

Department of the Navy SBIR/STTR Transition Program

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Approval # 43-1256-16

Topic # N122-139

Low Cost Manufacturing of Vector Velocity Sensors

TRS Ceramics, Inc.

WHO

SYSCOM: ONR

Sponsoring Program: Submarine Acoustic Systems (PMS 401), Integrated Warfare Systems Undersea Systems (PEO IWS-5A), Office of Naval Research (ONR)

Transition Target: ONR Future Naval Capability (FNC) Submarine Thin-Line Array

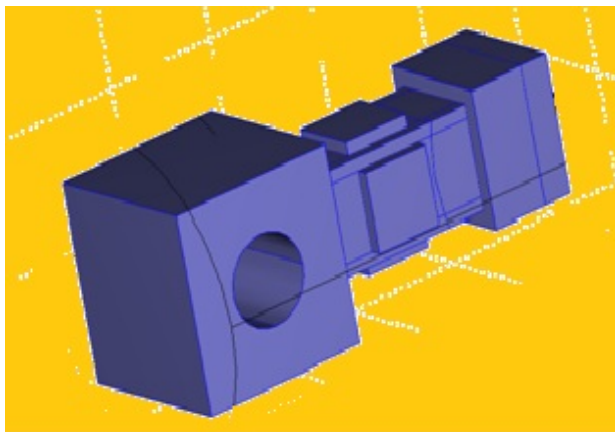
TPOC:

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Other transition opportunities:

Develop low-noise, very sensitive vector sensors in small packaging using lead magnesium niobate-lead titanate (PMN-PT) single crystals to support thin/fat line towed array, and variable depth sonar systems..

Notes: TRS's PMN-PT crystal elements are capable of operating at-depth with a piezoelectric coefficient of d32.



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WHAT

Operational Need and Improvement: Underwater vector sensors and vector sensor arrays improve the detection and localization of acoustic signals compared to conventional omni-directional hydrophones and hydrophone arrays. Their application is particularly useful in monitoring underwater acoustic noise near strategic points of interest. Vector sensors by their nature provide a steerable directional beam that measures the magnitude and direction of acoustic signals while providing a null that steers toward a known interfering noise source. These sensors have two appealing capabilities: the ability to selectively reject the noise emitted from discrete interfering noise sources, and the ability to localize noise targets.

Specifications Required: Single PMN-PT crystal elements provide a 5-10 times increase in piezoelectric properties ($d_{32} > 1600$ pC/N), higher electromechanical coupling than (Lead Zirconate Titanate) PZT ceramics, and exceed current sensitivity and signal-to-noise requirements, in a much smaller sensor.

Technology Developed: TRS has developed ferroelectric lead-magnesium niobate lead-titanate (PMN-PT) single crystal piezoelectric materials that make vector sensor technology a reality. The high performance enables the production and manufacturing of compact single crystal-based vector velocity sensors which exceed sensitivity and signal-to-noise requirements achieved using conventional lead zirconium titanate (PZT) ceramics. TRS has developed full-scale manufacturing processes to achieve low-cost fabrication of single crystal-based components for vector velocity sensors.

Warfighter Value: These vector sensors are employed in submarine towed arrays to reduce the left, right ambiguities, and in other naval applications. The directional benefits of vector sensors make them an ideal candidate for the Navy's thin line and towed array applications.

WHEN

Contract Number: N00014-14-C-0038

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Single crystals fabrication for vector sensors	Low	Done	4	May 2015
Fabrication of beams for vector sensors	Low	Done	4	December 2015
Fabrication of vector sensor modules	Low	In progress	4	March 2016
Reporting of cost analysis of vector sensor module	Low	In progress	4	March 2016

HOW

Projected Business Model: TRS's PMN-PT family of materials (PMN-PT, PIN-PMN-PT, and Mn doped PIN-PMN-PT) offer 5x the strain performance of traditional Type II PZT materials. With this revolutionary material, TRS has enabled a new generation of technologies, including medical ultrasound systems with higher resolution, reduced package size in sonar systems, and other high performance industrial sensors. Since, TRS will be a manufacturer of these single crystal component it does not need to license any technology. The automation and assembly process will be setup at the TRS facility in State College, PA.

Company Objectives: TRS Ceramics teamed with Progeny Systems is developing the vector velocity sensor technology for Navy submarine towed array systems. TRS is using advance manufacturing processes to fabricate single crystal elements and the vector sensor beam assemblies. Upon process development, TRS is focusing on automated sensor module fabrication processes to reduce the overall costs of the vector sensor components. Using the technology developed through this program, TRS will be able to deliver other value-added low cost components for Navy applications and also for other commercial applications.

Potential Commercial Applications: Along with vector sensors, there are other products like unimorphs, bimorphs, and multi-layer actuators and projectors that would benefit from similar automated processing that reduce handling and production cost of single crystal components. TRS is currently a leading manufacturer of shear mode ceramics for vibration sensor industry. TRS's automated assembly processes allows TRS to provide value-added components to a broader range of commercial sensor manufacturers.

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