Statement of Work

Development of Optical Material and Science (DOMS)

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Document Revision History

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Statement of Work

1. General

The focus of this effort will include tasks that support Optical Science and Optical Material Research and Development. Support for this effort requires not only technical proficiency operating Naval Research Labortaroy's (NRL) fabrication, characterization and testing equipment but also the ability to utilize existing software applications as needed to detail results, conduct assessments and provide recommendations. Personnel supporting this initiative must also be able to define and create experiments, approaches, processes, and capabilities within the Optical Science task listing. As such, support personnel must be able to function within NRL's existing laboratory capabilities, innovate new methodologies, characterize and test those approaches and assess results. A demonstrated capability to innovate, combined with prior successful leading-edge advances in the subject task areas are critical to providing an indication of likely success in this research field.

2. Functional Support Areas

2.1. Personnel support is needed to conduct research regarding the following Optical Science disciplines:

- Advanced Methods of Glass Fabrication
- Development of Extruded, 3D Printed and Molded Optical Products
- Advanced Methods of Ceramic Fabrication
- Advanced Methods of Improving Mechanical Properties of Ceramic Products
- Advanced Infrared Transmissive Materials Design, Fabrication and Performance
- Advanced Methods of Optical Fiber Fabrication
- Data Collection and Analysis Pertaining to Bulk and Fiber Characterization
- Optical Fiber Cable Fabrication
- Advanced Development of Fiber Optic Devices
- Development and Fabrication of Optical Waveguide Products
- Environmental and Vibration Testing
- Chemical Sensing
- Maintenance and Manufacturing Support for Related Research Equipment
- Optical Systems Algorithm Development
- Aircraft Test Platform Support
- Program Management and Government Range Coordination

2.2. Functional Support Area Expertise

Proposers should provide a description of the advanced methodology that will be provided/conducted in order to execute the tasks established for each functional support area from Para. 2.1 above. Each task area requires a summary response that demonstrates an understanding of the task, references to the capability to operate equipment needed to support the task and any other supporting information related to the task. This should be included in the proposal's technical approach. The task support methodology and understanding can be demonstrated by describing related challenges and technical hurdles that have been addressed by the proposer using historical capability examples where possible.

3. Statement of Work (By functional support area)

3.1. Advanced Methods of Glass Fabrication

3.1.1. Investigate advanced methods for the fabrication of glass preforms. Conduct experiments to meet quantity, quality and dimensional specifications based upon engineering analysis and experimentation that leads to the fabrication of glass preforms. Must be able to properly operate and maintain the following: glove box, high vacuum sealing system with turbo pump, an oxy-methane torch, and an modified chemical vapor deposition (MCVD) lathe. Operations include batching and loading material, mixing and melting material using single and multi-zone rocking furnaces and quenching samples while ensuring systems are operational. Must be able to handle emergencies should the systems become compromised.

3.1.2. Design, create and utilize high-quality quartz ampoules and crucibles for glass fabrication experiments.

3.1.3. Investigate methods to dope glasses with nanoparticles.

3.1.4. Conduct analysis of the preform shape, dimension and quality.

3.2. Development of Extruded, 3D-Printed and Molded Optical Products

3.2.1. Conduct engineering experiments utilizing extruding, 3D printing and molding methods to create unique samples from glasses, ceramics and crystals. Form complex geometric shapes including graded-index, laminated structures and more complex architecture and shapes.

3.2.2. Operations include the use of a furnace, motorized punch and die needed for extrusion and molding. Additionally, 3D printing might be desirable for some materials and structures. Must be able to ensure systems are operating properly, conduct routine maintenance and to handle emergencies should the system become compromised.

3.2.3. Quantify the performance characteristics of extruded, 3D printed, and molded samples.

3.3. Advanced Methods of Ceramic Fabrication

3.3.1. Investigate methods to make transparent ceramics.

3.3.2. Develop, test, and evaluate production processes that improve upon the purity of ceramic powders, such as silicon carbide, spinel, sesquioxides and other materials including laser materials.

3.4. Advanced Methods of Improving Mechanical Properties of Ceramic Products

3.4.1. Investigate methods to improve mechanical properties of ceramic products.

3.4.2. Assist in developing light-weight, multi-round hit transparent armor, domes, and windows that incorporate novel densification techniques.

3.4.3. Operate, service and be capable of executing appropriate emergency procedures whenever needed while using the following additional laboratory equipment:

3.4.3.1. MRF Refractory Metal Vacuum Furnace with Hydrogen system
3.4.3.2. Oxygen High Temperature Graphite Vacuum Furnace
3.4.3.3. Thermolyne 21100 Tube Furnace
3.4.3.4. Sentro Tech Corp 1700 deg. C Tube Furnace
3.4.3.5. Sturtevant OM2 Micronizer
3.4.3.6. Avure 42260 Cold Isostatic Press
3.4.3.7. Buehler Power Pro 500, EcoMet III and 250 Grinders
3.4.3.8. Buehler IsoMet 1000 Precision saw
3.4.3.9. Netzsch DIL 402 High Temp Dilatometer
3.4.3.10. JEOLJSM-7001F Thermal Field Emission Scanning Electron Microscope
3.4.3.11. ASAP 2020 Physisorption Analyzer
3.4.3.12. Horiba LA-950 High Performance Laser Diffraction Analyzer
3.4.3.13. TA Instruments and SDT Analysis Unit
3.4.3.14. Micrometrics AccuPyc II 1340 Pycnometer
3.4.3.15. Zeiss Discovery V-20 Stereo Microscope
3.4.3.16. Keyence VK-9700 Laser Scanning Microscope
3.4.3.17. Sintage XDS 2000 X-Ray Diffraction unit

3.5. Advanced Infrared Transmissive Materials Design, Fabrication and Performance

3.5.1. Conduct research, fabrication, characterization and assessment of low loss IR glass, ceramic and crystal materials with the objective of eliminating or mitigating impurities that create these losses.

3.5.2. Identify, develop, fabricate and test new materials and/or material combinations that possess unique thermo-optical properties that would yield a low optical path distortion as well as materials that possess excellent thermal shock figure of merits.

3.6. Advanced Methods of Optical Fiber Fabrication

3.6.1. Investigate methods to draw optical fibers based on preform drawing, crucible drawing and drawing from the melt using specialty materials.

3.6.2. Conduct experiments to meet quantity, quality and dimensional specifications based upon engineering analysis and experimentation that result in production and identification of high-quality optical fiber. Must be able to operate, service and clean one custom-built 4m draw tower, one 6.5m draw tower, one 8m fiber draw tower, and associated draw equipment. Operations include drawing fiber, coating and curing with UV acrylate and other materials, maintaining a furnace, laser micrometer and drum-winder, as well as ensuring the system is operating properly, conducting routine maintenance and to handle emergencies should the system become compromised.

3.6.3. Create, evaluate and utilize high-quality quartz crucibles for glass fiberizing experiments.

3.7. Data Collection and Analysis Pertaining to Bulk and Fiber Characterization

3.7.1. Establish methods for, and quantify the performance characteristics of optical fibers.

3.7.2. Conduct engineering analysis on glass, ceramic and crystal experiments in order to evaluate materials. Operations for this task includes operating the following: DSC/SDT system, FTIR spectrometer and/or CARY UV-Vis spectrometer, XRD, EDS, Class II Violet Laser Confocal microscope, 1.3μm Class IIIa laser and a low speed saw to obtain polishing samples. User must operate equipment properly and periodically conduct maintenance.

3.7.3. Operate and service an Analect FTIR Spectrometer. Operations include those needed for measuring optical fiber loss, ensuring the system is operating properly, conducting routine maintenance, and handling emergencies when the system becomes compromised.

3.7.4. Operate and service an optical microscope. Operations include those needed for measuring core and clad dimensions, ensuring the system is operating properly, conducting routine maintenance, and handling emergencies when the system becomes compromised.

3.7.5. Operate and service a Luna Optical Backscatter Reflectometer. Operations include those needed for testing the throughput of optical fiber, determining defect or break sites within the fiber, ensuring the system is operating properly, conducting routine maintenance, and handling emergencies when the system becomes compromised.

3.7.6. Operate and service the various lasers and other light sources and detectors/power meters. Operations include those needed for measuring Optical Fiber Loss, measuring lifetime, testing the high-power handling capability of the fibers, ensuring the systems are operating properly, conducting routine maintenance, and handling emergencies when the systems becomes compromised.

3.7.7. Use LabView software to control and acquire data from various pieces of equipment. Includes running, programming, updating and configuring LabView Virtual Instruments.

3.7.8. Use Zemax optical design and simulation software. Includes running, programming, updating and configuring optical parts.

3.7.9. Must be able to use RSoft photonic design software to model optics systems and fiber designs. Includes running, programming, updating and configuring models of optical systems and fibers.

3.7.10. Conduct analysis of the fiber shape, dimension, concentricity and sample quality across a variety of fiber drawing techniques using an optical microscope.

3.8. Optical Fiber Cable Fabrication

3.8.1. Develop and refine methods for cabling “specialty” fiber optics. This includes endface preparation, polishing, connector design, connector selection, jacketing, and fiber optic protection.

3.8.2. Operate and service the Ultratec Ultrapol Polisher. Operations include those needed for polishing optical fiber, ensuring the system is operating properly, conducting routine maintenance, and handling emergencies when the system becomes compromised.

3.8.3. Operate and service the Promet FiBO Fiber interferometer. Operations include those needed for measuring polished fiber endface quality, ensuring the system is operating properly, conducting routine maintenance, and handling emergencies when the system becomes compromised.

3.9. Advanced Development of Fiber Optic Devices

3.9.1. Design and fabricate fiber optic devices such as switches, couplers, combiners and variable optical attenuators.

3.9.2. Develop and utilize fiber lasers, such as 2-micron fiber lasers. Must be able to operate fusion splicer and fiber re-coater.

3.9.3. Identify problems, test alternatives and demonstrate the ability to provide a fiber amplifier that can achieve suitable performance in bands of interest, such as 2 microns.

3.9.4. Must be able to operate and service fiber optic splicers. Operations include those needed for splicing fiber, tapering fiber, ensuring the system is operating properly, conduct routine maintenance, and handling emergencies should the system become compromised.

3.10. Development and Fabrication of Optical Waveguide Products

3.10.1. Fabricate electro-optic devices, including non-mechanical beam steerers.

3.10.2. Advance the state-of-the-art capability for the performance of optical waveguides operating above 20 GHz. This includes identifying technical issues, conducting modeling, analysis and test activities in order to yield practical designs for applications.

3.10.3. Use NRL physical vapor deposition systems, such as sputtering, atomic layer deposition, CVD and evaporation, to deposit thin films required to produce electro-optic devices. Perform a characterization of both the thin film materials and the fabricated devices.

3.10.4. Experiment and evolve techniques, compounds and characterization methods in order to synthesize functional devices for capability demonstrations.

3.10.5. Design, control and apply thin film depositions for electro optical waveguide devices to enable advanced applications.

3.11. Environmental and Vibration Testing

3.11.1. Conduct testing of optical components based on MIL-SPEC standards for temperature, humidity and vibration profiles.

3.11.2. Must be able to operate and service the Thermotron F-40-CHMV Environmental and Vibration Testing Chamber. Operations include those needed for programming and operating the Chamber, ensuring the system is operating properly, conduct routine maintenance, and handling emergencies should the system becomes compromised.

3.12. Chemical Sensing

3.12.1. Develop methods, investigate and assess capabilities utilizing fiber optics, waveguides and infrared materials for detection, classification and related chemical sensing applications.

3.13. Maintenance and Manufacturing Support for Related Research Equipment

3.13.1. Maintain, oversee and perform preventative and repair services for clean rooms established as class 100 and 1000 as needed to keep them in service. Additional clean rooms may come online during the period of performance that will also need upkeep.

3.13.2. Provide management oversight and hands on maintenance and repair of Optical Sciences environmental control systems, compressed gasses, and liquid storage facilities and delivery systems. When needed, coordinate for acquisition, installation, operations and maintenance of additional systems.

3.13.3. Operate, service, and repair laboratory Chiller equipment in order to reduce temperature variances to less than 2 deg. C.

3.13.4. Conduct daily rounds of laboratory service equipment such as desiccant air dryers, air compressors, liquid nitrogen tanks, and exhaust fume hoods in order to ensure safe operations and serviceable conditions exist.

3.13.5. Act as the coordinating source to identify, coordinate and ensure routine maintenance personnel operating within the building understand and support critical laboratory condition requirements in the execution of their facilities maintenance tasks.

3.13.6. Supervise routine invasive maintenance and new construction in order to minimize laboratory system down-time, eliminate damage or contamination of optical science's laboratory equipment. Review routine construction/renovation plans to mitigate laboratory condition degrades or delays during construction periods or over the life-cycle of the activity. Make expeditious repairs when needed during and after work hours. Acquire parts, tooling, and materials as needed to minimize system down times for all repairs and upgrade initiatives.

3.13.7. Conduct revolving inventory, inspection, documentation and safety compliance for additional "non-complex", equipage such as ventilation systems, temperature controls, entry and exit environmental seals, and isolation systems from main work spaces.

3.14. Optical Systems Algorithm Development

3.14.1. Assist in the development of algorithms that filter large volumes of data in real time to identify targeted information by assessing, spatial, temporal, spectral, waveform, and other specific data property characteristics. Algorithm development target areas include: Laser-based sensor implementations, chemical or biological threat detection, threat weapon system, IR countermeasures, detection, alerting, locating, and classification from ground sea-based, ground land-based and airborne platforms. Provide algorithm development for countermeasures and countermeasure effectiveness evaluation for real-time responses. Support efforts for the investigation and assessment of related foreign technical material acquisition and exploitation.

3.15. Aircraft Test Platform Support

3.15.1. Provide a fixed wing flight platform capable of being task configured with alternative optical components, sensors, systems for flight testing, flight data collection, flight demonstration with both real time experiment feedback. The platform should be capable of flight in instrumented flight rules during administration transit to test locations and visual flight rules during operational testing. An additional task benefit would include operational testing during instrument flight conditions while in the test area.

3.15.2. Provide or obtain all required FAA certifications as needed to allow Normal, Prohibited and Experimental category flights throughout the continental US in order to capture performance capabilities over various surface features, environmental conditions and flight vehicle scenarios. Aircraft may be certified as normal, prohibited or experimental but the objective task is to retain a normal category while allowing NRL employees to operate, observe and control in flight experimental and data collection equipage.

3.15.3. Provide an information and image link when within visual range between the airborne platform and the ground facility. The system should be capable of relaying critical test information between the aircraft and ground station.

3.15.4. On occasion provide two flight vehicles in order to evaluate, demonstrate or operate equipment that must perform missions requiring a target air vehicle and a sensor platform vehicle. (Aircraft do not require speeds in excess of FAA maximum speeds allowed for the operating areas. Aircraft experimentation speeds are

anticipated to be between 110 and 250 knots with flights below 20,000 feet and without aerobatic maneuvering.)

3.15.5. Provide a flight crew (at least one but not greater than two) and equipment support personnel (up to two as needed) capable of operating for up to one month at continental US deployment sites.

Note: Proposers should provide equipment and personnel support costs as an individually captured cost using the following sample parameters:

Flights conducted are 1.5-2.0 hours with testing flown within visual range of NRL's Chesapeake Beach Detachment facilities. Cost should capture a yearly flight hour program of 120 hours, with no more than three fly days per week, over one month for a total of five such efforts per year. NRL will need access to the aircraft equipage each day in order to adjust or calibrate systems. Cost should identify rates for flight hours by aircraft type, crew hours/ pilot (assume only one pilot is needed unless the aircraft being proposed requires a crew of two) Identify both flying and ground time aircraft and labor cost). Do not include any engineering costs for the installation and certification of the equipage. Routine maintenance and aircraft repairs will not be covered by the government. Anticipate a contract "Option" will be initiated for each flight project that details overall cost allowance and reimbursement, such as transit costs, lodging, per diem, FAA engineering approvals, system installation, data collection, storage and transmission tailoring.

3.16. Program Management and Government Range Coordination

3.16.1. Provide personnel management and oversight of contractor employees' efforts to ensure the government research objectives will be satisfied.

3.16.2. Provide management support by submitting monthly labor hours, financial summaries, and activity reports.

3.16.3. Monitor non-routine emergent facility maintenance requirements such as overtime labor authorization, replacement parts authorization, and expedite repairs to minimize laboratory down-time.

3.16.4. Assist in the coordination of range testing to include scheduling, safety certification requirements, communication administration, test briefings/reviews, and asset employment (such as weapons, platforms, emulations, and maneuvers).

3.17. Contract Data Requirements List

3.17.1. A001 – Financial Status Report/Cost Report

3.17.1.1. Provide monthly Financial Status Report/Cost Report on a monthly basis reporting all labor expenditures (person, hours worked, cost); materials (description, cost, use); and travel (traveler's name, date, purpose and cost) on the 15th of each month.

3.17.2. A002 – Labor Hour Report

3.17.2.1. Provide monthly labor hour report (people and number of hours worked for the prior month) by the 10th of each month.

3.17.3. A003 – Quarterly Progress Report

3.17.3.1. Provide quarterly progress report every 90 days.

3.17.4. A004 – Task Technical Reports

3.17.4.1. Provide task technical reports as required.

4. Security Requirements

All Contractor personnel who require NRL base access or access to NRL unclassified material and/or unclassified systems shall possess a favorably completed DoD Tier 3 investigation. Contractors who require access to Secret material must have, at a minimum, a favorably completed DoD Tier 3 investigation and final DoD granted Secret security clearance the time of proposal submission. Contractor personnel requiring Top Secret/SCI access must have, at a minimum a favorably completed DoD Tier 5 investigation with eligibility of SCI at the time of proposal submission.

All contractors (including subcontractors) identified in the Statement of Work shall supplement their current security practices by requiring any personnel involved in executing the contract to complete. Government-sponsored and administered Operations Security (OPSEC) training, OPSE-1301 and any OPSEC guidance that may pertain to the project.

Contractor personnel who possess a DoD Interim Secret security clearance may only work on unclassified tasks, specifically tasks 3.1, 3.2, 3.3, 3.4, 3.10, 3.13, 3.14, and 3.15 outlined in this SOW until their final Secret DoD granted personnel security clearance is granted.