

# Hydrogen Sensors in Transportation Industry

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# Hydrogen Sensors

- Applications for hydrogen sensors
- Present system requirements
- Overview of current technologies
- Summary and Future directions



# Vehicle Programs/Applications

- **H2ICE**
    - Safety
    - Exhaust monitor/control
  - **Fuel Cell Vehicle**
    - Safety
    - Control of fuel loop (purge)
    - System control/diagnostics
- Commonize components when possible



# Hydrogen Sensor Specifications

- Selective/ low cross sensitivity
- Range:
  - Safety - 1000 ppm to 10%
  - Control – up to 100% depending on application
- Fast Response (~ 1 sec.)
- Low power (~ 10-100 mW)
- Durable and stable (120K miles)
- Cost effective (multiple sensors per vehicle)
- Temperature range (-40 to 140°C) or higher
- Not a potential source of ignition
  - low temperature or flash arrestor
- Automotive rated (Tier I or II supplier)



# Hydrogen Sensing Technologies

- Catalytic
  - Beads
  - Microcalorimeter
- Thermal conductivity
- Conductivity
  - Pd metal alloy resistors
  - Doped metal oxides, e.g.  $\text{SnO}_2$ ,  $\text{ZnO}$ ,  $\text{Ga}_2\text{O}_3$ , etc.
- FET
  - Si/SiC



# Hydrogen Sensing Technologies

- **Adsorption/absorption**
  - Microcantilever
  - SAW
  - Quartz Crystal Monitor
- **Electrochemical (proton conductor)**
  - Nafion (PEM) or solid oxide Sr:PSZ
  - Nernst cell
- **Optical**
  - Fiber optic (chemochromic)
  - NIR absorption
- **Acoustic (speed of sound)**



# Summary

- Current available technology adequate for safety applications
- Trend toward eventual elimination of on-board safety sensors
  - Re-fueling source
  - Identify leaks using pressure/flow sensors
- Needs:
  - High temperature/H<sub>2</sub>ICE exhaust
  - Multifunction sensors
    - (H<sub>2</sub> + CO + humidity + temperature + ...)

