micralyne

# Sensors for Intelligent Systems

A Detailed MEMS Example


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acamp
ALBERTA CENTRE FOR ADVANCED MNT PRODUCTS
seminar series

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# Micralyne Introduction


A top independent MEMS provider

Located in Edmonton, Alberta, Canada

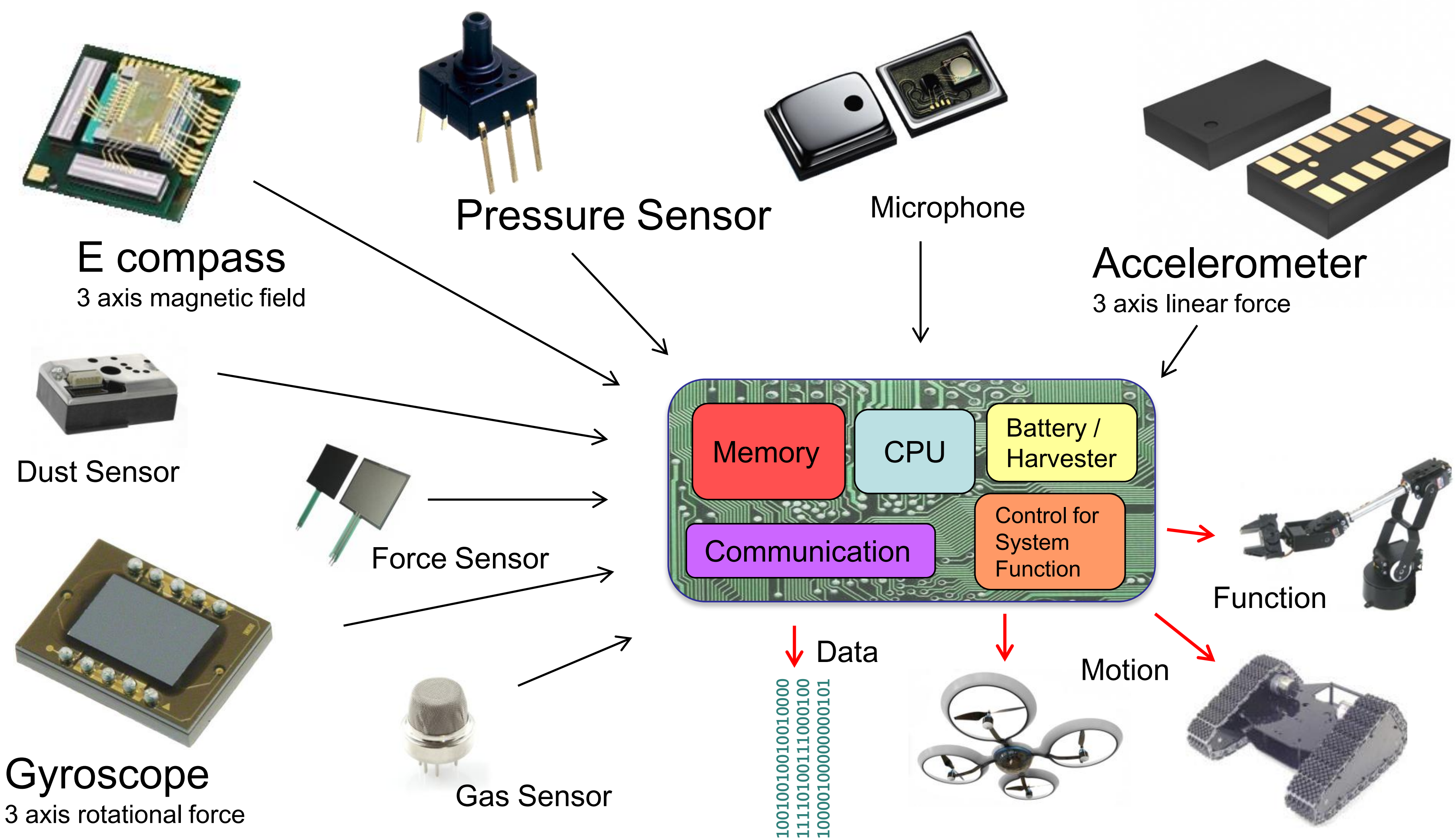
Founded in 1982 and privatized in 1998

55,000 sq ft. (5000 $m^2$) MEMS facility

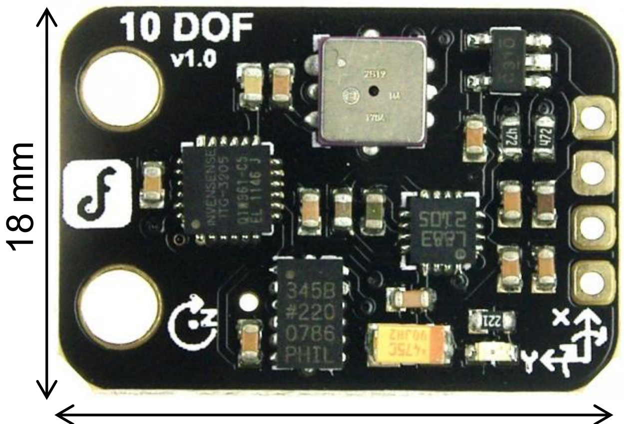
Sensors, Optical, Medical, and other MEMS devices

Development and Manufacturing of Complex MEMS

# MEMS and Microfabricated Sensors for Intelligent Systems



# Sensor Trends – Miniaturization, Integration, Cost



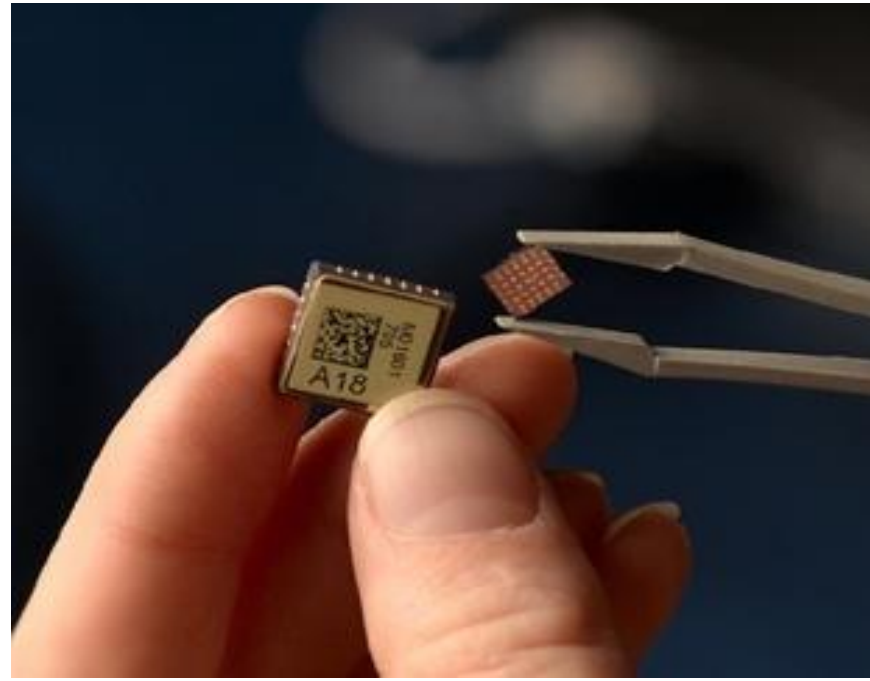

DF Robot

**9-Axis Sensors**


Absolute Orientation Sensors

| Product | Measurement range | Size ($mm^3$) | Digital Resolution | Promotion Status |
|---|---|---|---|---|
| BMX055 | Accelerometer: ±2g, ±4g, ±8g, ±16 g<br>Gyroscope: ±125°/s, ±250°/s, ±500°/s, ±1000°/s, ±2000°/s<br>Magnetometer: ±1200µT (x,y), ±2500µT (z) | 3.0 x 4.5 x 0.95 | Accelerometer (A): 0.98 mg<br>Gyroscope (G): 0.004 °/s<br>Magnetometer: (M): 0.3 µT | Active |

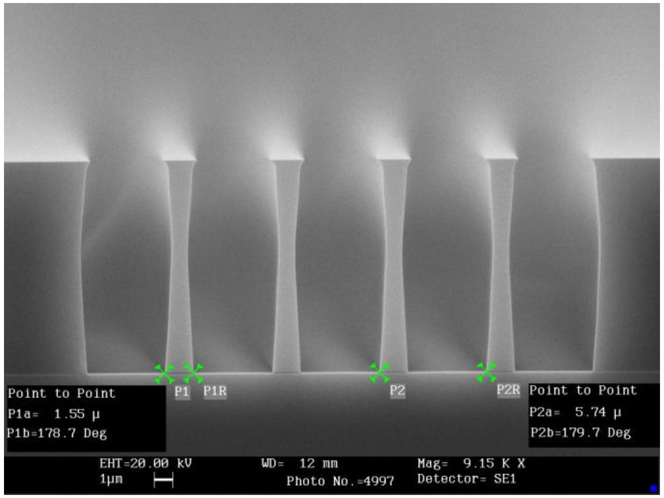
Bosch Sensortec



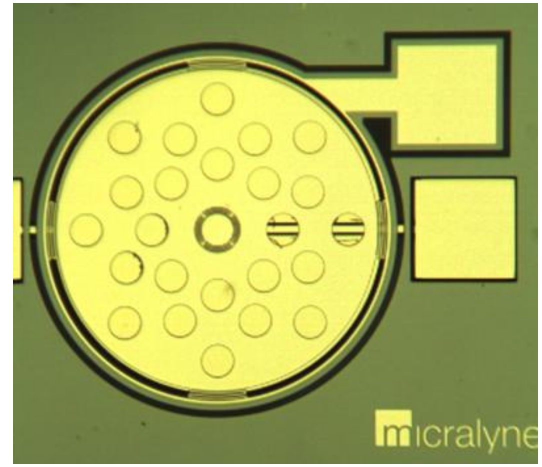

Micralyne Example: High Accuracy Accelerometer

- Eliminate the ceramic package through Wafer Level Packaging.
- MEMS mass and sensing structure is identical.
- Estimated selling price of WLP device is ~1/3 of ceramic packaged version for same functionality.

# Microfabrication Process Technology

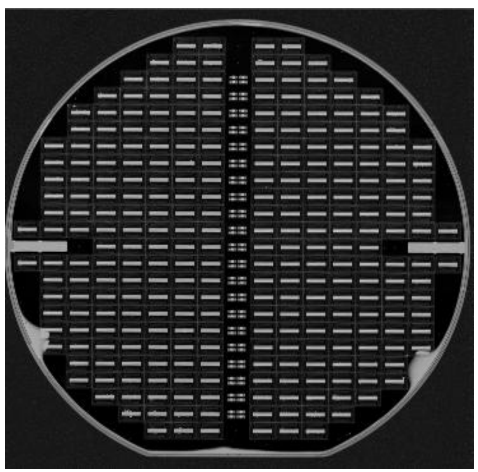


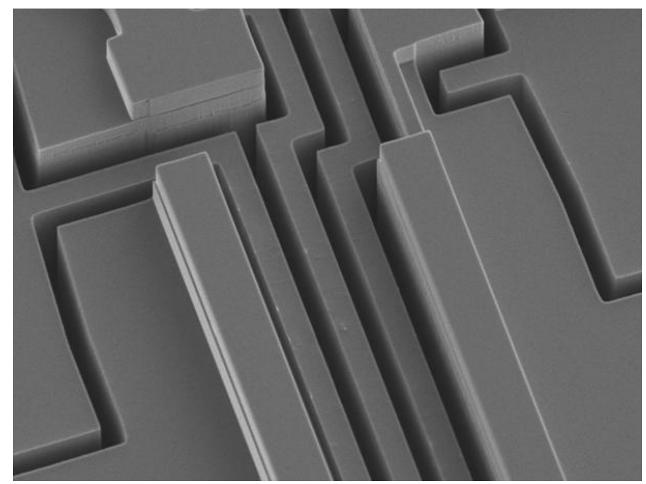

Photolithography (non contact stepper, 0.4 µm alignment)




Thin Film Deposition (high adhesion, low stress)

Aligned Wafer Bonding
Acoustic Microscope Image

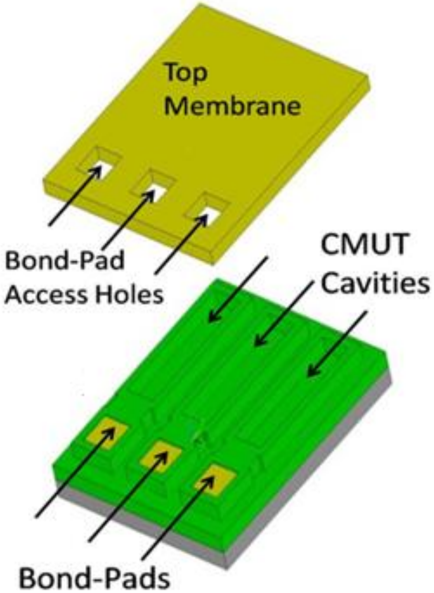




Deep Reactive Ion Etch of silicon (multiple layers)

# MEMS Process

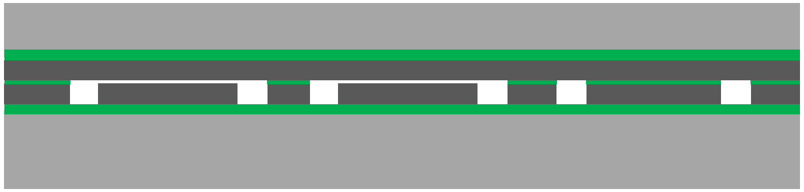
**C**apacitive
**M**icromachined
**U**ltrasonic
**T**ransducer




Highly Doped Si | Silicon Dioxide
Low Doped Si | Gold Thin Film

Trench Etch: 3.5 µm Si (SOI) with top oxide, Trench etch Si, 2 to 4 µm features

Oxide Removal: etch top oxide where CMUT gap is required



Bond: 2nd SOI, silicon to silicon dioxide fusion bond

Remove Top Handle Wafer: remove buried oxide

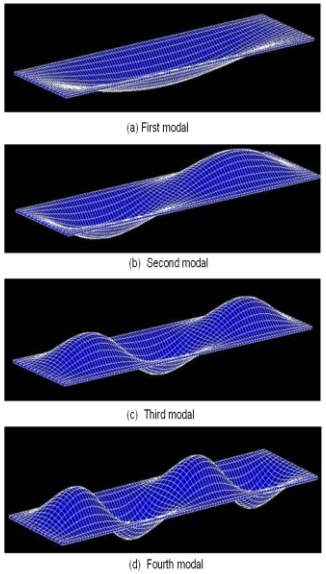
Top Etch: Isolate top electrodes and open lower electrode bond pads with etch

Metal Deposition: deposit contact metal to upper and lower electrodes, dice

# CMUT Devices

CMUT technology offers many potential advantages over traditional linear array piezoelectric transducer technology, including:

- Advantages of wafer fabrication scale
- 2D arrays offer higher resolution
- Greater sensitivity
- Superior acoustic impedance matching
- Potential to co-integrate with electronics
- Choice of frequencies of interest possible with just a change in geometry

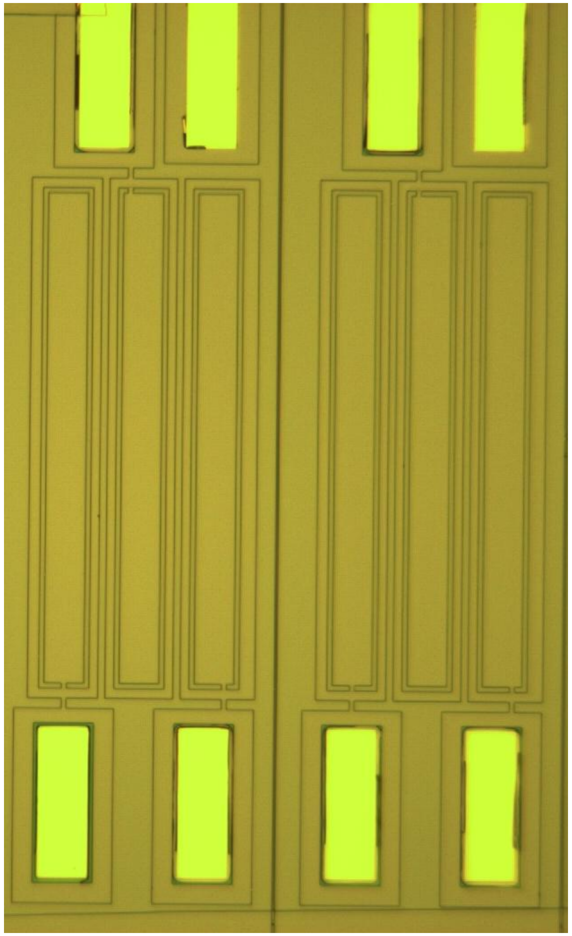


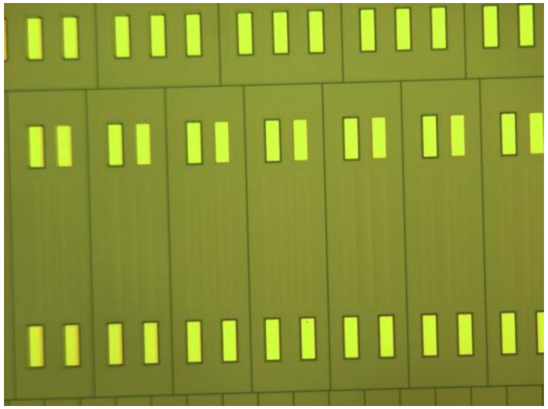
(a) First modal

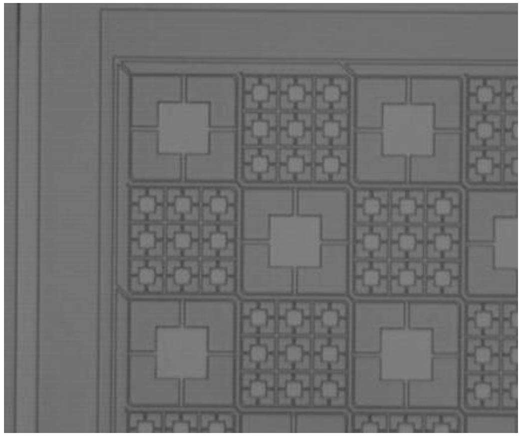
(b) Second modal

(c) Third modal

(d) Fourth modal

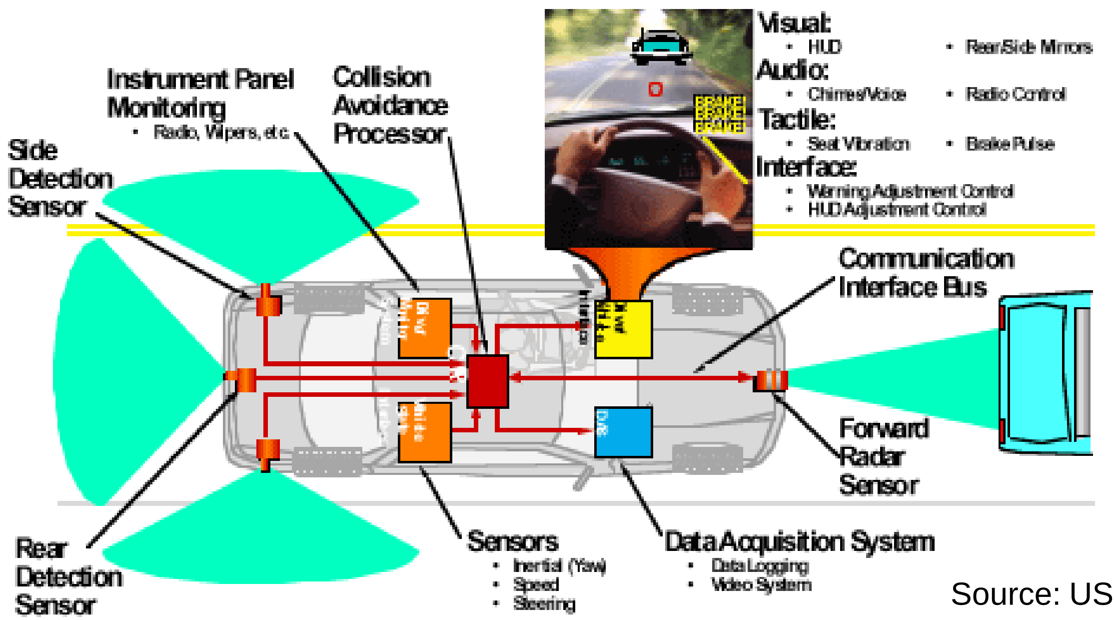






# MEMS Sensors for Smart Automobile Systems

- Current warning systems: Back up alarm, blind spot alarm.
- Current and future “Active” systems: park assist, adaptive cruise control, crash avoidance, autonomous vehicles.
- Safety regulation has accelerated the progress of these systems.
  - » MEMS CMUTs will offer multi-frequency arrays as well as superior acoustic coupling.




Google Driverless Car

Source: US Government http://www.nhtsa.gov

# Summary

- Sensor evolution has enabled Intelligent Systems.
- Successfully driving down size and cost, while increasing integration has led to wide scale adoption.
- MEMS technology has displaced several conventional technologies to meet the needs of Systems and this will continue.
- We are in the start the sensor revolution and It’s exciting to see what the future holds for this technology.

# Thank you

# Questions?

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