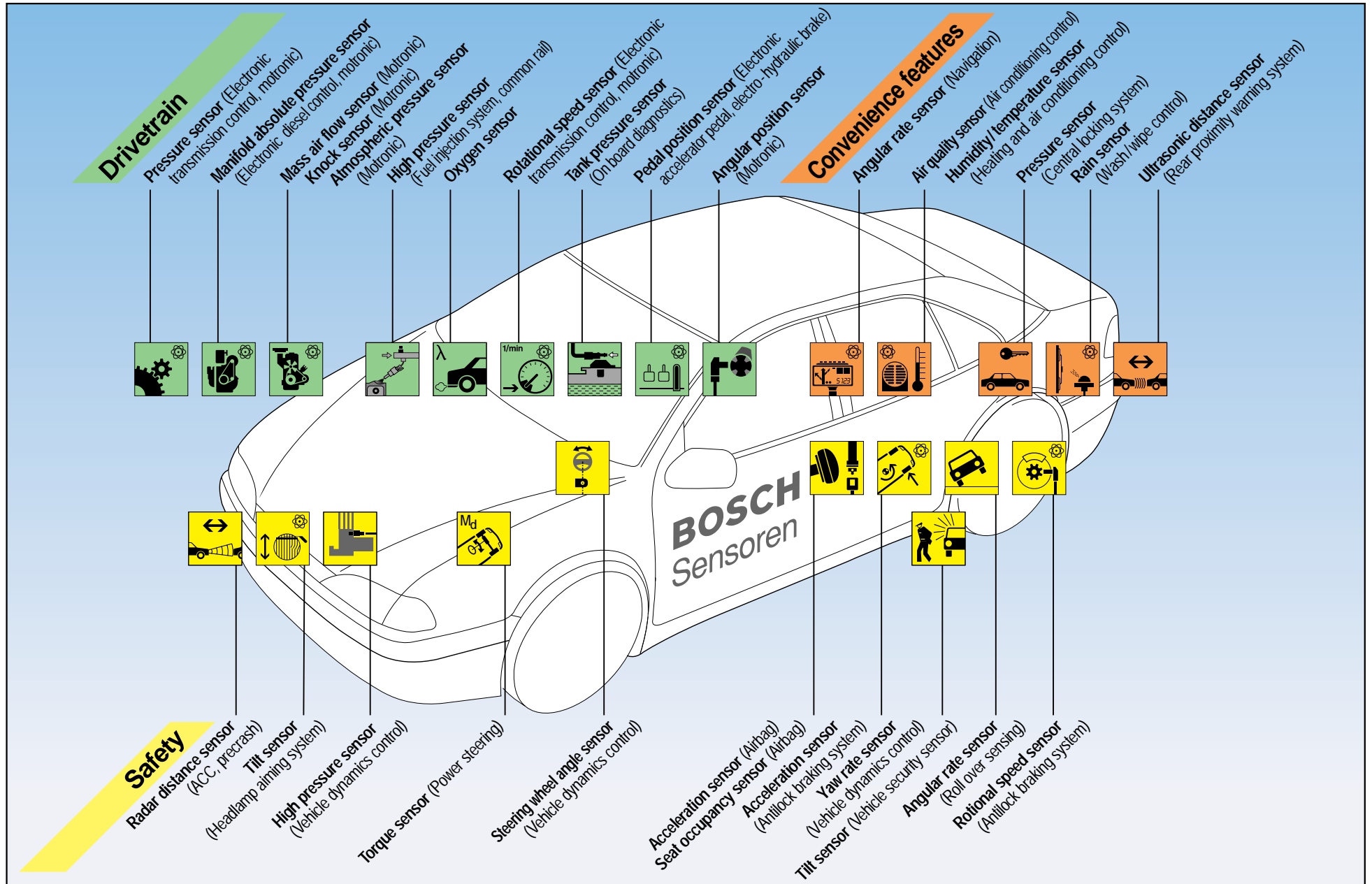


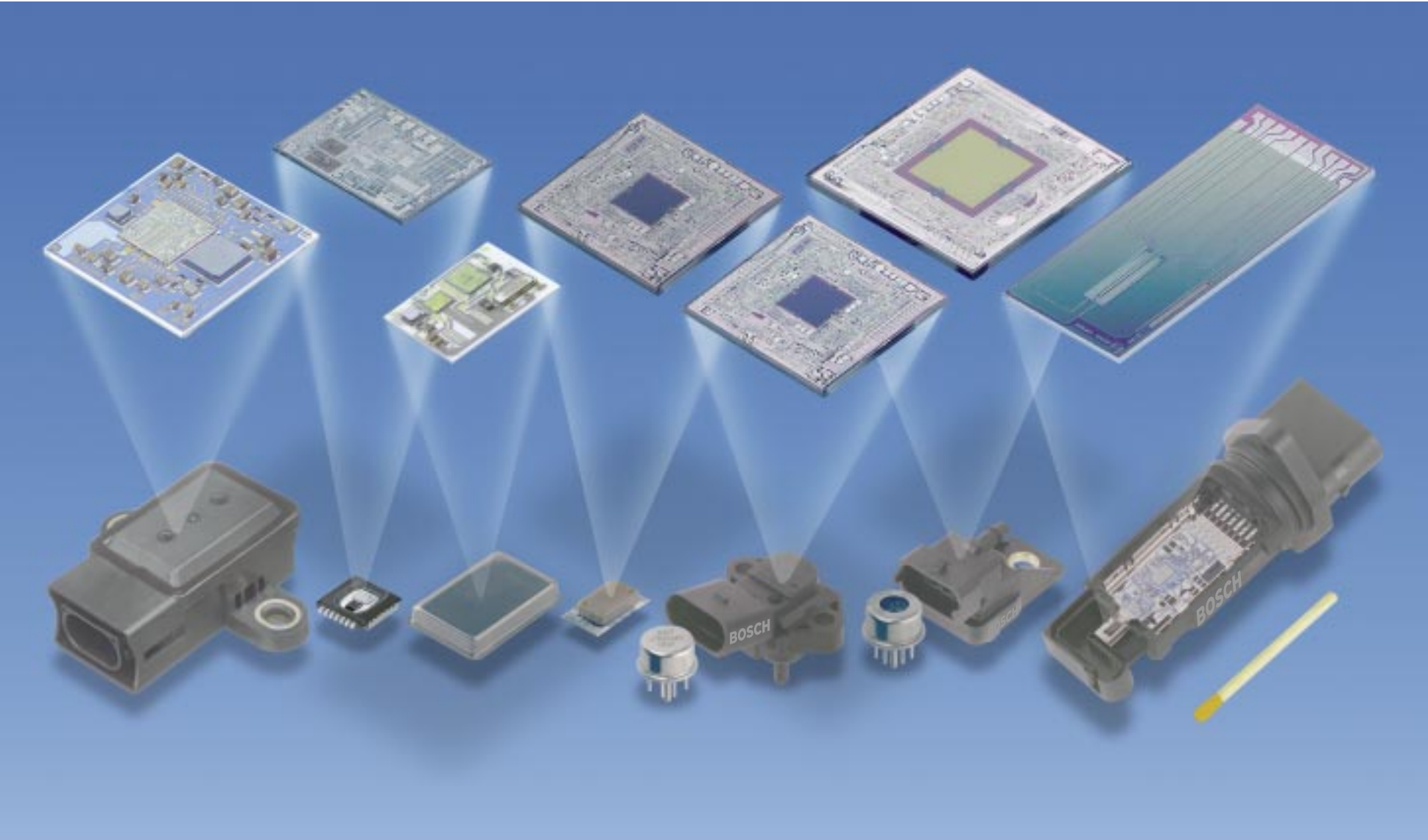
Bosch Micromachined Sensorsystems in Series Production

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Bosch Sensors for Automotive Applications



Silicon Sensors



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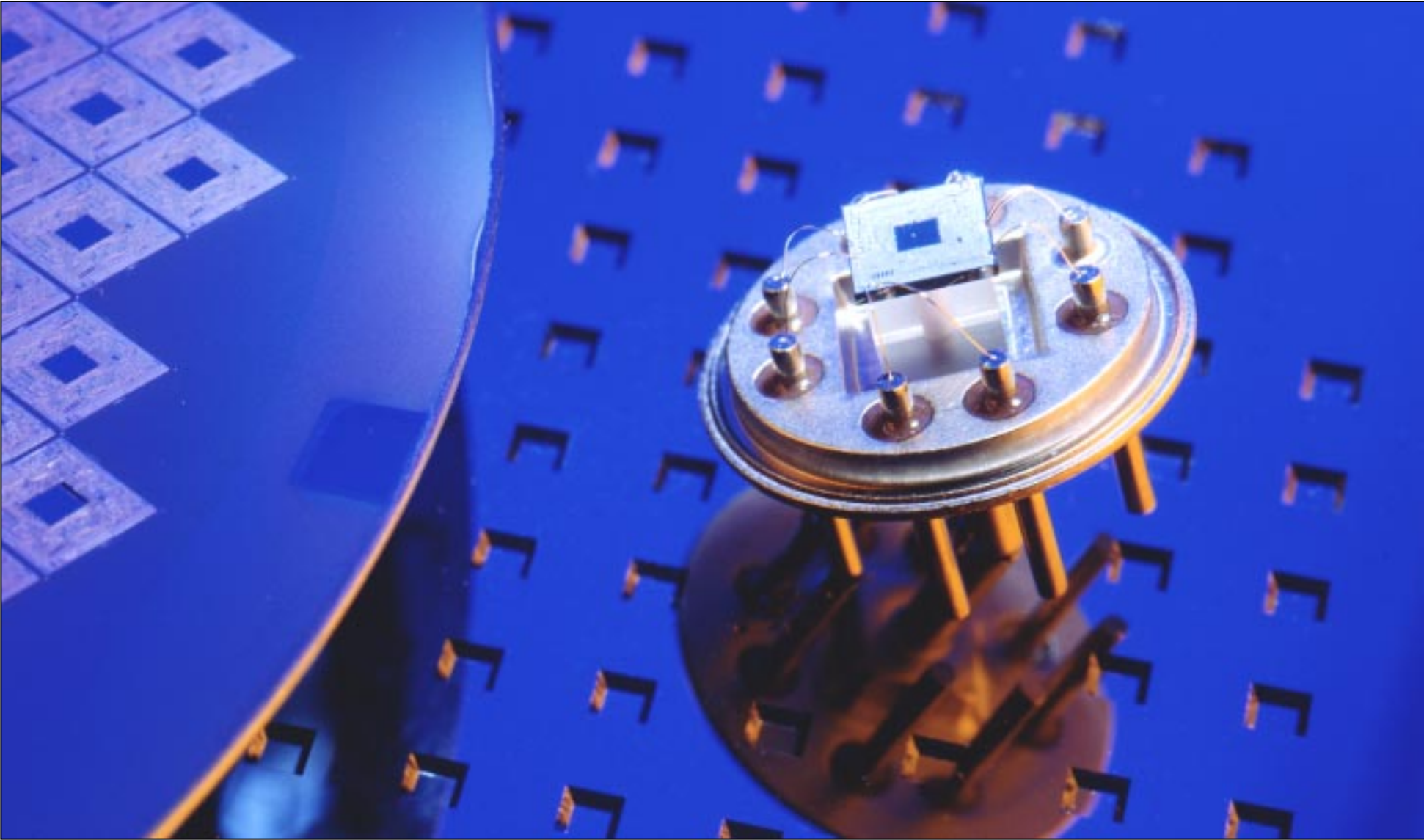


Bosch Micromachined Sensorsystems

Integrated Pressure Sensor

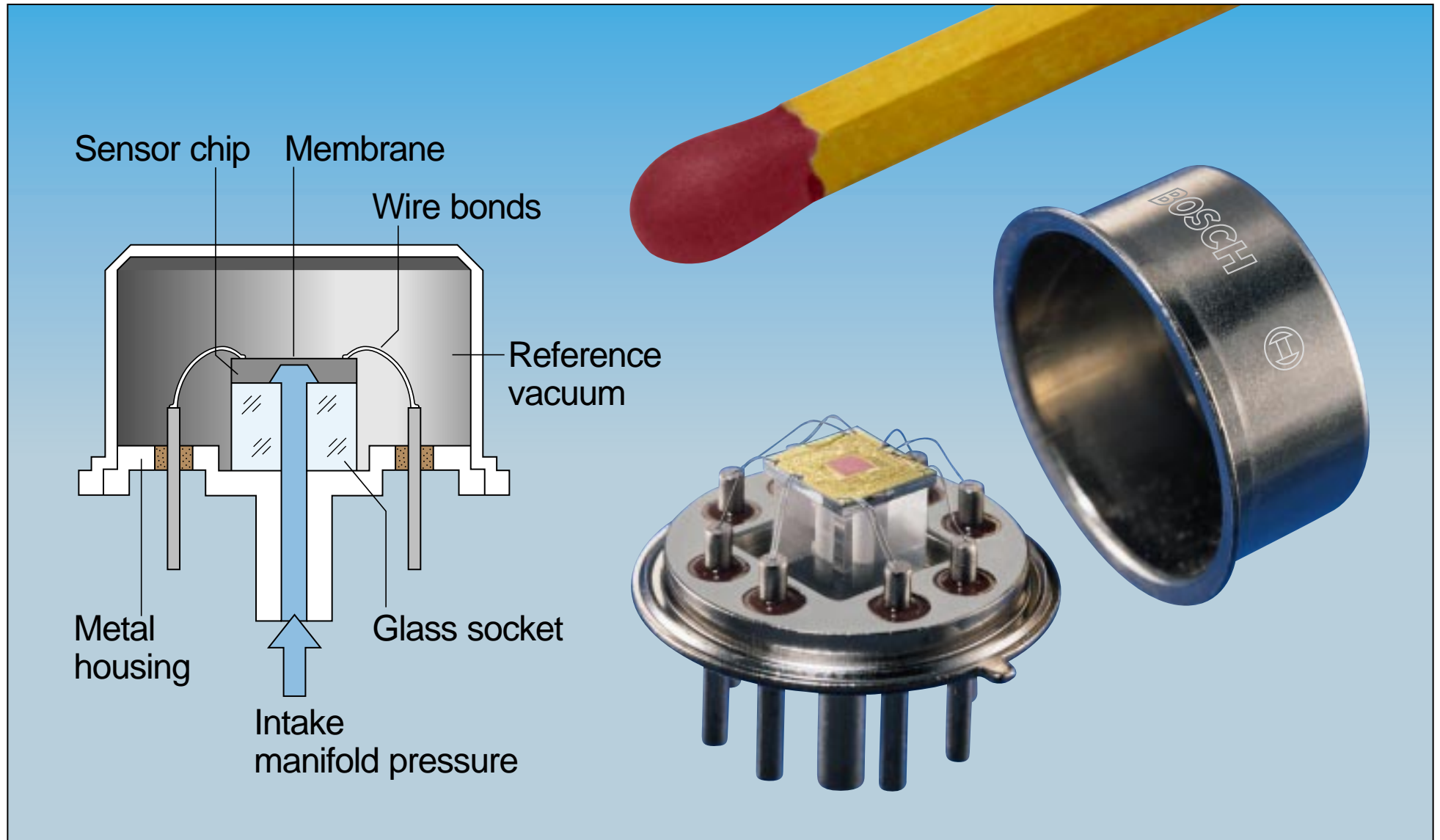
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Micromechanical Pressure Sensor



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Pressure Sensor in Bulk Micromachining



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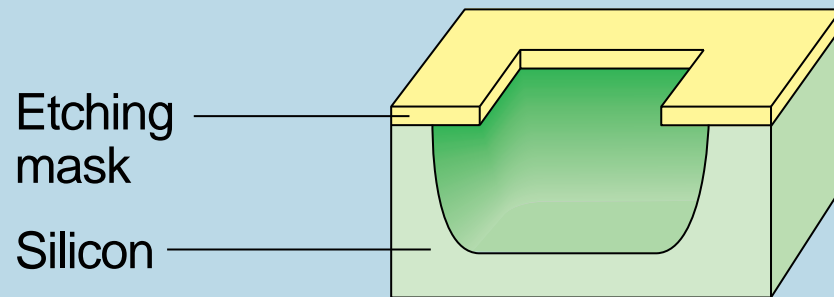


K8/L MPK60913 e

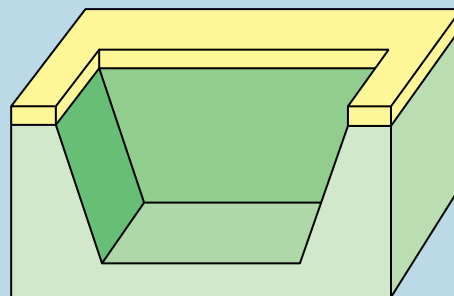
Bulk Micromachining

Wet chemical etching

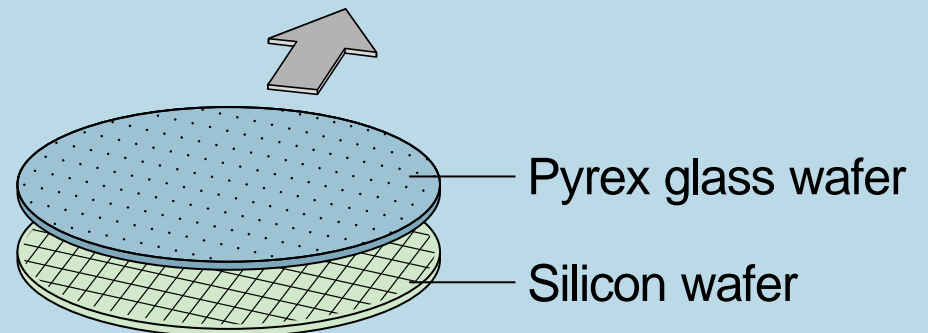
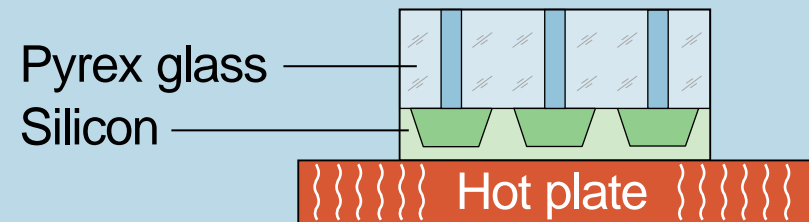
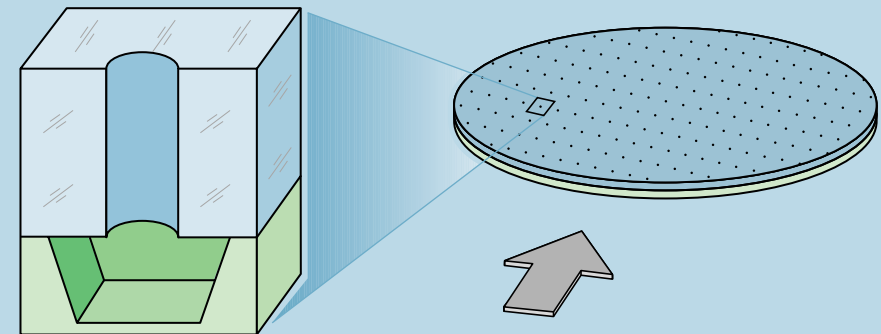
Isotropic etching in an acid etching bath
(imprecise shapes)



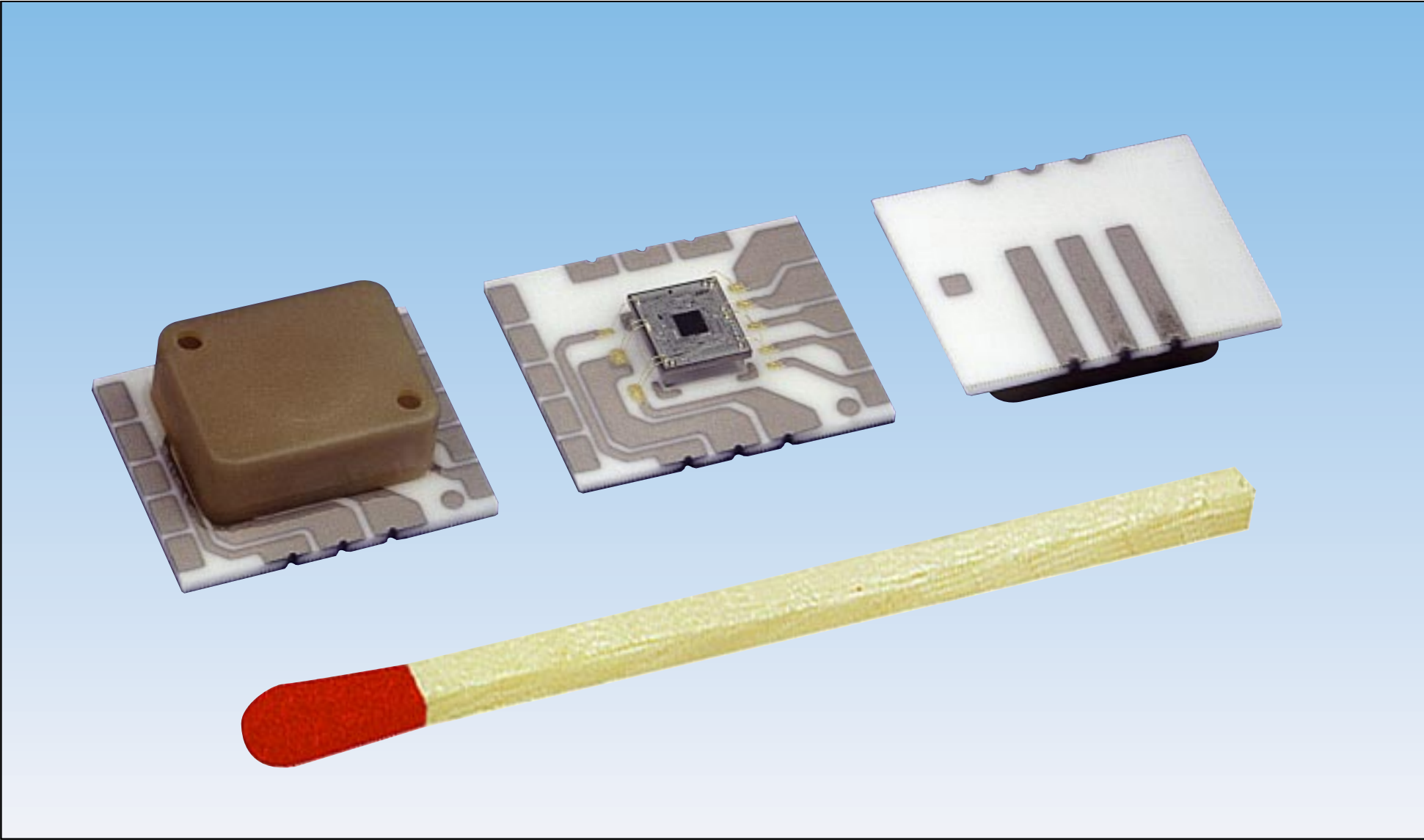
Anisotropic etching in an alkaline etching bath
(precise shapes)



Anodic wafer bonding



Atmospheric Pressure Sensor SMD082



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Micromechanical Intake Manifold Pressure Sensor



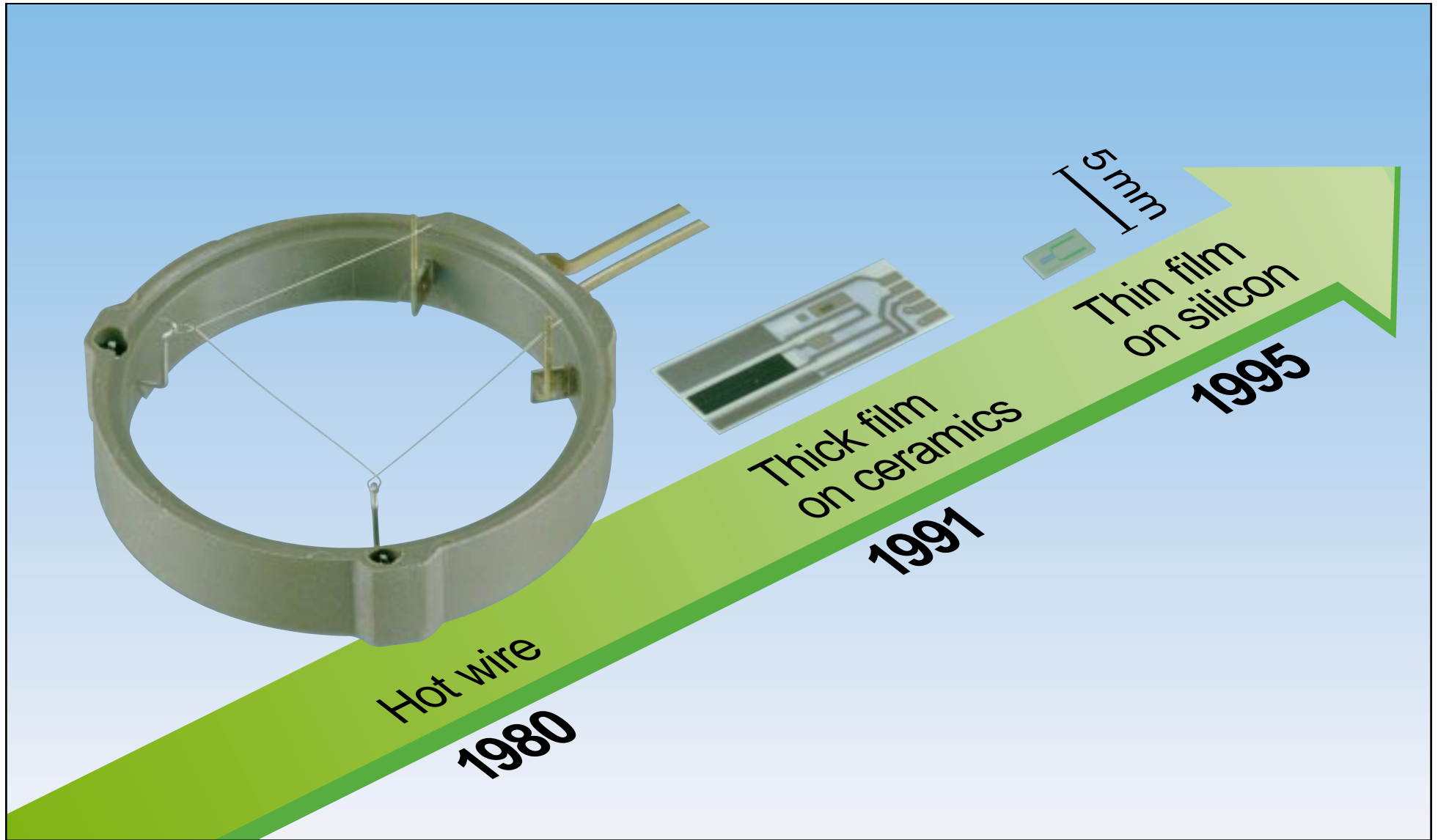
Sensor cell

Bosch Micromachined Sensorsystems

Mass Air Flow Sensor

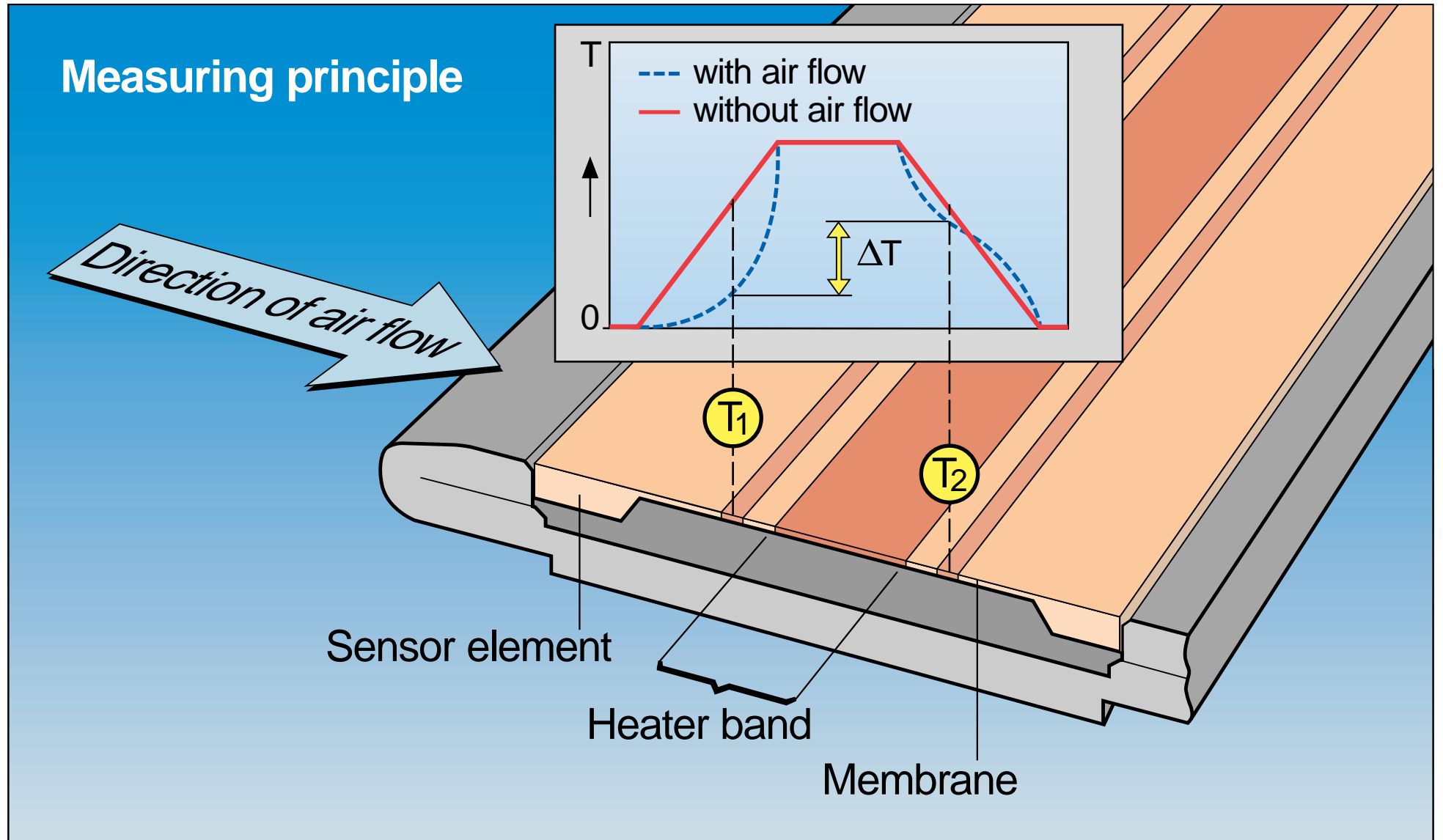
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Mass Air Flow Sensors – Generations

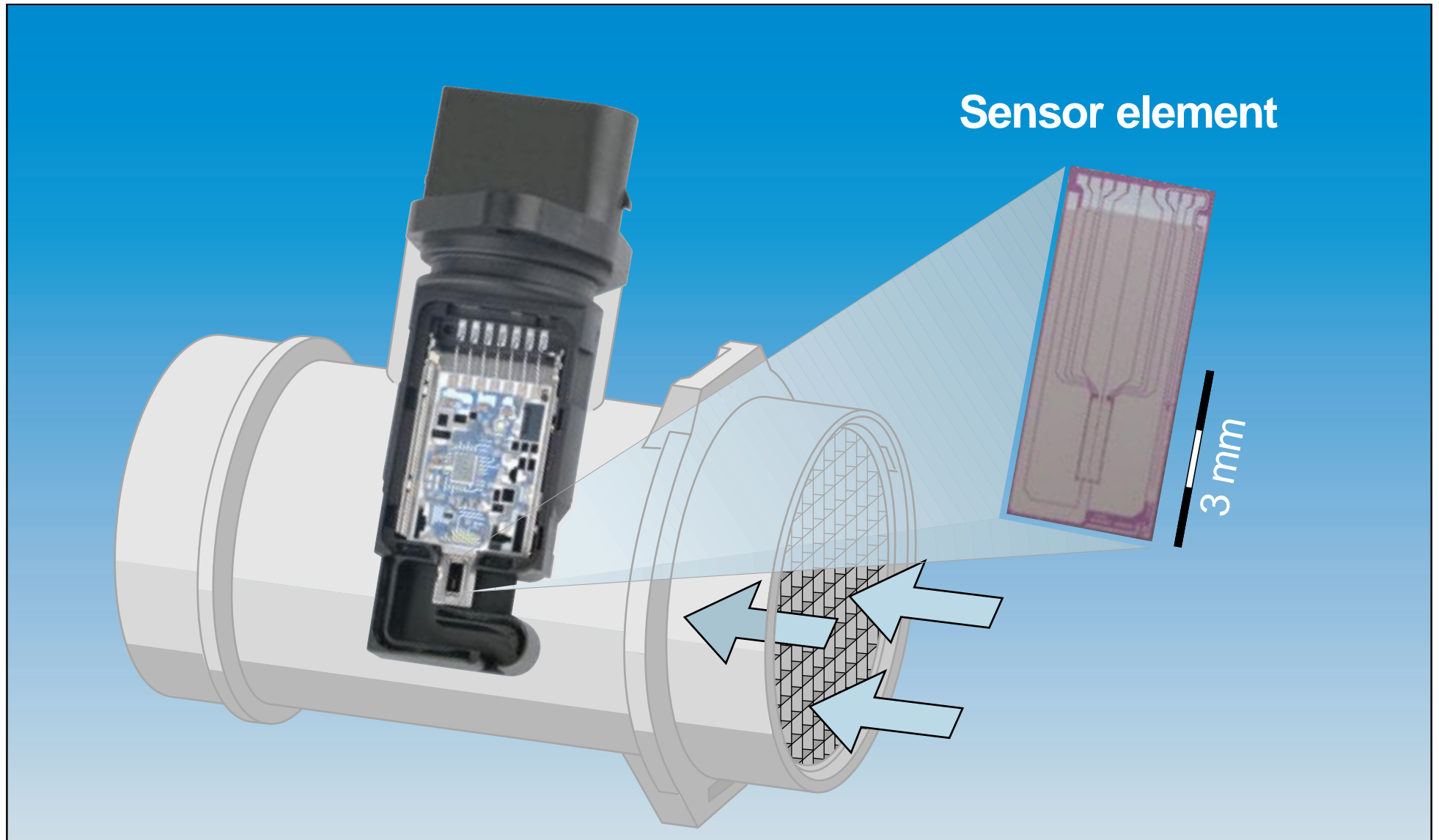


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HFM5 Micromechanical Mass Air Sensor



HFM5 Micromechanical Mass Air Flow Meter



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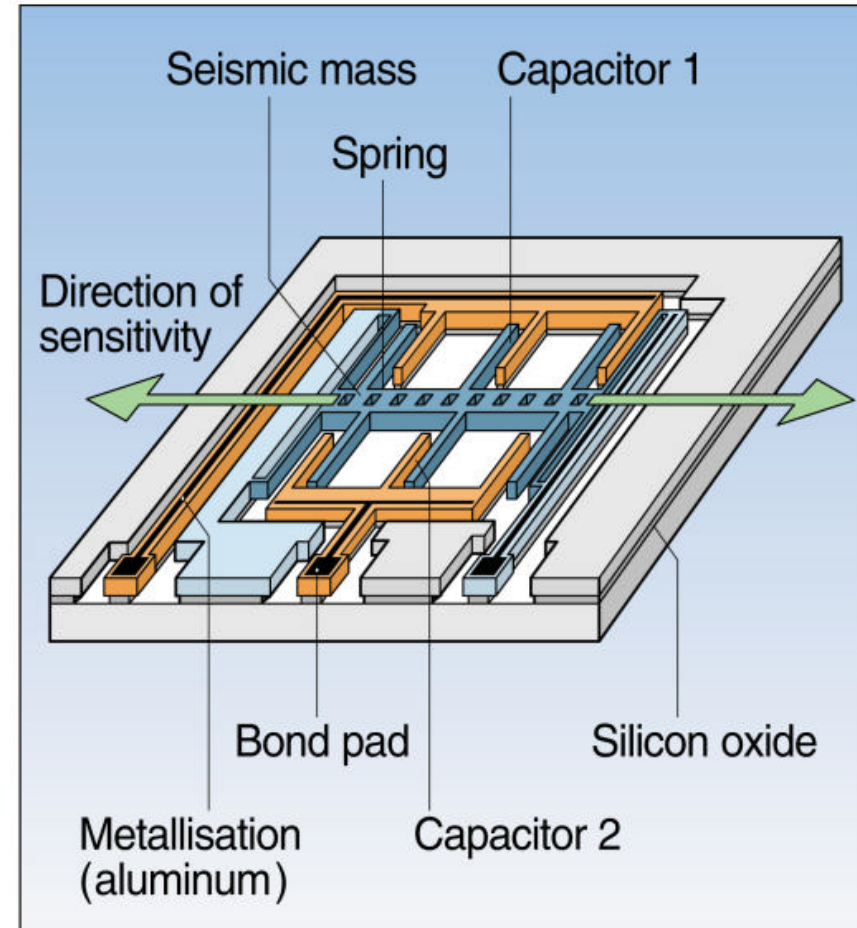
Surface Micromachined Acceleration Sensors

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K8-Sensor Center In-Plane Acceleration Sensor

Functional principle

- Surface micromachining with 10 μm thick poly silicon movable structures
 - ➔ Large output signal
 - ➔ Robust design
- Capacitive comb structure consisting of:
 - Movable proofmass with electrode fingers
 - Fixed electrodes
- Deflection of proofmass by acceleration
- Differential capacitor evaluation
 - ➔ Small non-linearity
- Self-test by electrostatic deflection

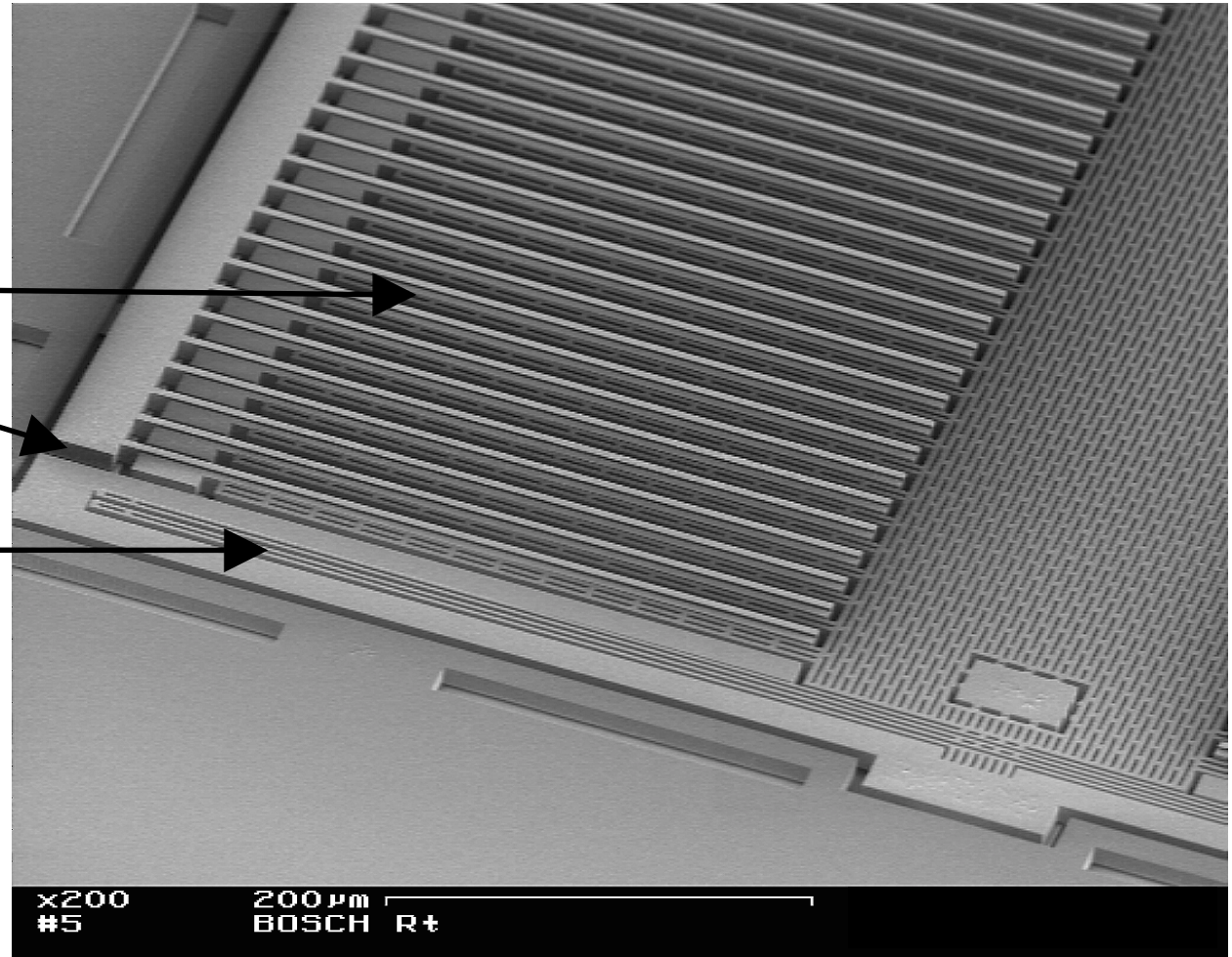


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Si Micromachined Yaw Rate Sensor Design

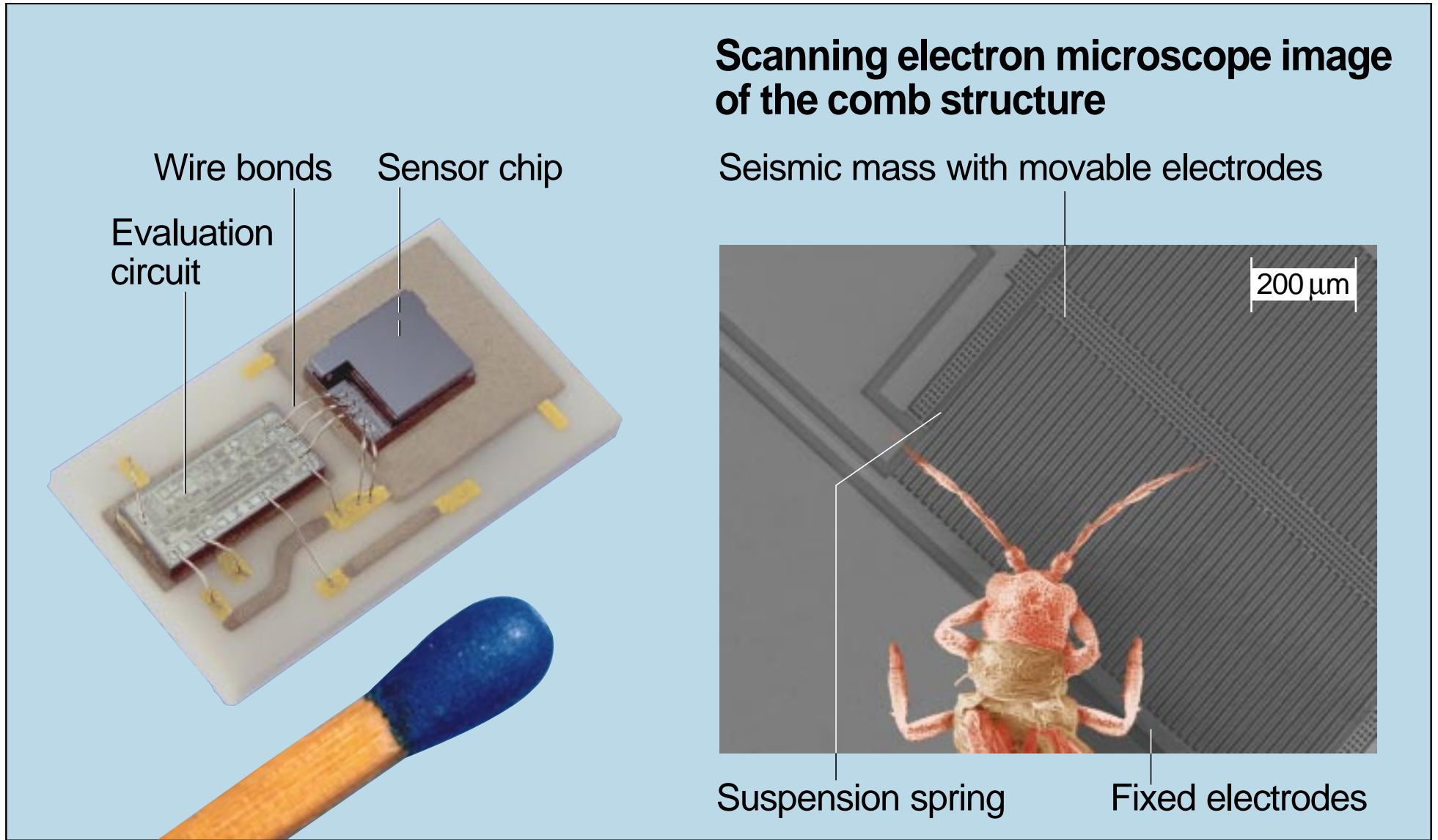
Linear Accelerometer:

- ❑ Surface micromachining
- ❑ 2 μ m gaps
- ❑ 12 μ m thick Poly-Silicon
- ❑ 1pF working capacitance
- ❑ folded springs
 - ➔ high sensitivity
 - ➔ internal stress compensation



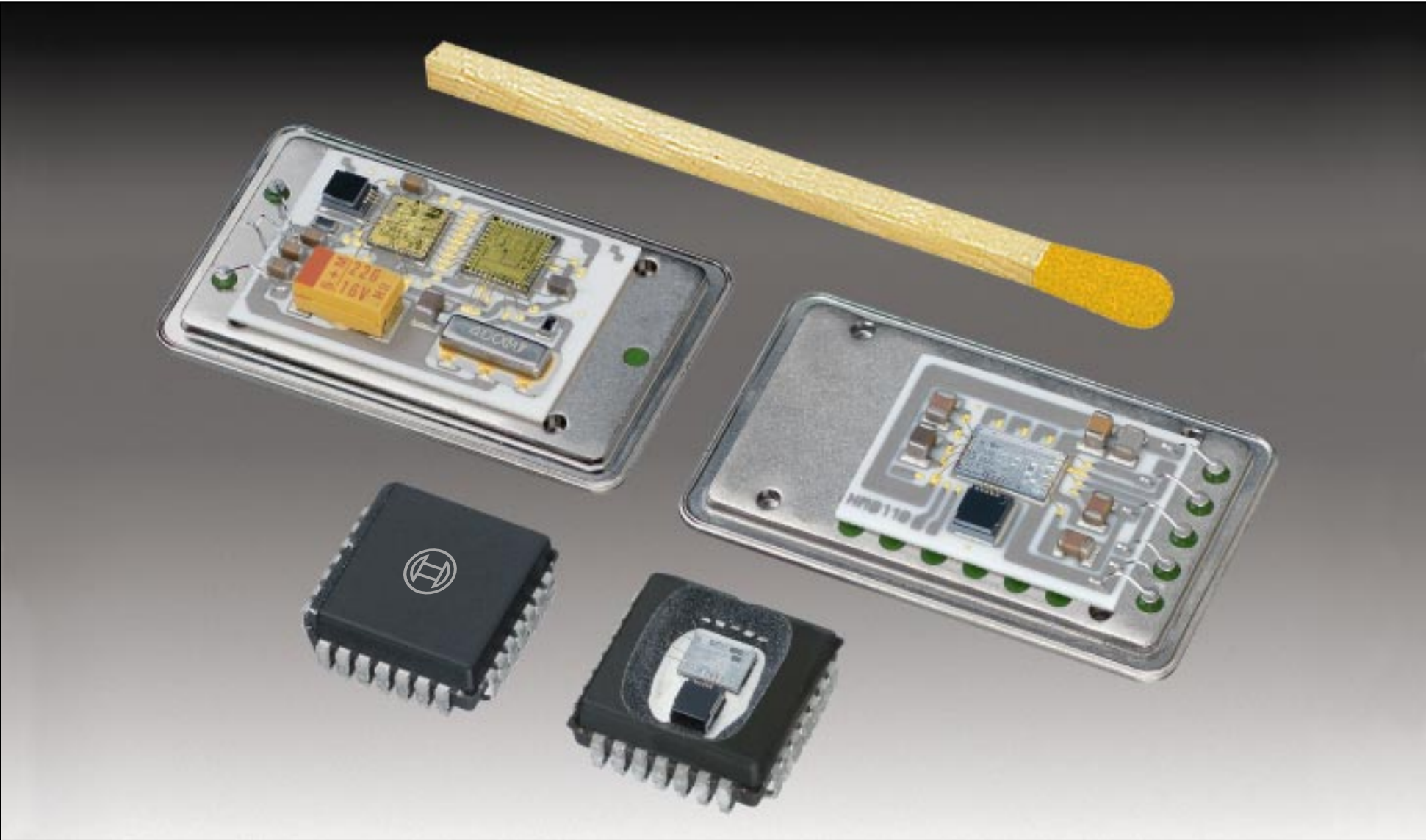
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Acceleration Sensor in Surface Micromachining



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Acceleration Sensors



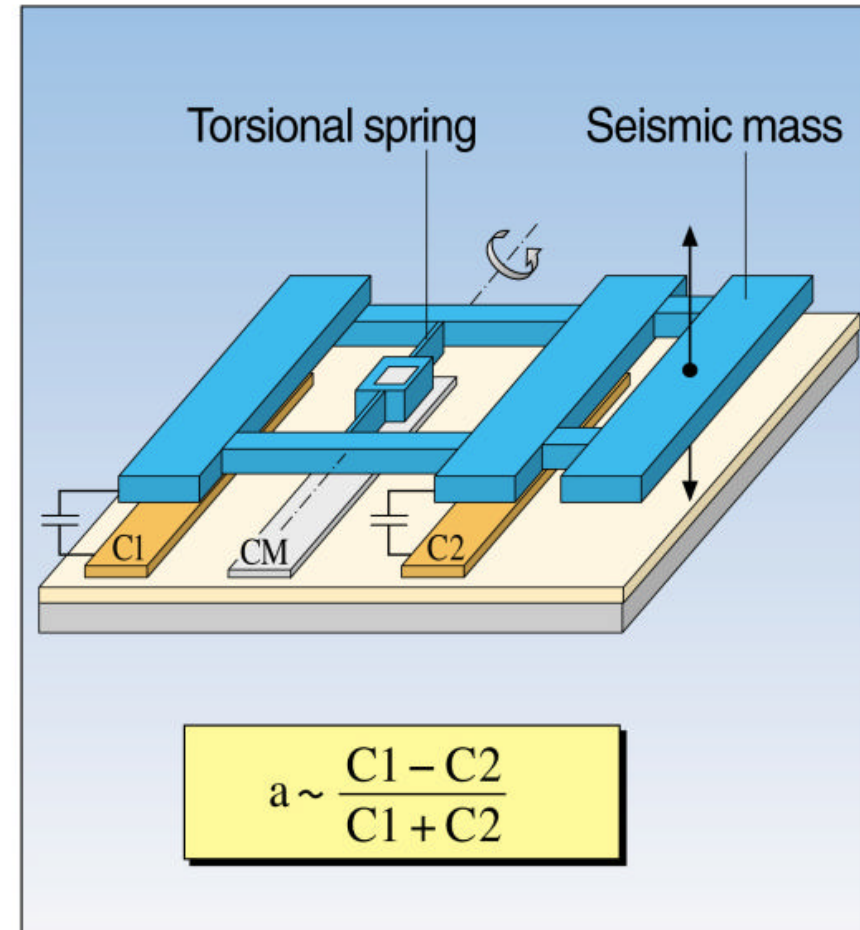
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K8-Sensor Center

Out-of-Plane Acceleration Sensor

Functional principle

- Surface micromachining with 10 μm thick poly silicon movable structures
 - ➔ Large output signal
 - ➔ Robust design
- Torsional springs
- Rotation of proofmass by acceleration
- Differential capacitor evaluation
 - ➔ Small non-linearity
- Counterelectrode by second poly layer
- Self-test by electrostatic deflection



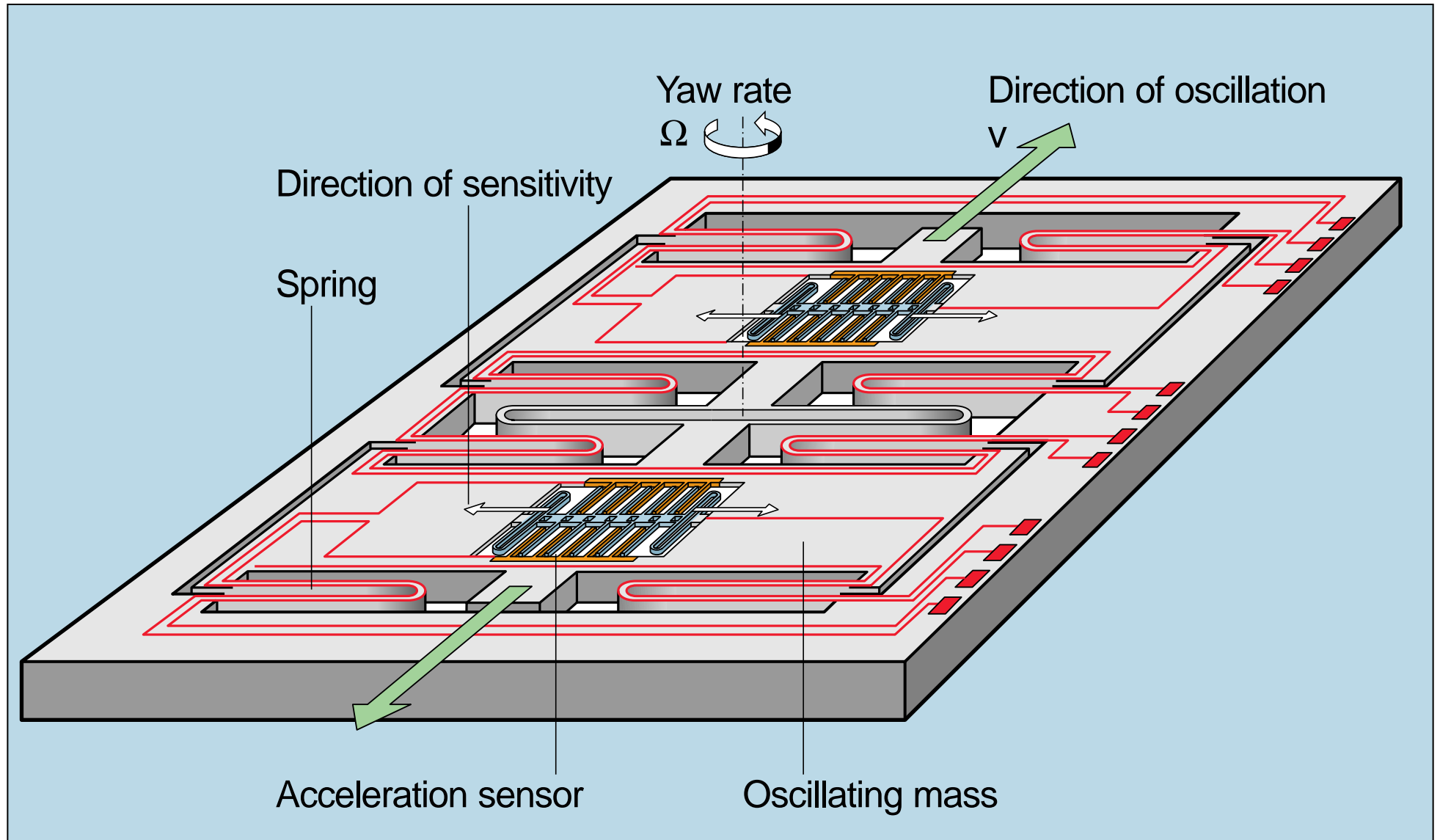
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Bosch Micromachined Sensorsystems

Si-Micromachined Yaw Rate Sensor

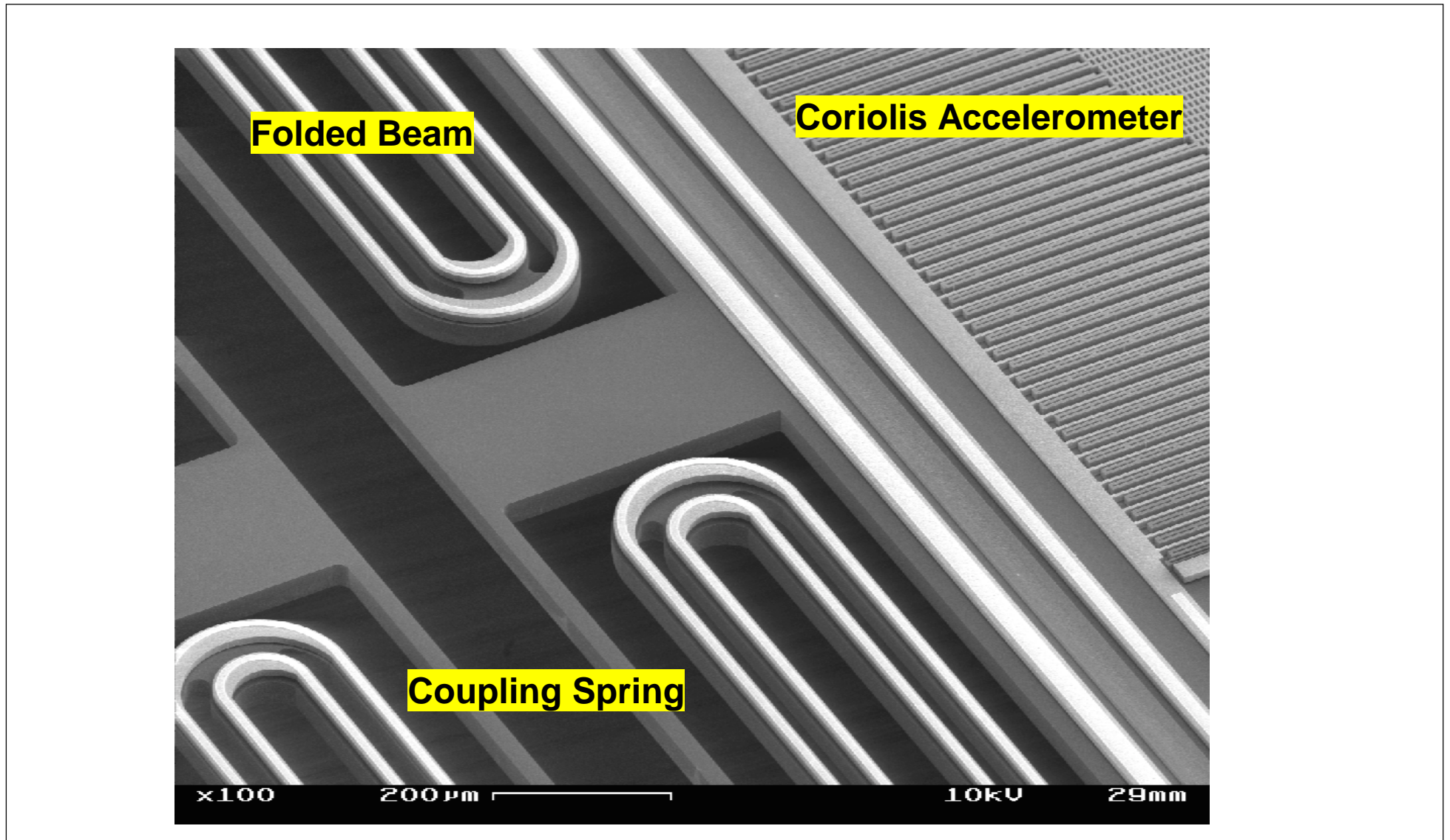
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Micromachined Yaw Rate Sensor



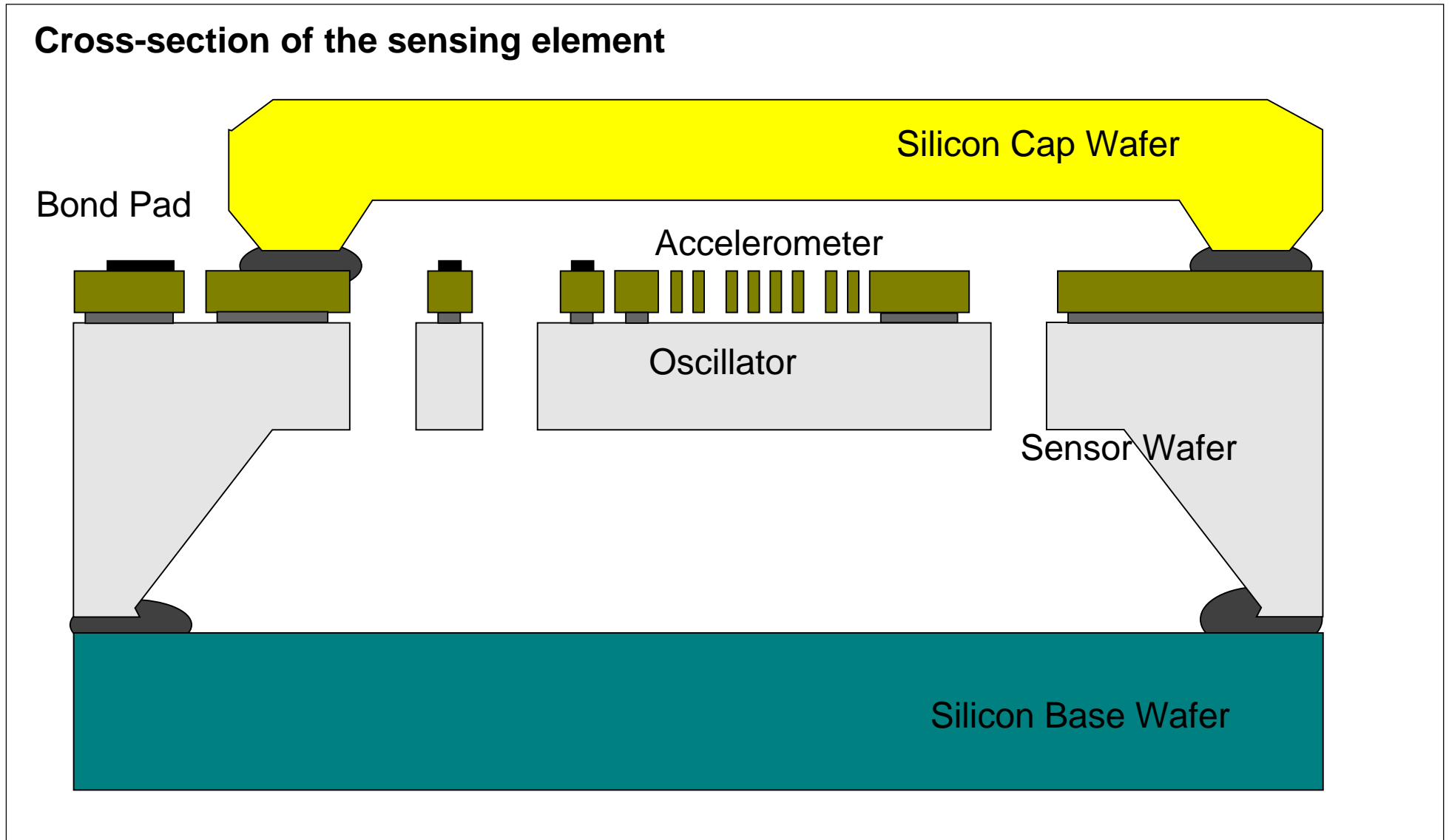
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Si Micromachined Yaw Rate Sensor Design



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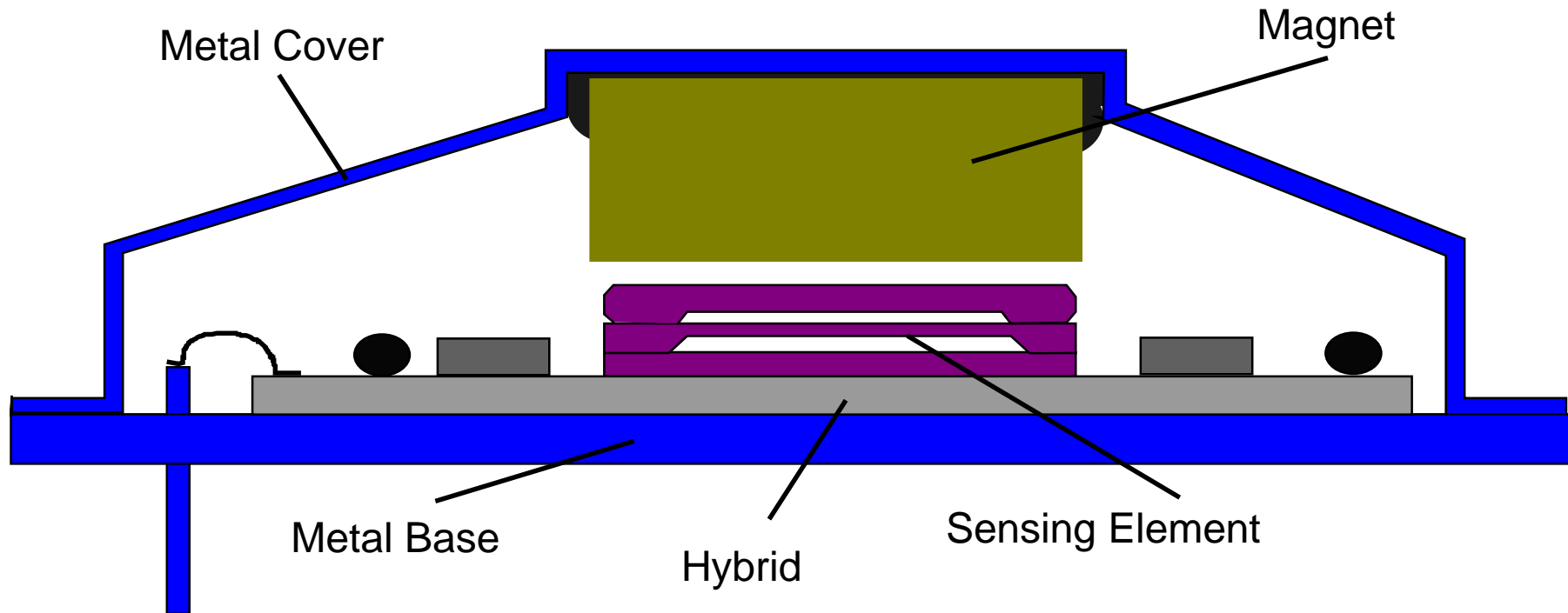
Si Micromachined Yaw Rate Sensor Packaging



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Si Micromachined Yaw Rate Sensor Packaging

Cross section of the module:



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K8-Sensor Center Angular Rate Sensor

Functional principle

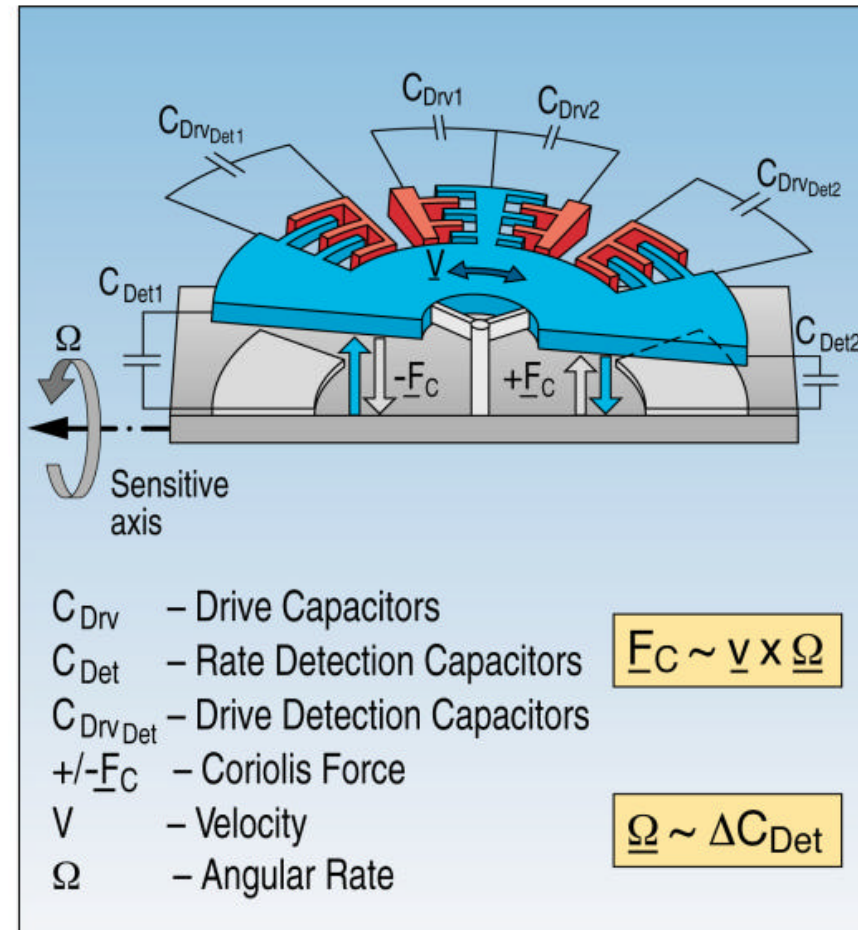
Coriolis-type working principle

Drive

- Capacitive comb structures (C_{Drv})
- In-plane oscillation of sensing mass

Detection

- Angular rate Ω causes coriolis force \underline{F}_C
- Coriolis force in out-of-plane direction
- Rocking motion in out-of-plane direction
- Differential capacitor structure (C_{Det})



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K8-Sensor Center Angular Rate Sensor

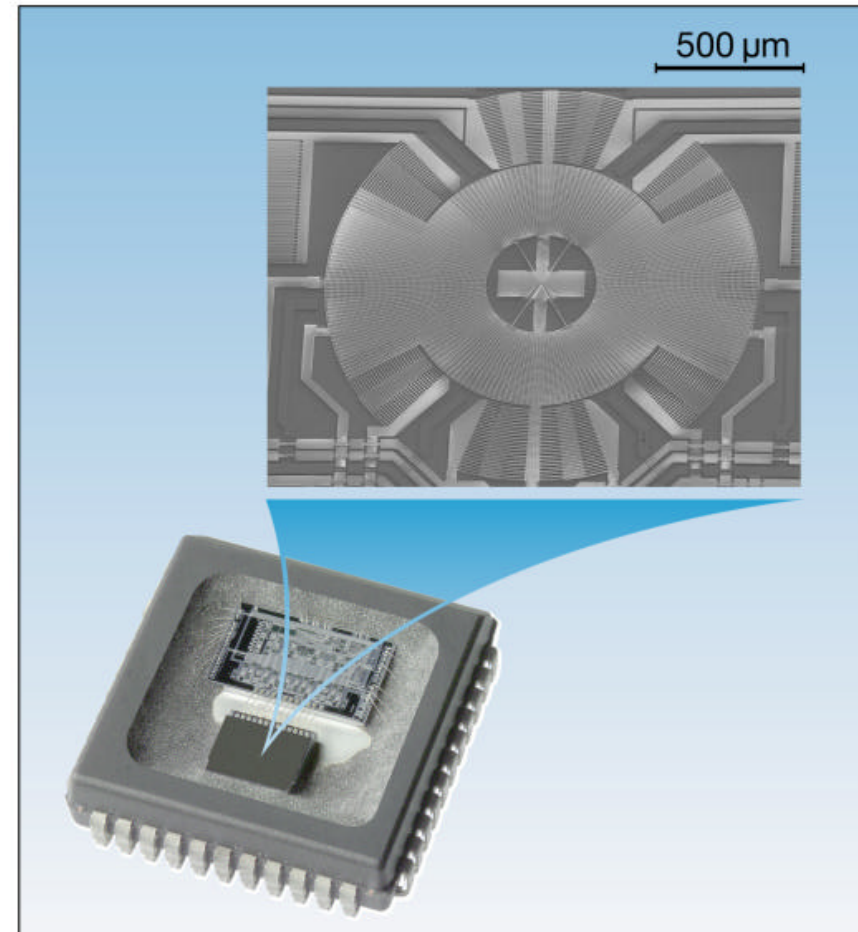
Features

- Sensing element: rotational oscillator
- Surface micromachining technology
- Sensitive axis: in-plane
- Ratiometrical analog output
- Low parameter drifts
- Low sensitivity to linear acceleration
- Self-test (electronics and mechanics)
- Small size (SMD: PLCC44)

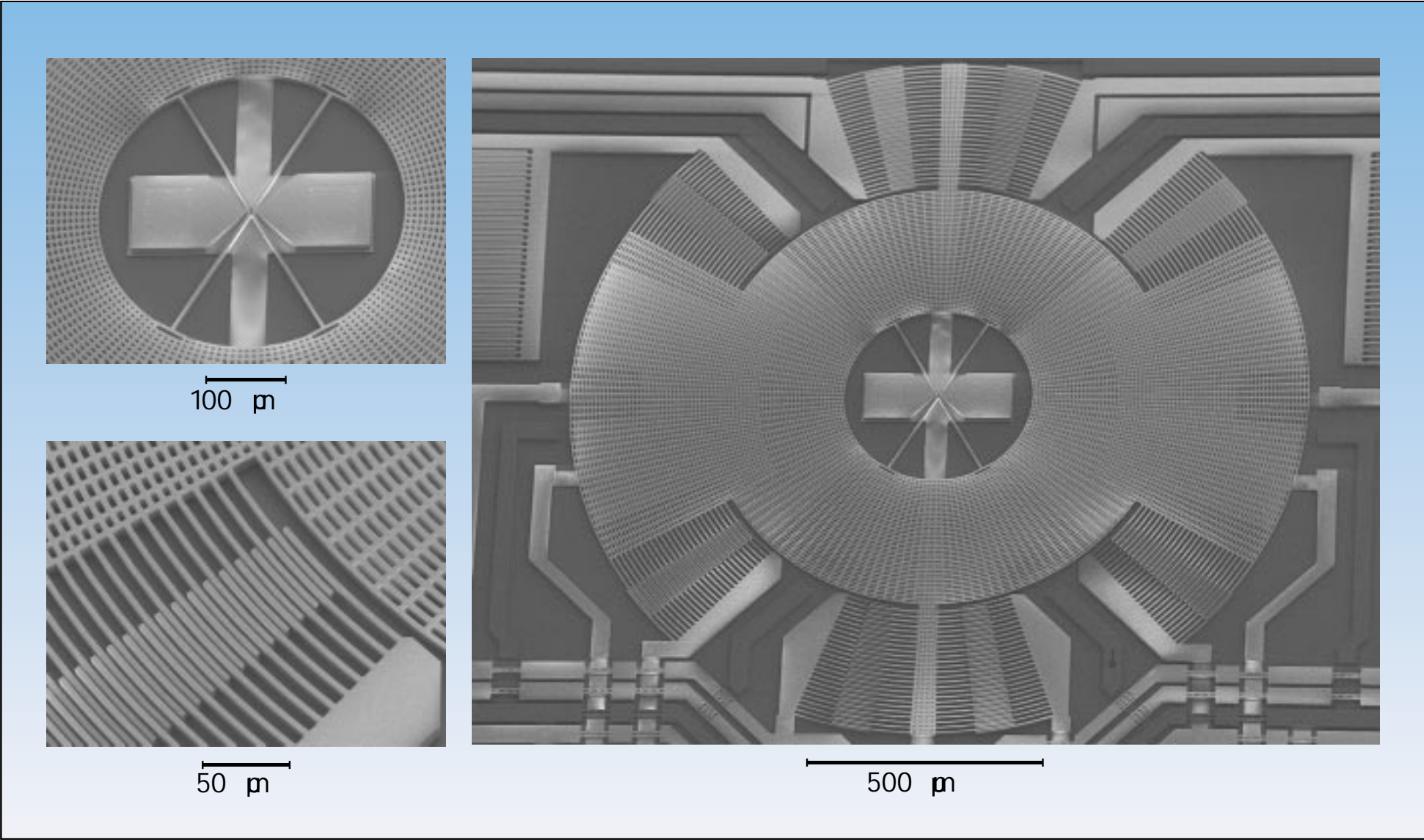
Applications

Roll over sensing: $\pm 250^\circ/\text{s}$ (SMG 040)

Automotive navigation: $\pm 100^\circ/\text{s}$ (SMG 045)

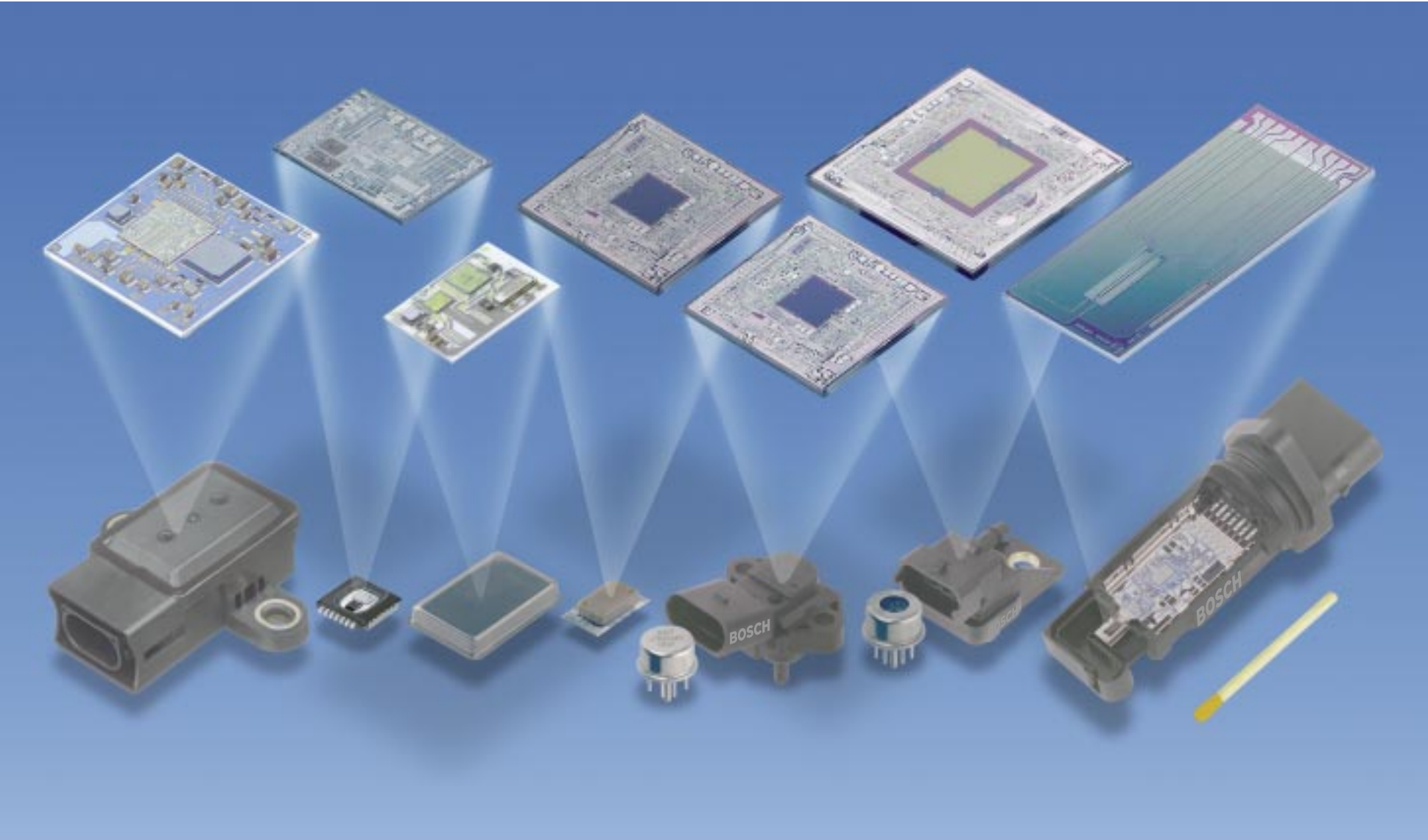


Micromachined Angular Rate Sensor



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