High Sensitivity, High Temperature, Gas Vortex Flow Metering

Ionix high-performance HPZ materials enabling hot gas vortex flow metering

Key deliverables

- Ionix HPZ allows gas flow metering at >400 °C, using the same cabling technology, electronics, and software, significantly extending market reach for OEM manufacturers of flow systems.
- Ionix HPZ offers plug-and-play compatibility for PZT; the physics and physical form are the same as those required for PZT.

Overview

There are a number of ways of measuring gas flow. Two standard methods are the use of active ultrasound, and passive vortex measurement:

- A vortex flow meter uses a bluff body, to generate a vortex. The frequency of the vortex can be used to determine the rate of flow of a gas; the same principle leads to oscillations in a flag, caused by the wind velocity. Such meters are commonplace, and used in a range of gases, including steam.
- An ultrasonic flow meter uses high frequency sound waves to determine the flow, often a pair of sensors crossing the stream gas.

Many flow meters use the piezoelectric effect, and most of these use PZT. This presents three limitations:

- variation of sensitivity with temperature
- a maximum operating temperature of approximately 200°C
- potential for damage to the brittle ceramic material

In addition, as the temperature increases, the attenuation of most gases also increases, compounding the problem.

The Challenge

A leading global process control major sought to access a wider temperature range of operation, affording them greater market adoption. Previous attempts to manufacture flow meters from a range of other piezo-materials that offer

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wider temperature ranges, including bismuth titanate and quartz, provided insufficient sensitivity. The charge that is generated by the vortices of these materials is a factor of 20+ lower for bismuth titanate, or >60 in quartz, compared to PZT. A piezoelectric ceramic, which could be used with their existing software and electronics, to exhibit similar sensitivity but with wide temperature operation, was required.

The Solution

The Ionix HPZ family of piezoelectric materials works in the same way as PZT and has comparable sensitivity. The relative performance of Ionix HPZ580 compared to bismuth titanate and quartz is shown in Figure 1, exhibiting order of magnitude increases in sensitivity.

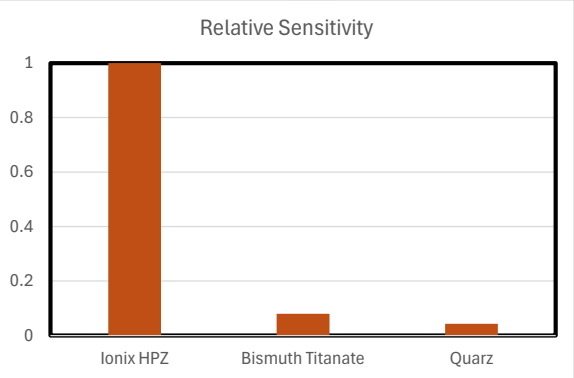

Figure 1 – Chart of relative sensitivity for various piezo-ceramics

The Ionix family is unique in offering our customers and partners high sensitivity over a wide temperature range. The Figure 2 shows the sensitivity (d_{33} = piezoelectric charge coefficient) vs. the Curie temperature (= the absolute maximum temperature, where piezoelectricity is permanently lost). This means that customers do not have to compromise on sensitivity.

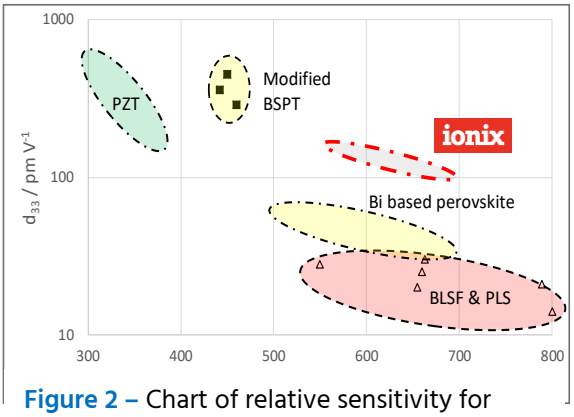

Figure 2 – Chart of relative sensitivity for various piezo-ceramics against Curie temperature.

The Ionix HPZ family offers several additional benefits:

- The physical characteristics are similar to those of PZT: the speed of sound, the density, the Young's modulus. This allows PZT to be "swapped out," reducing the engineering challenges.
- Variation in temperature. Ionix HPZ580 has a much lower variation in sensitivity with temperature compared to PZT, due to the much higher Curie point.
- Bonding and attachment: Ionix HPZ has a thermal expansion coefficient that is aligned with common engineering metals such as steel and titanium. In addition, we implement a number of solutions to allow permanent, efficient attachment methods.

The Ionix HPZ family has been adopted by a number of customers and allows them to measure gas flow over a wide temperature range. We work closely to allow the customers to move through development and into product launch.