Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2018-0529

Topic # N151-046

Low-Cost Gallium Nitride (GaN) on Diamond Semiconductors for Microwave Power Amplifiers

Kyma Technologies, Inc.

WHO

SYSCOM: NAVSEA

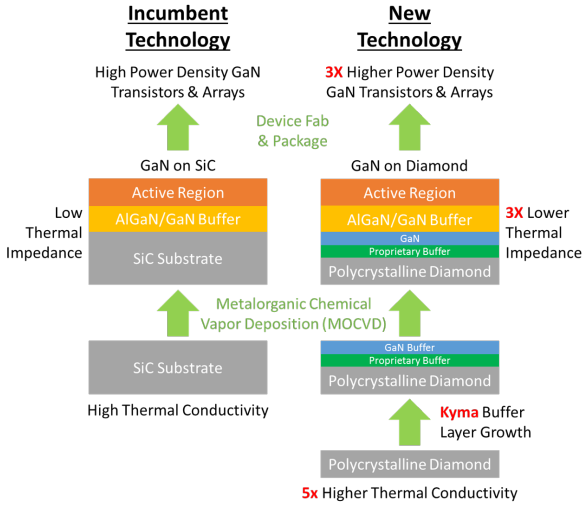
Sponsoring Program: Above Water Sensors Program Office PEO IWS 2.0

Transition Target: Silicon Carbide (SiC) Substrate Replacement for High Power Radio Frequency (RF) GaN Transistors & Arrays Made by Raytheon, Northrop Grumman, Cree/Wolfspeed, & Qorvo

TPOC:
(812)854-6385

Other transition opportunities: Any Application Requiring High Power RF GaN Transistors & Arrays Especially those for which Higher Power Density and/or Improved Thermal Dissipation is Important

Notes: Current technology, uses SiC substrate and Metal Organic Chemical Vapor Deposition (MOCVD) epi to realize high power density GaN transistors/arrays. By replacing the SiC substrate with a 5x higher thermal conductivity polycrystalline diamond wafer that has Kyma's proprietary buffer layers on it, a 3x thermal impedance device wafer reduction is realized translating to a 3x higher power density performance in the resulting GaN transistors and arrays.



WHAT

Operational Need and Improvement: GaN on SiC gives very good performance yet thermal impedance improvements are needed for millimeter-wave Radio Frequency Integrated Circuit (RFIC) designs where circuit elements are closely spaced. Such thermal impedance improvements will enable smaller RFICs which translates to smaller form factor and more RFICs per wafer, translating to higher power density operation and lower manufacturing cost.

Specifications Required: The GaN on diamond wafer shall have 3x lower thermal impedance and support 3x greater power density operation in the resulting GaN transistors.

Technology Developed: Kyma has developed a method for producing high quality GaN on diamond wafers that have the potential to enable higher power density GaN transistor performance because of their lower thermal impedance compared to incumbent GaN on SiC technologies.

Warfighter Value: Higher power density GaN transistors and arrays based on GaN on SiC are gaining importance in a number of RF transistor and array applications including military radar. Kyma's GaN on diamond wafer have the potential to reduce the number of parts or the volume of existing arrays or to increase the power output per unit device or array area, important for current defense systems and critically needed for future defense systems.

WHEN

Contract Number: N00178-17-C-0004

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate growth of c-plane GaN on polydiamond	N/A	Only c-oriented GaN by x-ray diffraction in multiple representative regions of the wafer	3	January 2017
Make or buy large area high quality buffer layer	Low	Good optical and structural properties over large area	4	July 2018
Demonstrate growth of large area high quality GaN on polydiamond	Med	Good GaN structural properties over most of the wafer	4	January 2019
Demonstrate high quality epitaxy of GaN transistor structure	Med	Demonstrate high performance GaN RF transistor	5	January 2020
Demonstrate GaN transistors with high performance & reliability	High	Low leakage, high output power, RF transistors that outperform GaN on SiC versions	5	January 2022

HOW

Projected Business Model: Kyma's near term business model is to supply prototype GaN on Diamond wafers at rates up to 100 wafers per month to defense primes and epiwafer suppliers for their evaluation. If customer response is strong as evidenced by increased demand, Kyma would increase its capacity to match demand for our wafers - and, in parallel, Kyma would offer the growth technology and the crystal growth tools to defense primes and/or epiwafer suppliers who might want to bring the process in-house. Kyma has a world-class US based semiconductor equipment Original Equipment Manufacturers (OEM) who would make the tools which Kyma will offer.

Company Objectives: To further develop this technology to the point at which defense primes will want to test it and ultimately implement it in next generation high power RF applications. Kyma seeks to meet with all defense primes and other potential collaborators who could benefit from higher power density GaN transistors and arrays. Kyma's initial GaN on Diamond wafer offering will consist of 4-inch diameter wafers.

Potential Commercial Applications: Wireless base stations, 5G communications

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