Small Ceramic Structural Components for Automotive Exhaust Sensors

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Automotive exhaust sensors

• Exhaust Oxygen Sensors are key to improving fuel economy and reducing pollution

• Global volume of exhaust sensors
  • Current: ~200 million sensors/year
  • Future: (2021) ~280 million sensors/year

• Exhaust Sensors are exposed to severe environments
  • -60°C to +1000°C (1832°F) exhaust gas
  • Soot, acids, high amounts of water (liquid and vapor) and toxic fumes
  • High vibrations levels
  • Stone impacts
Sensor size is decreasing

- Exhaust sensors are being mounted in tight spaces
  - Motorcycles/mopeds
  - Lawnmowers
  - Tight locations on cars

- New technology sensors are 50% smaller in size
  - Higher Performance
  - Increased requirements
  - Lower cost
OEM customer requirements drives cost

- Unnecessary/outdated performance requirements can result in increased product prices

Example: Wire size/terminal pull

- Requirement: 20 gage wire
- 100 N Individual wire pull (based on wire size – not requirement)
- Increased terminal dimensions required to meet target
- Terminal creates thin walls in ceramic connector
- Thin walls require injection molding ceramic
- Component price increase
- Sensor price increase
Trend in automotive exhaust sensor ceramics
Where can your company contribute?

**Smaller**

- Products are getting smaller
- Tolerances need to decrease accordingly
- Tooling decreases in size
- Tooling increasing in complexity
- Wall thicknesses decrease

**Stronger**

- Thinner walls require stronger materials
- Smaller tooling increases wear rate
- Smaller components have higher stress
- Less defects can be tolerated
- More extensive FEA is required
- Higher strength raw material is required

**Less Variation**

- Enables meeting tight tolerance requirements
- Allows for increased wall thickness
- Better particle size control minimizes voids

**Lower Cost**

- Market pressure is driving final product price lower and localization
- Ceramic components are becoming a larger percentage of total component cost
Prototypes

• Complex parts often require iteration in order to perfect
• Prototypes are required for testing sensors on various tests
  • Typically need 1,000 to 2,000 parts during a development cycle
  • Require parts to be representative of final product
• Creative methods must sometimes be used to keep prototype cost down
  • Potentially using fast wear tooling
  • Alternative fabrication methods for less complex components
  • Alternative low cost suppliers/partnerships that specialize in low volume “production”
  • As customers, we do not want vendors to lose money on prototypes
    • While working with the customer in the development stage builds a critical engineering relationship, it does not guarantee future production business without a competitive price
Effect of not meeting process capability metrics

• World class suppliers
  • Strive to meet all dimensions with a Ppk of 2.0
  • Inform the customer which ones cannot meet 2.0 so negotiations can be made

Example Effect of Ppk on simple 2-contributor stack

- Defects Per Million Opportunities (DPMO)
- Cpk: Process Capability
- Ppk: Process Performance Capability
Supplier input is critical!

- Suppliers are the experts, we as your customers need your comments and feedback!
- If there are difficult areas of a design that will cause more variation or cost, please offer your suggestions
- Together we will win!