

# Simulation of Digital Tilt Sensor

## Case Study of scFLOW

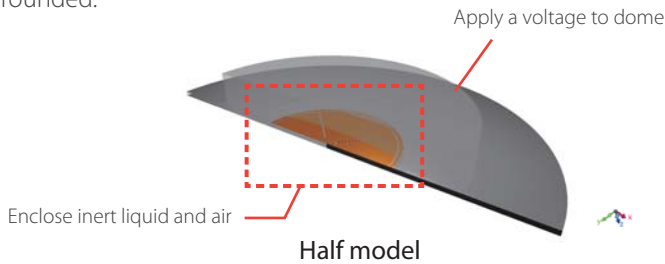
Using scFLOW to simulate free surface and electrostatics, and to verify results with experiments

### Analysis Purpose

To predict sensitivity of a capacitive tilt sensor which contains an air bubble, both the bubble shape and an electrostatic field must be analyzed. scFLOW is used to establish an accurate and effective method of analyzing the bubble shape first and electrostatic field subsequently. Verification of the results using experiments is also shown.

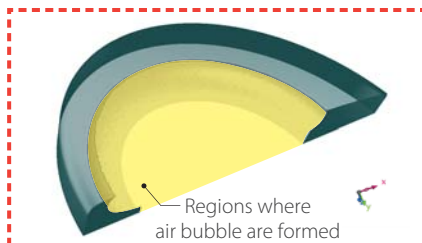
### Analysis example

Copper electrodes and dome exist on an FR4 plate, above which inert liquid and air are enclosed. Tilt the whole domain, and carry out electrostatic analysis with electrodes except for dome grounded.



### STEP1: Free Surface Analysis

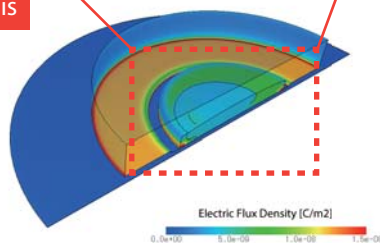
Pick only the enclosure as a target domain, and analyze bubble shape for a given tilt angle



Bubble shape (tilt angle: 2° in X positive direction)

### STEP2: Electrostatic Analysis

Solve only an electrostatic field with the obtained bubble shape embedded by mapping function



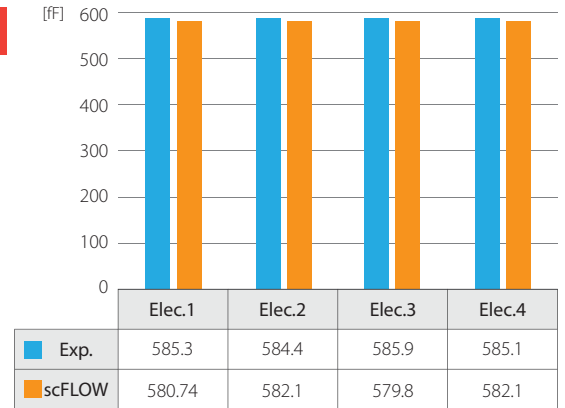
Electric flux density (tilt angle: 2°)

### Comparison with experiments: Dependence on tilt angles

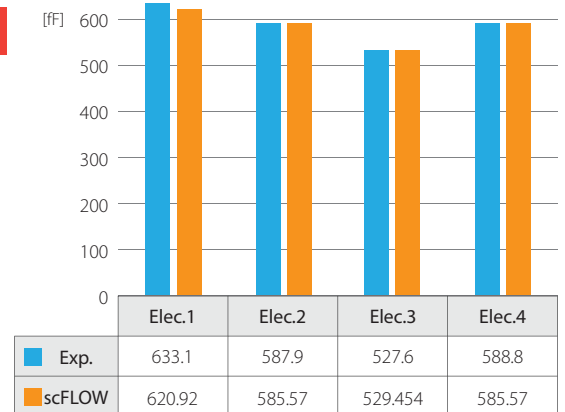
Quantitative comparison with experiments is made by measuring a capacitance value of each electrode.

Within a measurement error (approx. ±20fF), dependence of sensitivity on a tilt angle is successfully reproduces.

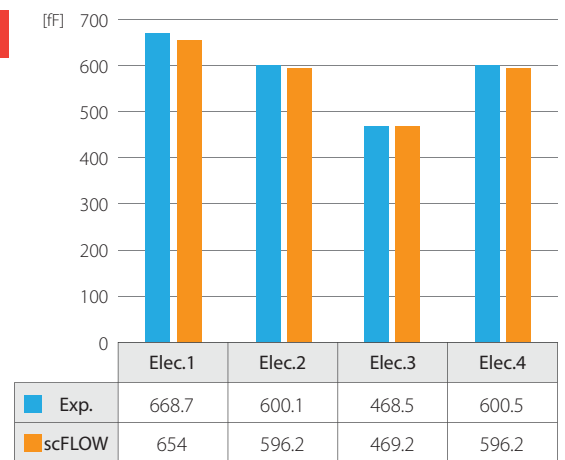
#### Tilted: 0°



#### Tilted: 1°



#### Tilted: 2°



### Notes

- scFLOW was used to simulate both a bubble shape and an electrostatic field in a tilt sensor.
- The result well agreed with experiments within a measurement error for 0 to 2° of tilt angles.
- The analyzed bubble shape was succeeded to electrostatic analysis by mapping function, which enables an accurate simulation with less computational cost by employing different mesh specialized to each simulation.