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QorTek Publishes Breakthrough Research in High Temperature Sustainable Piezoelectric Energy Harvesting and Self-Powered Sensing

With the onset of such technologies ranging from hypersonic munitions to very high ambient temperature space explorations there is a rapidly expanding need for materials that can act as sensors or energy harvesters at elevated temperatures. Although there is a history of development in high temperature piezoelectric materials, such prior efforts encounter the common issue that these materials become rapidly less effective as sensors or energy harvesters after a relatively low thermal threshold; quite typically rapidly diminishing above 100°C, depending upon composition.

The Journal of Applied Physics has this week published the breakthrough research in high temperature piezoelectrics developed at QorTek. Funded by NASA with view to applications to monitoring high temperature rocket launch subsystems, what is new as disclosed in the AIP JAP publication is not only that the new modified BSPT piezoelectric composition, $Bi(Me)O_3$-$PbTiO_3$, exhibits very high power density to well above 250°C, but critically that this high power density is near constant across a wide thermal excursion range up to 250°C. This ability to provide near constant, high performance, energy conversion or sensing capability across such a wide thermal excursion range is entirely new to the piezoelectric industry and is the culmination of developing both compositional modifications and introducing new process engineering techniques. Although increasing ambient temperatures to above 250°C does start to see a gradual fall-off in performance of these new compositions, they remain effective as energy harvester or sensor devices to well above 300°C.

A cantilever structure was selected as the initial demonstration device exhibiting the performance capability of these new high temperature capable piezoelectric compositions for energy harvesting and (vibration) sensing. To implement such a vibration energy harvesting/sensing device itself required some design advances. Typically, known literature notes the use of either mechanical bolts or high temperature epoxies to electrically connect to such cantilever devices. QorTek researchers determined that these solutions are unreliable and ineffective at high temperatures. QorTek patent application 62/958,783A discloses an entirely new method for electrical connectorization for piezo-cantilever structures that eliminates soldering or bonding of electrical wires. This new technique now eliminates any potential issues of connector detachment when operating at elevated temperatures and this new methodology is briefly described in the publication.

Additionally, the electroding process engineering and interface between the clamped region and the vibrating piezoelectric cantilever to operate over this functional temperature range had to be addressed. To solve this, QorTek developed a new process engineering approach for silver paste electroding BSPT-based devices. Further developments focused on selection of the different construction materials to minimize or prevent stress buildup in the interface region due to thermal expansion at higher temperatures of operation.

This breakthrough in high temperature piezoelectric materials could have a wide range of space, aerospace, and industrial applications from self-powered remote monitoring of high temperature aircraft engine and space thruster subsystems and components to energy harvesting/monitoring in chemical process engineering and energy exploration.

The publication entitled "*Introducing an extremely high output power and high temperature piezoelectric bimorph energy harvester technology based on the ferroelectric system $Bi(Me)O_3$-$PbTiO_3$,*" appears in: Journal of Applied Physics 128, 144102 (2020); https://doi.org/10.1063/5.0005789 .

About QorTek Inc.
With over 60 employees, including 35 Engineers (EE, ME, MatSE) and 5 PhDs, QorTek is a world leader in smart material devices and high-density power electronics, innovating, developing, and providing quality solutions to a diverse array of industries including underwater systems, land & air systems, military & commercial space systems, medical, and industrial. The dedicated and experienced team is committed to creatively advancing technology to promote sustainable business growth, driven by dynamic engineering enabled by advanced science and technology.

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