Technical Ceramics in Pressure Sensors: Why, When, and Where Are They Used?

Peter Fox, Business Development Manager
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Agenda

• Brief CoorsTek overview
• Pressure sensors explained
• Why, when, and where are Technical Ceramics used
• Choose the right Technical Ceramics partner
Brief CoorsTek Overview
Heritage of Innovation

1870s: COORS BREWERY IN GOLDEN/COLORADO

1900s: GOLDEN POTTERY

1920s: ISOSTATIC PRESSED GRINDING MEDIA

1940s: THIN-FILM SUBSTRATES

1960s: COORS CERAMICS BECOMES COORSTEK

1980s: GLOBAL EXPANSION

2000s: CENTER FOR ADVANCED MATERIALS

- DRY PRESS FORMING
- RECyclable ALUMINUM CAN
- ADVANCED TECHNICAL CERAMICS
- DURA-Z™ ZIRCONIA
- PLASMAPURE-UC™ ALUMINA
Technical Ceramics Leader

61/118
Utilizing over ½ of Earth’s known elements

GLOBAL CAPACITY
500,000 m² ceramic manufacturing space

EXPERTISE
6,000 employees worldwide

½+
CoorsTek
6000
Materials Expertise

Over ½ of Earth’s known elements

>300 advanced ceramic material formulations

∞ custom options, one optimized solution
300+ Technical Ceramic Compounds

- **OXIDES**
  - ALUMINAS
  - SILICATES

- **NON-OXIDES**
  - CARBIDES
  - NITRIDES

- **SPECIALTY**
  - RARE EARTHS
  - ZIRCONIAS
  - COMPOSITES
  - CUSTOM
Worldwide Facilities

30 manufacturing sites
Technology & manufacturing customers in 70 countries
Connect & collaborate worldwide
Diverse Offerings in Key Global Markets

AUTOMOTIVE
DEFENSE & AEROSPACE
CHEMICALS & ENERGY
SEMICONDUCTOR
Diverse Offerings in Key Global Markets

- **CHEMICALS**
- **CONSUMER & HOUSEHOLD**
- **ELECTRONICS**
- **EQUIPMENT & MANUFACTURING**
- **AGRICULTURE & NUTRITION**
- **MEDICAL**
Pressure Sensors Explained
## Basic Physics of Pressure Sensing

\[ P = \frac{F}{A} \text{ or } \frac{\Delta F}{\Delta A} \]

Where:
- \( P \): Pressure
- \( F \): Force
- \( A \): Area
- \( \Delta \): Change in

<table>
<thead>
<tr>
<th>Absolute Pressure:</th>
<th>Measured relative to a perfect vacuum</th>
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<tbody>
<tr>
<td>Differential pressure:</td>
<td>Difference in pressure between two points of Measurement</td>
</tr>
<tr>
<td>Gauge Pressure:</td>
<td>Measured relative to ambient pressure</td>
</tr>
<tr>
<td>Gas Effects:</td>
<td>Gases are highly compressible</td>
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<tr>
<td>Temperature Effects:</td>
<td>Temperature can influence density and other mechanical properties</td>
</tr>
<tr>
<td>Dynamic Effects:</td>
<td>Most practical applications involve dynamic pressures</td>
</tr>
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In practice, many noise factors exist:
- **Absolute Pressure**: Measured relative to a perfect vacuum.
- **Differential pressure**: Difference in pressure between two points of measurement.
- **Gauge Pressure**: Measured relative to ambient pressure.

Pressure Sensing Technologies

Pressure sensor types which use either single crystal or synthetic piezoelectric materials as sensing element

Functional Block Diagram of Basic Pressure Sensor

Pressure sensor types that commonly use technical ceramics shown in dark red

Why, When, and Where Are Technical Ceramics Used
Why Technical Ceramics?

**MECHANICAL**
- Hardness
- Rigidity
- Toughness
- Wear

**THERMAL**
- Shock & Stability
- Conductivity
- Expansion
- Creep

**CHEMICAL**
- Corrosion
- Biocompatible
- Ultra-pure
- Inert (or active)

**ELECTRICAL**
- Resistivity
- Conductivity
- ESD-safe
- Dielectric Strength
Why Use Technical Ceramics for Pressure Sensors?

- **Durability** – Ceramics are inherently resistant to chemical corrosion and mechanical abrasion
- **Reliability** – Ceramic diaphragms operate at their calibrated values longer than other conventional materials
- **Precision** – Ceramics can be manufactured into complex and precise form factors for optimal packaging
- **Temperature** – Ceramics maintain superior thermal stability during extreme temperature exposure
When and Where Are Technical Ceramics Used?

Pressure Sensors

Ceramic pressure sensors are ideally suited for high duty cycle applications and can handle a wide range of working media. This combination of requirements commonly exist in the following industries:

- Agricultural & Off-Road Vehicles
- Automotive & Transportation
- Energy & Chemical
- Equipment & Machinery
- Food & Beverage
- Heating, Ventilation, and Air Conditioning (HVAC)
- Medical
- Military

<table>
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<tr>
<th>Range</th>
<th>Classification</th>
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<tr>
<td>&lt;10 bar</td>
<td>Low</td>
</tr>
<tr>
<td>10-100 bar</td>
<td>Medium</td>
</tr>
<tr>
<td>100-250 bar</td>
<td>High</td>
</tr>
<tr>
<td>&gt;250 bar</td>
<td>Extreme</td>
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Pressure Sensing Technologies using Technical Ceramics:

- **Strain Gauge**
  - Strain gauge element to measure membrane deflection
  - Ceramic component with integrated membrane

- **Capacitive**
  - Ceramic component
  - Defined gap to measure deflection due to change in electrical capacitance
Choose The Right Technical Ceramics Partner
Choose The Right Technical Ceramics Partner

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<tr>
<th>Ease of Doing Business</th>
<th>Design Expertise</th>
<th>Material Portfolio</th>
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<tr>
<td>Global presence</td>
<td>Material and manufacturing</td>
<td>Customized material options</td>
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<tr>
<td>Manufacturing Capabilities</td>
<td>Advanced Secondary Processing</td>
<td>Quality Systems</td>
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<tr>
<td>Vertically integrated</td>
<td>Single source service</td>
<td>State of the Art</td>
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Thank You

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