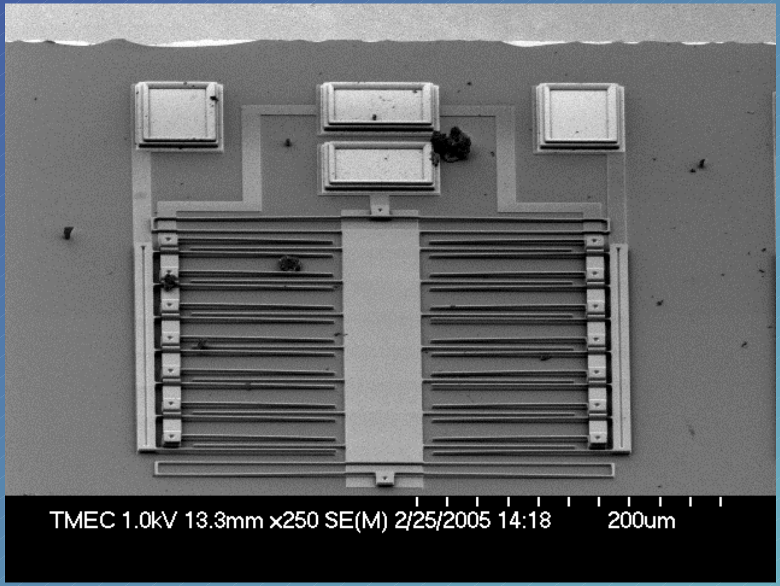
1Asian Institute of Technology P.O. Box 4 Klong Luang, Pathumthani, Thailand 12120.

2Nanoelectronics and MEMS Laboratory, National Electronic and Computer Technology Center 112 Thailand Science Park, Pahol Yothin Rd., Klong Luang, Pathumthani, Thailand 12120

Micro Elector Static Comb drive

Surface micromachined polysilicon resonators which are driven by electrostatic combs has several attractive properties. Electrostatic combs have recently been used for the moving and sensing devices.

Airbag sensor



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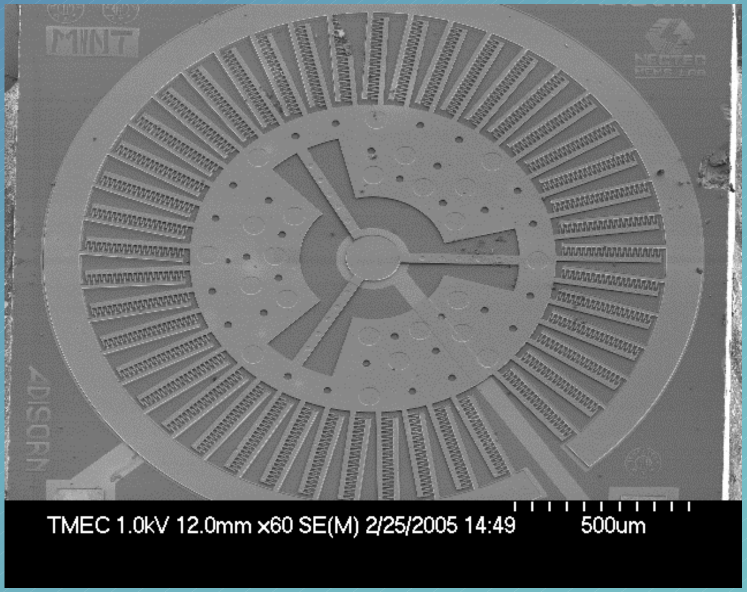
Microactuator



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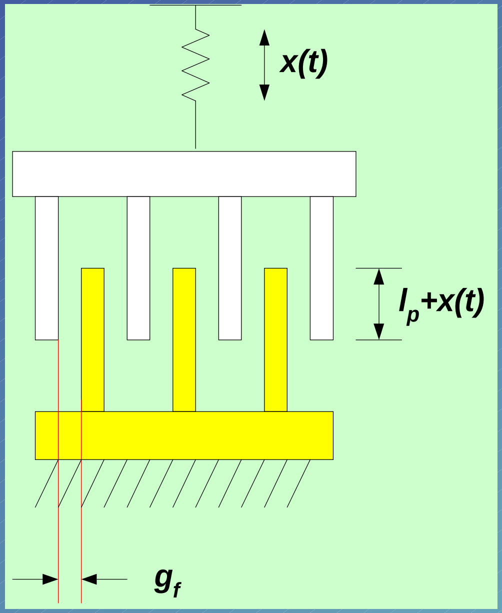
Electrostatic force

The bias voltage a stator and shuttle, the electrostatic force take place between them and try to move in front direction. Movement of combs drive can control by increase or decrease bias voltage



$$f(x,V) = \frac{1}{2}\frac{\partial C(x)}{\partial x}V^2$$

$$C = \frac{\varepsilon_a h(l_p + x(t))}{g_f}$$

$$f_1(V) = \frac{1}{2}\frac{\varepsilon_a h}{g_f}V^2$$

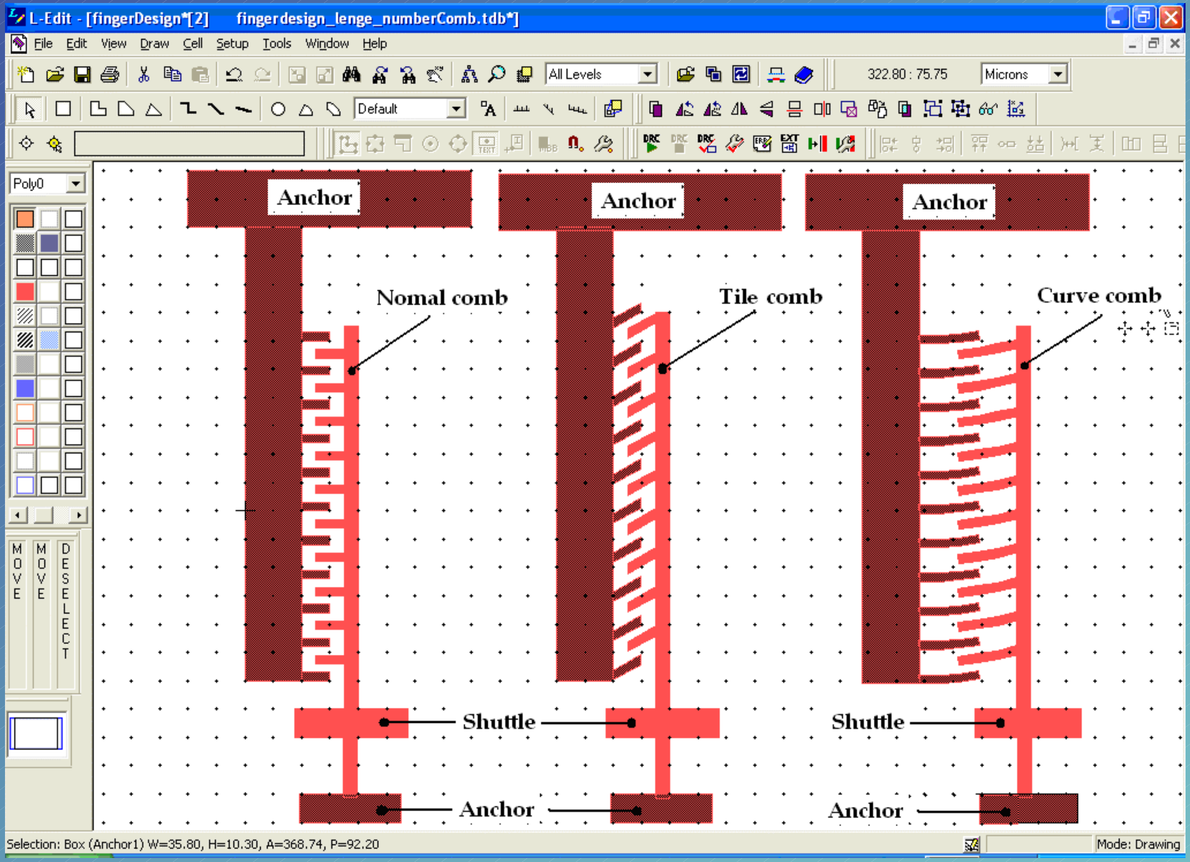
Objective

Enhancement of comb drive design by using electrostatic.

Three types of comb drive design; a normal come drive, a tile comb and a curve comb are comparing a *charge density* between two side of comb and *displacement* that can move a shuttle. The proving method is done by Coverter Ware which is MEMS simulation software.

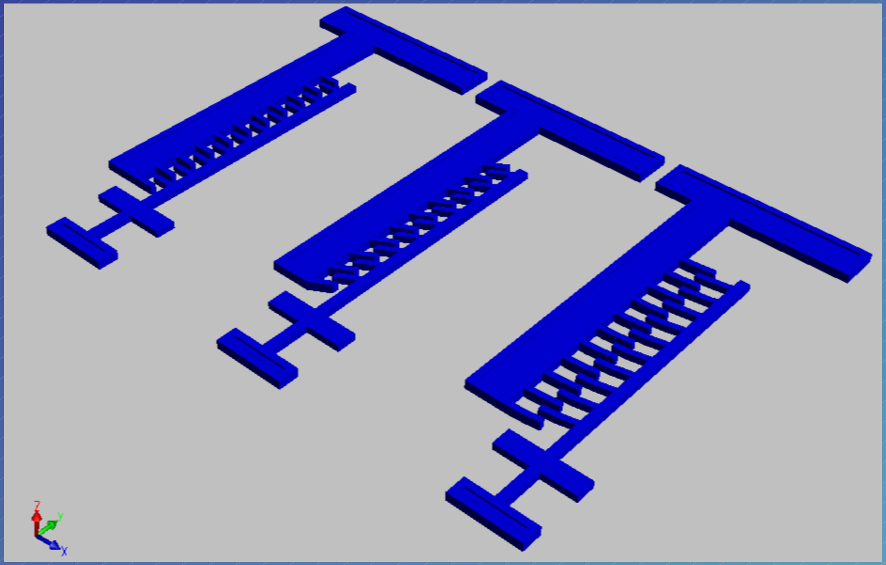
Design

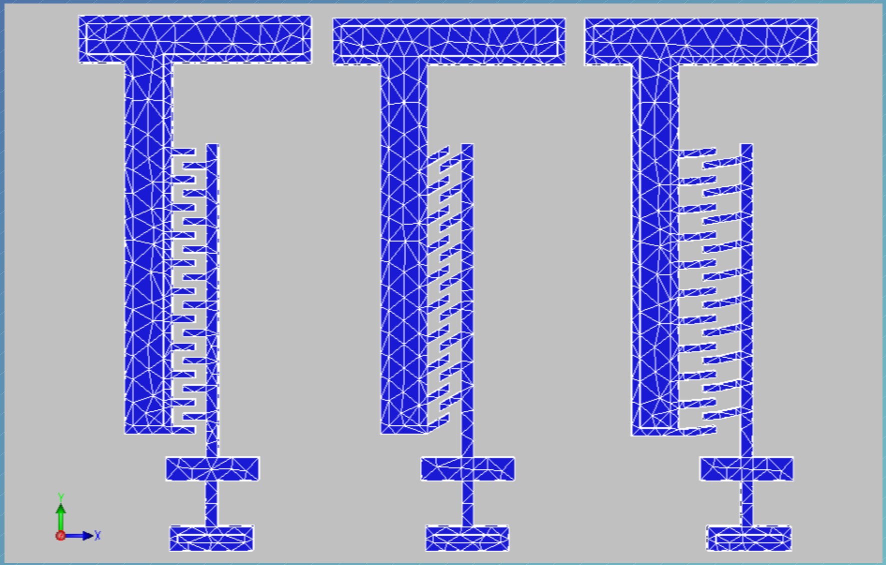
- Using L-Edit software to layout 2D design



Simulation

Coventor ware is the simulation software



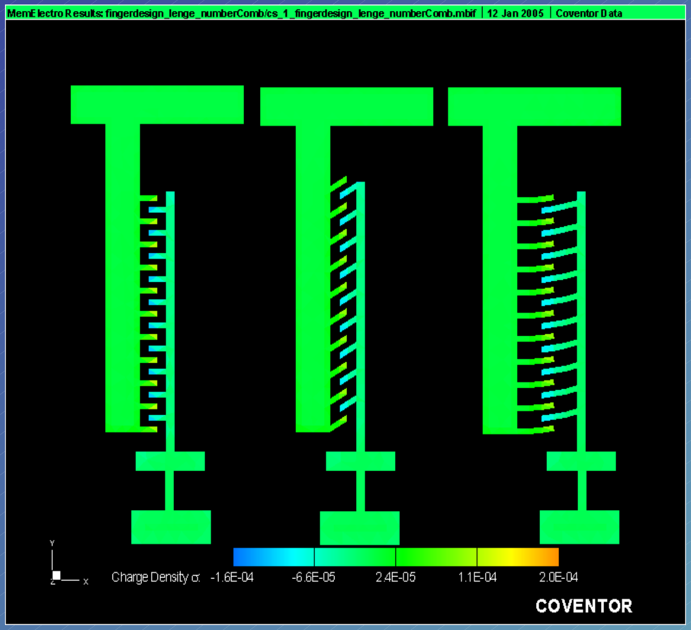


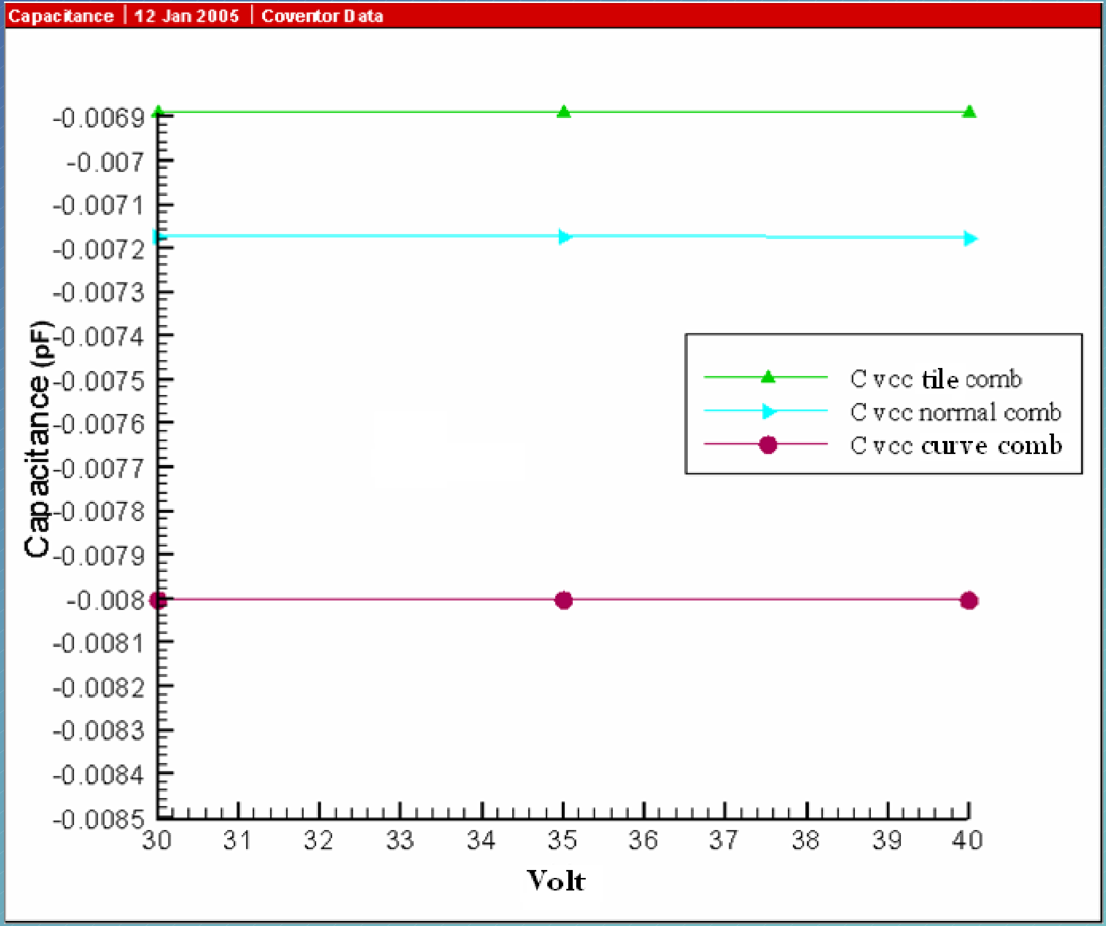
Solid model in 3D   Mashing Model

The boundary conditions were putting bias voltage 30 to 40 volt to stator ground to shuttle

Results

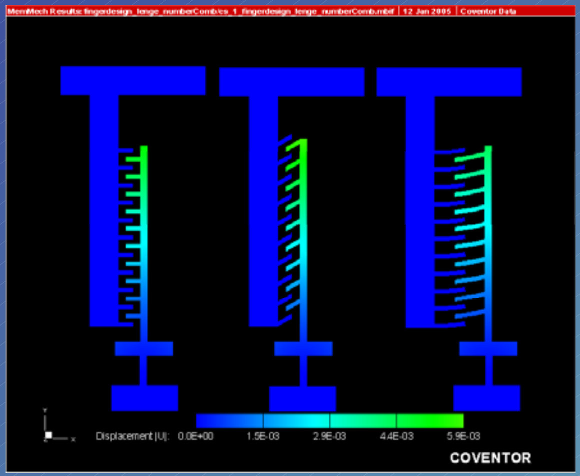
Capacitance between two comb by increasing voltage



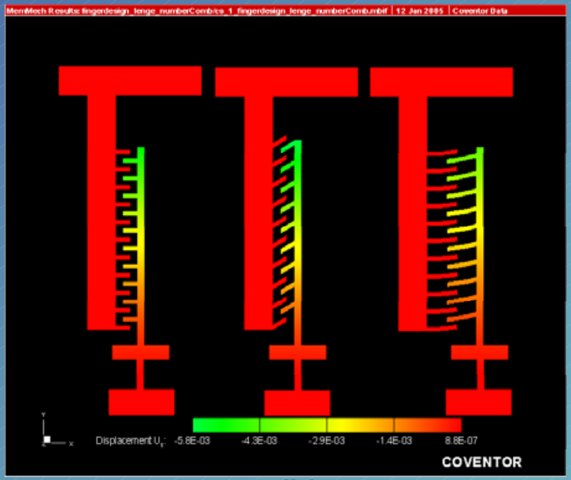


Results

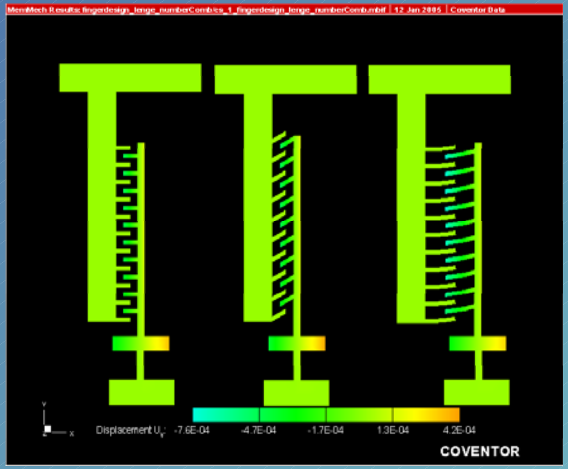
Displacement on shuttle show as the difference of colure



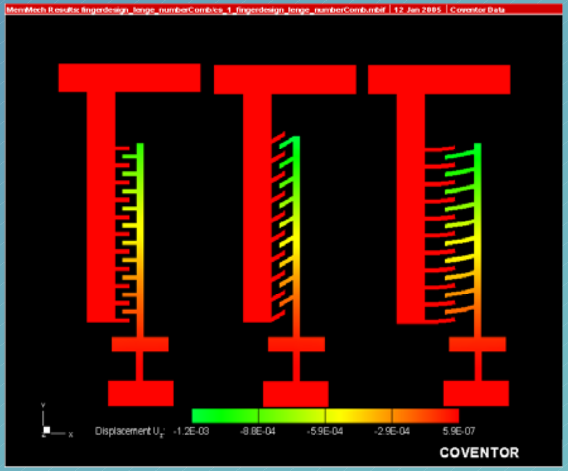
(a)



(b)



(c)



(d)

Results

Displacement on shuttle

Comb drive	Normal comb	Tile comb drive	Curve comb
Total displacement (μm)	2.73029E-4	3.23281E-4	2.66598E-4
Displacement in x (μm)	-2.64199E-4	-3.16433E-4	-2.5508E-4
Displacement in y (μm)	7.25541E-7	7.1144E-7	2.12648E-5
Displacement in z (μm)	-5.02838E-5	-4.77973E-5	-6.48665E-5

Concussion

- The tile comb drive gives highest value of chard density and displacement from normal comb and curve comb respectively.

$$f_1(V) = \frac{1}{2}\frac{\varepsilon_a h}{g_f}V^2$$

The negligible fringing capacitance

- But we have difference shape of comb drive comparative, this cause might by consider in micrometer scale
- However the limitation of fabrication technology we can not design the ending sharp comb because the machine should have very high resolution.

References

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