

Topic: N17A-T020

Plasmonics Inc.

Phase-Change Materials for Tunable Infrared Devices

The high transmission of thermal infrared light through haze and fog makes it ideal for secure, ship-to-shore communication in inclement weather. However, the lack of practical tunable optical systems has resulted in limited utilization of infrared light for communication applications. To address this issue, Plasmonics Inc has developed a new class of active optical elements employing phase change materials (PCM). Unlike existing acousto-optic modulators, the PCM infrared modulator is compact (active region < 1mm thick), broadband (> 10% bandwidth), and has a wide field-of-view (> 60 degrees). Plasmonics Inc is looking for partnerships to integrate this new technology into a variety of platforms, including free-space optical communication systems, beam deflectors, and active tags for target identification.

Technology Category Alignment:

Satellite Communications (SATCOM)

Robotics/Automated Material Handling Equipment

Shipyards/Shipbuilding

Supply; Storage

Satellite Communications (SATCOM)

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Supply; Storage

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Satellite Communications (SATCOM)

Shipyards/Shipbuilding

Robotics/Automated Material Handling Equipment

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Robotics/Automated Material Handling Equipment

Robotics/Automated Material Handling Equipment

Protection, Sustainment, and Warfighter Performance

Medical Chem-Bio Defense

Military Infectious Diseases

Propulsion and Extreme Environments

Fixed Wing Vehicles (includes UAS)

Survivability

Maintainability/Sustainability

Unmanned Ground and Sea Vehicles

Corrosion

Advanced Computing/Software Development

Networks and Communications

Modular/Open/Reconfigurable Architectures

RF Components for sensing, transmission and communication

Electronics Integration

Broadband/Multispectral Components and Systems

Sensors, Electronics and Photonics

Radio Frequency (RF) (non-EW)

Survivability

Broadband/Multispectral Components and Systems

RF Components for sensing, transmission and communication

Radio Frequency (RF) (non-EW)

Networks and Communications

Guidance, Navigation & Control (GN&C) and Data Links

RF Components for sensing, transmission and communication
Networks and Communications
Cognitive/Adaptive Capabilities
Preemptive/Proactive Effects
Broadband/Multispectral Components and Systems
Advanced Computing/Software Development
Networks and Communications
Personalized Assessment, Education, and Training
System Interfaces & Cognitive Processes
Aircraft Propulsion, Power and Thermal
Modeling, Simulation & Test Infrastructure
Rotary Wing Vehicles
Fixed Wing Vehicles (includes UAS)
Fixed Wing Vehicles (includes UAS)
Acoustic, Seismic and Magnetic
Rotary Wing Vehicles
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Energy storage
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Mobility
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Advanced Computing/Software Development
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Power Generation/Energy Conversion
High Energy Lasers (HEL)

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Assuring Effective Missions
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Biomedical Informatics / Health Information Systems & Technology
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EO/IR Components for sensing, transmission and communication

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Aircraft Propulsion, Power and Thermal
Rotary Wing Vehicles
EO/IR Components for sensing, transmission and communication
Satellite Communications (SATCOM)
Networks and Communications
Trust Foundations
Electro-Optical/Infrared (EO/IR)
Unmanned Ground and Sea Vehicles
Maintainability/Sustainability
Modularity
Survivability
Electro-Optical/Infrared (EO/IR)
Sensors, Electronics and Photonics
EO/IR Components for sensing, transmission and communication
RF Components for sensing, transmission and communication
Networks and Communications
Broadband/Multispectral Components and Systems
Electronics Integration
Protection, Sustainment, and Warfighter Performance
Clinical & Rehabilitative Medicine
Combat Casualty Care
Medical Chem-Bio Defense
Energy storage
Protection, Sustainment, and Warfighter Performance
Human Computer Interfaces (HCI) for Decision Making
Synthesis/Analytics/Decision Tools
Undersea Weapons
Human Computer Interfaces (HCI) for Decision Making
Information Collection/Management

Synthesis/Analytics/Decision Tools
Power and Energy
Propulsion and Extreme Environments
RF Components for sensing, transmission and communication
Fixed Wing Vehicles (includes UAS)
Broadband/Multispectral Components and Systems
Preemptive/Proactive Effects
Radio Frequency (RF) (non-EW)
Energy storage
Manufacturing Technology for Affordability
Power and Energy
Structures and Protection
Synthesis/Analytics/Decision Tools
Fixed Wing Vehicles (includes UAS)
Advanced Computing/Software Development
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Integrating Architecture and Capability Demonstrations
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Fixed Wing Vehicles (includes UAS)
Rotary Wing Vehicles
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Propulsion
Protection, Sustainment, and Warfighter Performance
Individual Warfighter
Synthesis/Analytics/Decision Tools
Collaborative Analysis and Decision-making
Survivability
Modeling, Simulation & Test Infrastructure

Fixed Wing Vehicles (includes UAS)
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RF Components for sensing, transmission and communication
Fixed Wing Vehicles (includes UAS)
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Synthesis/Analytics/Decision Tools
Electromechanical conversion
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Power Control and Distribution
Power Generation/Energy Conversion
Electronics Integration
Energy storage
Power Control and Distribution
Power Generation/Energy Conversion
Survivability
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Thermal Transport and Control
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EO/IR Components for sensing, transmission and communication
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Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-5915-19/43-6031-19

Topic # N17A-T020

Phase-Change Materials for Tunable Infrared Devices
Plasmonics Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR

Transition Target: Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR)

TPOC:

Dr. Brian Bennett
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Other transition opportunities: We see multiple transition options for this technology, with the initial focus on use as an infrared (IR) Free-Space Optical Communication (FSOC) modulator for secure communications. The modulator can also be deployed as part of a thermal transponder for target identification, as a dynamic beam deflector or as a dynamic polarizer for target classification.



Photo courtesy of US Marine Corps, 180817-M-HF454-0101.JPG

WHAT

Operational Need and Improvement: There is a critical need for the development of dynamic IR materials that can be used to form device level components and systems necessary for mid- to long-wave IR (3-12 μm) applications. Communication systems utilizing the thermal IR band have several advantages over existing optical systems including higher transmission through haze and fog and improved covertness. These benefits make the proposed technology ideal for use in ship-to-shore or ship to unmanned aerial system communication systems when existing communication channels are degraded. Developing materials that are responsive, dynamic (spectrally tunable and externally controllable), affordable, and high speed are key operational factors.

Specifications Required: The goal of this project is to design and fabricate tunable elements with the following specifications:

- Volume less than 20 cubic centimeters
- At least four simultaneous channels in the 3-12 μm range
- Field of view of at least +/- 60 degrees

Technology Developed: Under this program, Plasmonics Inc has developed a new class of Spatial Light Modulators (SLMs) utilizing phase-change materials (PCMs). Controlling the optical property of PCM's is achieved by electrical biasing and results from the re-ordering of the material's crystal structure. Coupling these materials to an IR coating makes it possible to engineer an active surface with a wide range of optical behaviors including dynamic amplitude, polarization, and directionality. These behaviors can be leveraged to assemble various compact, dynamic optical elements such as filters, polarizers, beamsteerers, and absorbers.

Warfighter Value: Dominance of the electromagnetic (EM) spectrum is critical for DoD. Emerging communication technologies that operate within untapped portions of the spectrum, such as the thermal IR, will shape the battlespace and disrupt the adversaries ability to do the same.

WHEN

Contract Number: N68335-18-C-0659 **Ending on:** September 24, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Fabrication of Single Element SLM	Med	Demonstrate the dynamic properties of the PCMs. Metrics to be validated include bit rate, field-of-view, and dynamic contrast.	3	4th QTR FY19
Fabrication of Multiple Element SLM	Low	Demonstrate multiple SLM pixel functioning independently, without impact on overall performance. Multiple pixels will increase aperture size and allow for multi-channel operation.	4	4th QTR FY20
CMOS Control Board Integration (in Phase II Option)	Med	Complete the packaging of the SLM by integrating a CMOS control board. At this stage, full fabrication of the SLM array will have been demonstrated.	5	4th QTR FY22
Field-Relevant Test and Integration (During Phase III)	Med	Demonstrate the use of the SLM within a platform, including relevant sources and detectors. Baseline performance will be demonstrated in a relevant environment.	6	4th QTR FY23

HOW

Projected Business Model: Plasmonics Inc intends to manufacture and sell the modulator developed under this STTR. However, we recognize the value of partnering with an established DoD supplier to ensure quality and to address the volume needs of the DoD. Existing relationships with key industry players will facilitate prototype testing, high volume production, and acquisition. We would also note that development of the technology has been done to minimize fabrication cost and to support ease of transition to an established DoD contractor. All of the processes used are CMOS compatible and utilize affordable deposition techniques, such as sputtering. Plasmonics Inc is also actively seeking partnerships with larger DoD integrators to integrate the SLM within existing platforms and systems.

Company Objectives: Plasmonics Inc envisions the development of the IR SLMs as the initial step towards an expanded product line based around dynamic thermal IR optical elements. Mature, non-mechanical, dynamic optical elements for the thermal IR do not currently exist and Plasmonics Inc seeks to become the industry leader in this area.

Potential Commercial Applications: With the emergence of affordable of thermal IR sources and cameras, there exists a significantly greater demand for IR optical elements and systems within the civilian marketplace. IR FSOC systems are a promising alternative to traditional RF communication networks due to overburdening of the US RF spectrum and the fact that optical communication channels do not require licensing from the FCC. FSOC systems are also ideal for situations where high security, quick setup, and low power consumption are critical. Potential applications include last-mile access when physical network connections are not possible, temporary networks for disaster recovery, air-to-air communication (including satellites), and high-security communication networks such as stock trading. Unlike prior FSOC designs, the system under development by Plasmonics Inc provides improved operational range and reduced signal degradation during inclement weather, which are currently the largest limiting factors of competitor platforms.

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