DEPARTMENT OF THE AIR FORCE (DAF)
22.4 Small Business Innovation Research (SBIR) Direct to Phase II (D2P2)
Proposal Submission Instructions
Air Force Release 3 (AR3)
Amendment 4

This Amendment accomplishes the following revisions to this solicitation:

1) Oasis is added to the list of companies that may handle proposals for administrative purposes only in Section IV of this solicitation.

All other solicitation provisions remain unchanged as a result of this amendment.

DEPARTMENT OF THE AIR FORCE (DAF)
22.4 Small Business Innovation Research (SBIR) Direct to Phase II (D2P2)
Proposal Submission Instructions
Air Force Release 3 (AR3)
Amendment 3

This Amendment accomplishes the following revisions to this solicitation:

1) Topic AF224-D021. The description for Phase I is changed, with language deleted and added. The following language was deleted:
    a. ~~IVHMS and Luna Acuity LS have already been developed as independently funded systems. Documentation demonstrating the IVHMS and Acuity LS device has passed HH-60W environmental requirements shall be supplied to help determine if Phase I feasibility has been met.~~
    b. The above language is replaced with:
        The applicant should be able to demonstrate that it has competency with software development for health monitoring systems (e.g. IVHMS) interfacing with other devices/systems (e.g. previous software development and/or integration projects.)

All other solicitation provisions remain unchanged as a result of this amendment.

DEPARTMENT OF THE AIR FORCE (DAF)
22.4 Small Business Innovation Research (SBIR) Direct to Phase II (D2P2)
Proposal Submission Instructions
Air Force Release 3 (AR3)
Amendment 2

This Amendment accomplishes the following revisions to this solicitation:

1) Topic AF224-D008. The description for topic AF224-D008 is changed, with language being deleted and added. The following language was deleted:
    a. "cannot keep up with DoD production demand required to replenish depleted inventories as a result of recent operations in Syria and is therefore affecting the production rate of critical weapon systems"
    b. And replaced with "cannot keep up with expected DoD production demand."

2) Topic AF224-D019. A colon was added in Line 2 of the Phase I description.

All other solicitation provisions remain unchanged as a result of this amendment.

DEPARTMENT OF THE AIR FORCE (DAF)
22.4 Small Business Innovation Research (SBIR) Direct to Phase II (D2P2)
Proposal Submission Instructions
Air Force Release 3 (AR3)
Amendment 1

This Amendment accomplishes the following revisions to this solicitation:

1) The TPOC information associated with topics SF224-D006 and SF224-D007 is changed.

All other solicitation provisions remain unchanged as a result of this amendment.

DEPARTMENT OF THE AIR FORCE (DAF)

22.4 Small Business Innovation Research (SBIR) Direct to Phase II (D2P2)
Proposal Submission Instructions
Air Force Release 3 (AR3)

The DAF intends these proposal submission instructions to clarify the Department of Defense (DoD) Broad Agency Announcement (BAA) as it applies to the topics solicited herein. **Firms must ensure proposals meet all requirements of the 22.4 SBIR BAA posted on the DoD SBIR/STTR Innovation Portal (DSIP) at the proposal submission deadline date/time.**

The following dates are applicable to this solicitation:

Release Dates
Pre-Release: 11 August 2022 **Open:** 1 September 2022 **Close:** 29 September 2022 at 12:00pm ET **Question & Answer Period Close:** 15 September 2022 at 12:00pm ET

Chart 1- Topic Index

Topic Number(s)	**Topic Title**	**Maximum Price**	**Maximum Duration (in months)**	**Vol 2 Technical Volume Page Limit**
AF224-D001	Prediction of human tissue heating due to near-field RF exposure	$1,250,000	24	50
AF224-D002	Virtual Reality Laser Dazzle Demonstrator	$1,250,000	24	50
AF224-D003	Actionable Insights from Human Performance and Training Data Sets for Proficiency-Based Training	$1,250,000	24	50
SF224-D004	Mixed Reality for Space Operations	$1,250,000	24	50
SF224-D006	Persistent Wide-field Regional Geosynchonous Belt Surveillance	$1,250,000	24	50
SF224-D007	24/7 geosynchonous belt Surveillance using Passive Radio Frequency	$1,250,000	24	50
AF224-D008	Continuous Flow Recrystallization of Nitramines	$1,250,000	24	50
AF224-D009	Dye-containing Sol-gel Glass Optical Elements	$1,250,000	24	50

AF224-D010	C-Band Reflectometer	$1,250,000	24	50
AF224-D011	VHF Embedded Resistive Materials Measurement System	$1,250,000	24	50
AF224-D012	Durable, Extreme Temperatures and Environments Rope Seals	$1,250,000	24	50
SF224-D013	Re-Usable High Area Ratio Nozzles for 5000 lbf Thrust Rotating Detonation Rocket Engines	$1,250,000	24	50
AF224-D014	Development of New Oxidation Resistant Coating Technology for Refractory Additively Manufactured (AM) Components	$1,250,000	24	50
AF224-D015	Large Acreage Composite Bonded Joint Strength Non-Destructive Inspection Method	$1,250,000	24	50
AF224-D016	ROC STAR (ROcket Cargo System Technology And Research)	$1,250,000	24	50
AF224-D017	STABILIZE (Stabilization of Teu containers for Air-drop capaBilities and Internal LoadIng optimiZation Experiments)	$1,250,000	24	50
AF224-D018	Aerospace-Capable Pressure Sensitive Adhesives for Difficult-to-Bond Substrates	$1,250,000	24	50
AF224-D019	Microstructural Fragmentation Control in Penetrating Munitions	$1,250,000	24	50
AF224-D020	Shape Stable Segmented Nozzles for Scramjets	$1,250,000	24	50
AF224-D021	Demonstration of Corrosion Monitoring Capability for the HH-60W	$1,250,000	24	50
AF224-D022	Scale-Up of High-Pressure Chemical Vapor Deposition for Non-Eroding Materials	$1,250,000	24	50
AF224-D023	Manufacturing of All-Weather Non-Eroding Nosetip for Ballistic Reentry	$1,250,000	24	50
SF224-D024	Enabling Materials and Technologies for Surviving Landing Area Rocket Plume Interactions	$1,250,000	24	50
AF224-D025	Rapid Materials Development & Testing for High Speed Propulsion Systems (scramjet components)	$1,250,000	24	50

SF224-D026	Photonic Integrated Circuits for Optical Communications and PNT	$1,250,000	24	50
SF224-D027	Additive Manufacturing of Imaging Cubesat with Lightweight Radiation Hardened Enclosure	$1,250,000	24	50
AF224-D028	Low Noise Magnetic Materials for Next-Generation Brain-Machine Interfacing	$1,250,000	24	50
AF224-D029	Epitaxial Growth of Galium Oxide for Next-Gen Microwave Electronics	$1,250,000	24	50
AF224-D031	Fog and Edge Computing	$1,250,000	24	50
AF224-D033	Improving Transparency of Object Tracking Technology for Intelligence Analysis	$1,250,000	24	50
SF224-D034	Cis-lunar and X-GEO Space Weather Model Development	$1,250,000	24	50
SF224-D035	Ultra-Lightweight Materials for Space Structures through Novel Geometric Design	$1,250,000	24	50
AF224-D036	Environmental Performance Prediction of Ceramic Matrix Composites in Extreme Environments	$1,250,000	24	50

Complete proposals **must** be prepared and submitted via https://www.dodsbirsttr.mil/submissions/ (DSIP) on or before the date published in the DoD 22.4 SBIR BAA. Offerors are responsible for ensuring proposals comply with the requirements in the most current version of this instruction at the proposal submission deadline date/time.

The AF recommends early submission, as computer traffic gets heavy near the proposal submission date/time and could slow down the system. **Do not wait until the last minute.** The AF is not responsible for incomplete proposal submission due to system lag or inaccessibility. Please ensure contact information, i.e., names/phone numbers/email addresses, in the proposal is current and accurate. The AF is not responsible for ensuring notifications are received by firms for which this information changes after proposal submission without proper notification. Changes of this nature shall be sent to the Air Force SBIR/STTR One Help Desk.

Please ensure all e-mail addresses listed in the proposal are current and accurate. The AF is not responsible for ensuring notifications are received by firms changing mailing address/e-mail address/company points of contact after proposal submission without proper notification to the AF. **If changes occur to the company mail or email addresses or points of contact after proposal submission, the information must be provided to the AF SBIR/STTR One Help Desk.** The message shall include the subject line, “22.4 Address Change”.

Points of Contact:

- General information related to the AF SBIR/STTR program and proposal preparation instructions, contact the AF SBIR/STTR One Help Desk at usaf.team@afsbirsttr.us.
- Questions regarding the DSIP electronic submission system, contact the DoD SBIR/STTR Help Desk at dodsbirsupport@reisystems.com.
- For technical questions about the topics during the pre-announcement and open period, please reference the DoD 22.4 SBIR BAA.
- Air Force SBIR/STTR Contracting Officer (CO):
  Mr. Daniel Brewer, Daniel.Brewer.13@us.af.mil

General information related to the AF Small Business Program can be found at the AF Small Business website, http://www.airforcesmallbiz.af.mil/. The site contains information related to contracting opportunities within the AF, as well as business information and upcoming outreach events. Other informative sites include those for the Small Business Administration (SBA), www.sba.gov, and the Procurement Technical Assistance Centers (PTACs), http://www.aptacus.us.org. These centers provide Government contracting assistance and guidance to small businesses, generally at no cost.

I. DIRECT TO PHASE II

15 U.S.C. §638 (cc), as amended by NDAA FY2012, Sec. 5106, and further amended by NDAA FY2019, Sec. 854, PILOT TO ALLOW PHASE FLEXIBILITY, allows DoD to make a SBIR Phase II award to a small business concern with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project. AF is conducting a "Direct to Phase II" implementation of this authority for these 22.4 SBIR topics and does not guarantee D2P2 opportunities will be offered in future solicitation. Each eligible topic requires documentation to determine whether the feasibility requirement described in the Phase I section of the topic has been met.

II. INTRODUCTION: Direct to Phase II proposals must follow the steps outlined below:

1. Offerors must create a Cover Sheet in DSIP; follow the Cover Sheet instructions provided in the DoD SBIR Program BAA.Offerors must provide documentation satisfying the Phase I feasibility requirement* to be included in the Phase II proposal. Offerors must demonstrate completion of research and development through means other than the SBIR/STTR Programs to establish the feasibility of the proposed Phase II effort based on the criteria outlined in the topic description.
2. Offerors must submit D2P2 proposals using the instructions below.

*NOTE: AF will not consider the offeror's D2P2 proposal if the offeror fails to demonstrate technical merit and feasibility have been established. It will also not be considered if it fails to demonstrate the feasibility effort was substantially performed by the offeror and/or the principal investigator (PI). Refer to the topics' Phase I descriptions for minimum requirements needed to demonstrate feasibility. Feasibility documentation MUST NOT be solely based on work performed under prior or on-going Federally funded SBIR and/or STTR work.

II. PROPOSAL SUBMISSION

The complete proposal must be submitted electronically through DSIP. Ensure the complete technical volume and additional cost volume information is included in this sole submission.

The preferred submission format is Portable Document Format (.pdf). Graphics must be distinguishable in black and white. **VIRUS-CHECK ALL SUBMISSIONS.**

Firms shall register in the System for Award Management (SAM) at https://www.sam.gov/, to be eligible for proposal acceptance. Follow instructions located in SAM to obtain a Commercial and Government Entity (CAGE) code and Unique Entity Identifier (UEI) number. Firms shall also verify "Purpose of Registration" is set to "I want to be able to bid on federal contracts or other procurement opportunities. I also want to be able to apply for grants, loans, and other financial assistance programs", NOT "I only want to apply for federal assistance opportunities like grants, loans, and other financial assistance programs." Firms registered to compete for federal assistance opportunities only at the time of proposal submission will not be considered for award. Addresses must be consistent between the proposal and SAM at award. Previously registered firms are advised to access SAM to ensure all company data is current before proposal submission and, if selected, award.

Complete proposals must include all of the following:
Volume 1: DoD Proposal Cover Sheet
Volume 2: Technical Volume
Volume 3: Cost Volume
Volume 4: Company Commercialization Report
Volume 5: Supporting Documents, e.g., SBIR/STTR Environment, Safety and Occupational Health (ESOH) Questionnaire; DoD Form 2345, Militarily Critical Data Agreement (if applicable); etc.
Volume 6: Fraud, Waste, and Abuse Training Completion

Phase II proposals require a comprehensive, detailed description of the proposed effort. D AF D2P2 efforts are to be proposed in accordance with the information in these instructions and Chart 1 (above). Commercial and military potential of the technology under development is extremely important. Proposals emphasizing dual-use applications and commercial exploitation of resulting technologies are sought.

All D2P2 research or research and development (R/R&D) must be performed by the small business and its team members in the United States, as defined in the DoD SBIR 22.4 BAA. The Principal Investigator's (PI's) primary employment must be with the small business concern at the time of awardand during the entire period of performance. Primary employment means more than one-half the PI's time is spent in the small business' employ. This precludes full-time employment with another entity.

Knowingly and willfully making false, fictitious, or fraudulent statements or representations may be a felony under18 U.S.C. Section 1001, punishable by a fine up to $250,000, up to five years in prison, or both.

Please note the FWA Training must be completed prior to proposal submission. When training is complete and certified, DSIP will indicate completion of the Volume 6 requirement. The proposal cannot be submitted until the training is complete. The AF recommends completing submission early, as site traffic is heavy prior to solicitation close, causing system lag. **Do not wait until the last minute.** The AF will not be responsible for proposals not completely submitted prior to the deadline due to system inaccessibility unless advised by DoD. The AF will not accept alternative means of submission outside of DSIP.

III. PHASE II PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

See Chart 1 (above). Advocacy letters, if any; SBIR/STTR Environment, Safety and Occupational Health (ESOH) Questionnaire; and the additional cost proposal itemized list, 17.a-j, should be included in Volume 5, Supporting Documentation. This documentation and the Cover Sheet will not count toward the technical volume limits. There is no set format requirement for white papers or slide decks, if required.

Complete the SBIR/STTR Environment, Safety, and Occupational Health (ESOH) Questionnaire found at:https://www.afsbirsttr.af.mil/Portals/60/Pages/Overview/Air%20Force%20SBIR_STTR%20Environment%20Safety%20and%20Occupational%20Health_ESOH_Oct%202021_JSH.pdf . Include the completed document in the proposal under Volume 5, Other Documents.

A. Proposal Requirements. A Phase II proposal shall provide sufficient information to persuade the AF the proposed technology advancement represents an innovative solution to the scientific or engineering problem worthy of support under the stated criteria. All sections below count toward the page limit, unless otherwise specified.

B. Proprietary Information. Information constituting a trade secret, commercial/financial information, confidential personal information, or data affecting National Security must be clearly marked. It shall be treated in confidence to the extent permitted by law. Be advised, in the event of proposal selection, the Work Plan will be incorporated into the resulting contract by reference. Therefore, DO NOT INCLUDE PROPRIETARY INFORMATION in the work plan. See the DoD BAA regarding proprietary information marking.

C. General Content. Proposals should be direct, concise, and informative. Type shall be no smaller than 11-point on standard 8 ½ X 11 paper, with one-inch margins and pages consecutivelynumbered. Offerors are discouraged from including promotional and non-programmatic items. If included, such material will count toward the page limit.

D. Proposal Format. The technical proposal includes all items listed below in the order provided.

(1) **Proposal Cover Sheet:** Complete the proposal Cover Sheet in accordance with the instructions provided via DSIP. The technical abstract should include a brief description of the program objective(s), a description of the effort, anticipated benefits and commercial applications of the proposed research, and a list of key words/terms. The technical abstract of each successful proposal will be submitted to the Office of the Secretary of Defense (OSD) for publication and, therefore, must not contain proprietary or classified information. The term "Component" on the Cover Sheet refers to the AF organization requesting the Phase II proposal.

(2) **Table of Contents:** A table of contents should be located immediately after the Cover Sheet.

(3) **Glossary:** Include a glossary of acronyms and abbreviations used in the proposal.

(4) **<u>Milestone Identification</u>:** Include a program schedule with all key milestones identified.

(5) **<u>Identification and Significance of the Problem or Opportunity</u>:** Briefly reference thespecific technical problem/opportunity to be pursued under this effort.

(6) **<u>Phase II Technical Objectives</u>:** Detail the specific objectives of the Phase II work and describe the technical approach and methods to be used in meeting these objects. The proposal should also include an assessment of the potential commercial application for eachobjective.

(7) **<u>Work Plan</u>:** The work plan shall be a separate and distinct part of the proposal package, using a page break to divide it from the technical proposal. It must contain a summary description of the technical methodology and task description in broad enough detail to provide contractual flexibility. The following is the recommended format for the work plan; begin this section on a new page. **DO NOT include proprietary information.**

a) <u>1.0 – Objective</u>: This section is intended to provide a brief overview of thespecialty area. It should explain the purpose and expected outcome.

b) <u>2.0 – Scope</u>: This section should provide a concise description of the work to beaccomplished, including the technology area to be investigated, goals, and majormilestones. The key elements of this section are task development and deliverables, i.e., the anticipated end result and/or the effort's product. This section must also be consistent with the information in Section 4.0 below.

c) <u>3.0 – Background</u>: The offeror shall identify appropriate specifications, standards, andother documents applicable to the effort. This section includes information or explanation for, and/or constraints to, understanding requirements. It may include relationships to previous, current, and/or future operations. It may also include techniques previously determined ineffective.

d) <u>4.0 – Task/Technical Requirements</u>: The detailed individual task descriptions for accomplishing proposed work are considered to be legally binding on the offeror.Therefore, it must be developed in an orderly progression with sufficient detail to establish overall program requirements and goals. The work effort must be segregated into major tasks and identified in separately numbered paragraphs.

Each numbered major task should delineate the work to be performed by subtask. The work plan MUST contain every task to be accomplished in definite, realistic, and clearlystated terms. Use "shall" whenever the work plan expresses a binding provision. Use "should" or "may" to express a declaration or purpose. Use "will" when no contractor requirement is involved, i.e., "... power will be supplied by the Government."

(8) **<u>Deliverables</u>:** Include a section clearly describing the specific sample/prototype hardware/ software to be delivered, as well as data deliverables, schedules, and

quantities. Be aware of the possible requirement for unique item identification IAW DFARS 252.211-7003, ItemIdentification and Valuation, for hardware. If hardware/ software will be developed but not delivered, provide an explanation. At a minimum, the following reports will be required under ALL Phase II contracts.

a) Scientific and Technical Reports: Rights in technical data, including software, developed under the terms of any contract resulting from a SBIR Announcement generally remain with the contractor. The Government obtains SBIR/STTR data rights in all data developed or generated under the SBIR/STTR contract for a period of 20 years, commencing at contract award. Upon expiration of the 20-year SBIR/STTR license, the Government has Government purpose rights to the SBIR data.

   i. Final Report: The draft is due 30 days after Phase II technical effort. The first page of the final report will be a single-page project summary, identifying the work's purpose, providing a brief description of the effort accomplished, and listing potential result applications. The summary may be published by DoD. Therefore, it must not contain any proprietary or classified information. The

   remainder of the report should contain details of project objectives met, work completed, results obtained, and technical feasibility estimates.

   ii. Status Reports: Status reports are due quarterly at a minimum.

   iii. Small Business Online Success Stories: Success Story submissions are dueat the end of the technical effort via http://launchstories.org. If selected, referto the Contract Data Requirements List (CDRL) in the contract for submission instructions.

b) Additional Reporting: AF may require additional reporting documentationincluding:
   i. Software documentation and users' manuals;
   ii. Engineering drawings;
   iii. Operation and maintenance documentation
   iv. Safety hazard analysis when the project will result in partial ortotal development and delivery of hardware; and
   v. Updates to the commercialization results.

(9) **Related Work:** Describe significant activities directly related to the proposed effort, including any previous programs conducted by the Principal Investigator, proposing firm, consultants, or others, and their application to the proposed project. Also list any reviewersproviding comments regarding the offeror's knowledge of the state-of-the-art in the specificapproach proposed.

(10) Company Commercialization Report (CCR)/Commercialization Potential:

a) Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD SBIR Program BAA for full details on this requirement. Information contained in the CCR will not be considered by the Air Force during proposal evaluations.

b) The DoD requires a commercialization plan be submitted with the Phase II proposal,specifically addressing the following questions:
   i. What is the first planned product to incorporate the proposed technology?
   ii. Who are the probable customers, and what is the estimated market size?
   iii. How much money is needed to bring this technology to market and how will it be raised?
   iv. Does your firm have the necessary marketing expertise and, if not, how will your firm compensate?
   v. Who are the probable competitors, and what price/quality advantage is anticipated by your firm.

c) The commercialization strategy plan should briefly describe the commercializationpotential for the proposed project's anticipated results, as well as plans to exploit it.Commercial potential is evidenced by:

   i. The existence of private sector or non-SBIR/STTR Governmentalfunding sources demonstrating commitment to Phase II efforts/results.
   ii. The existence of Phase III follow-on commitments for the research subject.
   iii. The presence of other indicators of commercial technology potential,including the firm's commercialization strategy.

d) If awarded a D2P2, the contractor is required to periodically update the commercialization results of the project via SBA. These updates will be required at completion of the effort, and subsequently when the contractor submits a new SBIR/STTR proposal to DoD. Firms not submitting a new proposal to DoD will be requested to provide updates annually after the D2P2 completion.

(11)**Military Applications:** Briefly describe the existing/potential military requirement and the military potential of the SBIR/STTR Phase II results. Identify the DoD agency/organization most likely to benefit from the project. State if any DoD agency has expressed interest in, or commitment to, a non-SBIR, Federally funded Phase III effort. This section should include not more than one to two paragraphs. Include agency point of contact names and telephone numbers.

(12)**Relationship with Future R/R&D Efforts**:
   i. State the anticipated results of the proposed approach, specifically addressing plans for Phase III, if any.
   ii. Discuss the significance of the D2P2 effort in providing a basis for the Phase III R/R&D effort, if planned.

E. **Key Personnel:** In the technical volume, identify all key personnel involved in the project. Include information directly related to education, experience, and citizenship. Atechnical resume for the Principal Investigator, including publications, if any, must also be included. Concise technical resumes for subcontractors and consultants, if any, are also useful. Identify all non-U.S. citizens expected to be involved in the project as direct employees, subcontractors, or consultants. For these individuals, in addition to technical resumes, please provide countries of origin, type of visas or work permits held, and identify the tasks they are anticipated to perform.

Foreign Nationals (also known as Foreign Persons) means any person who is NOT:

a. a citizen or national of the United States; or
b. a lawful permanent resident; or
c. a protected individual as defined by 8 U.S.C. § 1324b

ALL offerors proposing to use foreign nationals MUST follow the DoD 22.4 BAA and disclose this information regardless of whether the topic is subject to ITAR restrictions.

When the topic area is subject to export control, these individuals, if permitted to participate, are limited to work in the public domain. Further, tasks assigned must not becapable of assimilation into an understanding of the project's overall objectives. This prevents foreign citizens from acting in key positions, such as Principal Investigator, Senior Engineer, etc. Additional information may be requested during negotiations in order to verify foreign citizens' eligibility to perform on a contract awarded under this BAA.

The following will apply to all projects with military or dual-use applications developingbeyond fundamental research (basic and applied research ordinarily published and sharedbroadly within the scientific community):

(1) The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, andthe Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of (including deemed exports) hardware, technical data,and software, or for the provision of technical assistance.
(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where thework is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technologies,including technical data or software.
(3) The Contractor shall be responsible for all regulatory record keeping requirementsassociated with the use of licenses and license exemptions/exceptions.
(4) The Contractor shall be responsible for ensuring that these provisions apply to its subcontractors.

F. **<u>Facilities/Equipment</u>:** Describe instrumentation and physical facilities necessary and available to carry out the D2P2 effort. Justify equipment to be purchased (detail in cost proposal). State whether proposed performance locations meet environmental laws andregulations of Federal, state, and local Governments for, but not limited to, airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulkwaste disposal practices, and handling and storage of toxic and hazardous materials.

G. **Consultants/Subcontractors**: Private companies, consultants, or universities may be involved in the project. All should be described in detail and included in the cost proposal. In accordance with the Small Business Administration (SBA) SBIR PolicyDirective, a minimum of 50% of the R/R&D must be performed by the proposing firm, unless otherwise approved in writing by the Contracting Officer. Signed copies of all consultant or subcontractor letters of intent must be attached to the proposal. These letters should briefly state the contribution or expertise being provided. Include statements of work and detailed cost proposals. Include information regarding consultant or subcontractor unique qualifications. Subcontract copies and supporting documents do not count against the Phase II page limit. Identify any subcontract/consultant foreign citizens per E above.

H. Prior, Current, or Pending Support of Similar Proposals or Awards:
WARNING: While it is permissible, with proper notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work forconsideration under numerous Federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. Any potential for this situation must be disclosed to the solicitation agency(ies) before award. If a proposal submitted in response to BAA is substantially the same as another proposal previously, currently, or in process of being funded by another Federal agency/DoD Component or the same DoD Component, the company must so indicate on the Cover Sheet and provide the following:

a) The name and address of the Federal agency(ies) or DoD Component(s) towhich proposals were or will be submitted, or from which an awarded is expected or has been received;
b) The proposal submission or award dates;
c) The proposal title;
d) The PI's name and title for each proposal submitted or award received; and
e) Solicitation(s) title, number, and date under which the proposal was or will besubmitted, or under which an award is expected or has been received.
f) If award was received, provide the contract number.
g) Specify the applicable topics for each SBIR proposal submitted or award received.

NOTE: If this section does not apply, state in the proposal, "No prior, current, or pending support for proposed work."

I. **Cost Proposal:** A detailed cost proposal must be submitted. Cost proposal information will be treated as proprietary. Proposed costs must be provided by both individual cost element and contractor fiscal year (FY) in sufficient detail to determine the basis for estimates, as well as the purpose, necessity, and reasonableness of each. This information will expedite award if the proposal is selected. Generally, firm fixed price contracts are appropriate for Phase II awards. In accordance with the SBA SBIR/STTR Policy Directive, Phase II contracts must include profit or fee.

Cost proposal attachments do not count toward proposal page limitations. The cost proposalincludes:

a) **Direct Labor:** Identify key personnel by name, if possible, and labor category, if not. Direct labor hours, labor overhead, and/or fringe benefits, and actual hourly rates for each individual are also necessary for the CO to determine whether these hours, fringe rates, and hourly rates are fair and reasonable.

b) **Direct Cost Materials:** Costs for materials, parts, and supplies must be justified and supported. Provide an itemized list of types, quantities, prices, and, where appropriate, purpose. If computer or software purchases are planned, detailed information such as manufacturer, price quotes, proposed use, and support for theneed will be required.

c) **Other Direct Costs:** This includes specialized services such as machining or milling, special test/analysis, and costs for temporary use/lease of specialized facilities/ equipment. Provide usage (hours) expected, rates, and sources, as well as brief discussion concerning the purpose and justification. Proposals including leased hardware must include an adequate lease versus purchase rationale.

d) **Special Tooling, Special Test Equipment, and Material:** The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness to the work proposed. Special tooling and special test equipment purchases must, in the CO's opinion, be advantageous to the Government and relate directly to the effort. These toolings or equipment should not be of a type that an offeror would otherwise possess in the normal course of business. These may include such items as innovative instrumentation and/or automatic test equipment.

e) **Subcontracts:** Subcontract costs must be supported with copies of subcontract agreements. Agreement documents must adequately describe the work to be performed and cost bases. The agreement document should include a SOW, assignedpersonnel, hours and rates, materials (if any), and proposed travel (if any). A letter from the subcontractor agreeing to perform a task or tasks at a fixed price is not considered sufficient. The proposed total of all consultant fees, facility leases or usage fees, and other subcontract or purchase agreements may not exceed one-half of the total contract price, unless otherwise approved in writing by the Contracting Officer.

The prime contractor must accomplish price analysis, including reasonableness, of the proposed subcontractor costs. If based on comparison with prior efforts, identify the basis upon which the prior prices were determined reasonable. If price analysis techniques are inadequate or the FAR requires subcontractor cost or pricing data submission, provide a cost analysis. Cost analysis includes but is not limited to, consideration of materials, labor, travel, other direct costs, and proposed profit rates.

f) **Consultants:** For each consultant, provide a separate agreement letter briefly stating the service to be provided, hours required, and hourly rate, as well as ashort, concise resume.

g) **Travel:** Each effort should include, at a minimum, a kickoff or interim meeting. Travel costs must be justified as required for the effort. Include destinations, numberof trips, number of travelers per trip, airfare, per diem, lodging, ground transportation, etc. Per Diem and lodging rates may be found in the Joint Travel Regulation (JTR),Volume 2, www.defensetravel.dod.mil.

h) **Indirect Costs:** Indicate proposed rates' bases, e.g., budgeted/actual rates per FY, etc. The proposal should identify the specific rates used and allocation bases to which they are applied. Do not propose composite rates; proposed rates and applications per FY throughout the anticipated performance period are required.

i) **Non-SBIR Governmental/Private Investment:** Non-SBIR Governmental and/or private investment is allowed. However, it is not required, nor will it be a proposal evaluation factor.

j) **DD Form 2345:** For proposals submitted under export-controlled topics (either ITAR or EAR), a certified DD Form 2345, Militarily Critical Technical Data Agreement, or evidence of application submission, must be included. The form, instructions, and FAQs may be found at the US/Canada Joint Certification Program website, http://www.dlis.dla.mil/jcp/. DD Form 2345 approval will be verified if theproposal is selected for award.

J. **Feasibility Documentation –** Should be uploaded to Volume 5, Supporting Documents

a. Offerors must adequately document completion of the Phase I feasibility requirement*. Offerors must demonstrate completion of R/R&D through means not solely based on previous efforts under the SBIR/STTR Programs to establish Phase II proposal feasibility based on criteria provided in the D2P2 topic descriptions. Phase II proposals require a comprehensive, detailed effort description. Proposals should demonstrate sufficient technical progress or problem-solving results to warrant more extensive RDT&E. Developing technologies with commercial and military potential is extremely important. Particularly, AF is seeking proposals emphasizing technologies' dual-use applications and commercialization.

b. * NOTE: The offeror shall provide information to enable the agency to make the 15 U.S.C. 638(cc) determination of scientific and technical feasibility and merit. Offerors are required to provide information demonstrating scientific and technical merit and feasibility has been established as part of the Technical Volume described in Section 9.7. The AF will not review the Phase II proposals if it is determined the offeror 1) fails to demonstrate technical merit and feasibility are established or 2) the feasibility documentation does not support substantial performance by the offeror and/or the PI. Refer to the Phase I description within the topic to review the minimum requirements needed to demonstrate scientific and technical feasibility. **Feasibility documentation MUST NOT be solely based on work performed under prior or ongoing Federally-funded SBIR or STTR work.**

c. If appropriate, include a reference or works cited list as the last page.

d. Feasibility efforts detailed must have been substantially performed by the offeror and/or the PI. If technology in the feasibility documentation is subject to intellectual property (IP) rights, the offeror must provide IP rights assertions. Additionally, proposers shall provide a short summary for each item asserted with less than unlimited rights describing restriction's nature and intellectual property intended for use in the proposed research. Please see DoD SBIR 22.4 BAA for technical data rights information.

e. DO NOT INCLUDE marketing material. Marketing material will NOT be evaluated andWILL be redacted.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The Air Force does not participate in the Discretionary Technical and Business Assistance (TABA) Program. Proposals in response to Air Force topics should not include TABA.

IV. METHOD OF SELECTION AND EVALUATION CRITERIA

A. Introduction: D2P2 proposals are evaluated on a competitive basis by subject matter expert (SME)scientists, engineers, or other technical personnel. Throughout evaluation, selection, and award, confidential proposal and evaluation information will be protected to the greatest extent possible. D2P2 proposals will be disqualified and not evaluated if the Phase I equivalency documentationdoes not establish the proposed technical approach's feasibility and technical merit.

B. Evaluation Criteria: Phase II proposals will be reviewed for overall merit based on the criteria discussed in the DoD 22.4 BAA.

NOTE: Restrictive notices notwithstanding, proposals may be handled for administrative purposes only, by support contractors: APEX, Peerless Technologies, Engineering Services Network, HPC- COM, Mile Two, REI Systems, MacB (an Alion company), Oasis, and Infinite Management Solutions. In addition, only Government employees and technical personnel from Federally Funded Research and Development Centers (FFRDCs) MITRE and Aerospace Corporations working under contract to provide technical support to AF Life Cycle Management Center and Space Force may evaluate proposals. All support contractors are bound by appropriate non-disclosure agreements. **Contact the AF SBIR/STTR Contracting Officers with concerns about any of these contractors**.

V. CERTIFICATIONS

In addition to the standard Federal and DoD procurement certifications, the SBA SBIR/STTR Policy Directive requires the collection of certain information from firms at the time of award and during the award life cycle. Each firm must provide these certifications at the time of proposal submission, prior to receiving 50% of the total award amount, and prior to final payment.

VI. FEEDBACK

The PI and Corporate Official indicated on the Proposal Cover Sheet will be notified by email regarding proposal selection or non-selection. The small business will receive one notification for eachproposal submitted. Please note the referenced proposal number and read each notification carefully. **If changes occur to the company mail or email addresses or points of contact after proposal submission, the information must be provided to the AF via AF SBIR/STTR One Help Desk.**

Feedback requests will be provided to offerors with proposals determined "Not Selectable" ONLY. The notification letter will include instructions for submitting a feedback request. Offerors are entitled to no more than one feedback per proposal. NOTE: Feedback is not the same as a FAR Part 15 debriefing. Acquisitions under this solicitation are awarded via "other competitive procedures." Therefore, offerors are neither entitled to, nor will they be provided, FAR Part 15 debriefs.

Refer to the DoD SBIR Program BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Air Force SBIR/STTR Contracting Officer Daniel Brewer, Daniel.Brewer.13@us.af.mil.

Air Force SBIR 22.4 Topic Index
Release 3

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AF224-D001 TITLE: Prediction of human tissue heating due to near-field RF exposure

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Bio Medical

OBJECTIVE: Design, develop, and test fast, automated tools for predicting heating of human tissue from exposure from very near RF emitting devices.

DESCRIPTION: The government has access to a suite of tools for simulating the human body's thermal response to radio frequency (RF) exposure from nearby electronic equipment, radar, and other RF devices, with a focus on the safety of soldiers in these scenarios. These tools include the ability to pose and morph human phantoms before running electromagnetic and thermal analyses; the tools run on graphical processing units (GPU) and can be used to rapidly evaluate a broad sample of body types, body mass index (BMI), poses, etc. Despite these successes, the tools treat all sources as being far away from the human; this assumption limits the accuracy when attempting to simulate nearby sources because electric and magnetic fields are not predictably aligned as they are in a far-field region. Furthermore, fields very close to antennas may not radiate or interact with materials as they would in the far field region. Therefore, an opportunity exists to develop a near-field antenna model that can be used within these tools to rapidly assess safety and/or efficacy of nearby RF sources. This capability will potentially expand the user base of these tools to include analysts who are modeling military devices such as warfighter radios, headsets, and nearby directed energy sources as well as medical experts evaluating treatments such as hyperthermia and RF ablation catheters used for therapeutic effects. Solutions should focus either on techniques to streamline the development of near-field sources and enable their field pattern consumption within FDTD electromagnetic solvers, or on surrogate modeling approaches that approximate the SAR and thermal response from idealized versions of antenna sources. Use of government equipment, data, or facilities is not expected.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like• effort, including a feasibility study. This includes a review of the scientific and technical merit and feasibility of ideas appearing to have commercial potential. The offeror should have defined a clear, immediate actionable plan with the proposed solution and the AF customer. The offeror should be able to demonstrate validated tools for simulating the human body's thermal response to RF exposures in the far field and should be capable of evaluating a broad sample of body types. Solutions should focus either on techniques to streamline the development of near-field sources and enable their field pattern consumption within FDTD electromagnetic solvers, or on surrogate modeling approaches that approximate the SAR and thermal response from idealized versions of antenna sources.

PHASE II: Implement and deliver code to execute on DoD computers. Demonstrate accurate prediction of temperature rise from RF exposure in near field of antennas.

PHASE III DUAL USE APPLICATIONS: Military applications include engagement modeling and simulation, risk assessment, and occupational health evaluations. Civilian applications include real time prediction of risks from RF occupational exposure. Criterion to transition to Ph III is successful demonstration of near field predictions against published near-field exposure case studies.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF

Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:

1) Gajsek, P., Walters, T., Hurt, W., Ziriax, J., Nelson, D. and Mason, P. (2002), Empirical validation of SAR values predicted by FDTD modeling . Bioelectromagnetics, 23, 37-48.

KEYWORDS: Computation models; RF exposure; near field

AF224-D002 TITLE: Virtual Reality Laser Dazzle Demonstrator

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Bio Medical

OBJECTIVE: Design and develop a Virtual Reality (VR) Laser Dazzle/glare and laser eye protection (LEP) effects Demonstrator or for short, a Laser Dazzle Demonstrator (LDD). The demonstrator should simulate representative visual effects on a pilot from a laser directed at an aircraft. Cloud based, real-time, laser dazzle effects should be incorporated into a flight simulator program running on a commercial VR headset. Laser dazzle effects on night vision goggles and camera sensors should also be developed. Programs to familiarize pilots to the effects of laser dazzle should be included in the demonstrator, other distinct types of VR-style technology, to include augmented reality and mixed reality may be utilized.

DESCRIPTION: Laser systems have become increasingly prominent in military use, they are employed in systems that are used for tracking and shooting down airborne targets and for targeting practice during familiarization exercises. However, as a result of improvements in laser diode technology, commercial laser systems have become more affordable and efficient, offering a variety of wavelength ranges and power levels which are easily accessible to the general public, making them more of an issue for pilots and aircrews to contend with during flight operations. Laser Eye Protection (LEP) is required flight equipment that is supplied to Air Force (AF) aircrews to prevent vision impairments when lasers are being utilized in the field or when known operational threats exist. In general, Aircrews are briefed about the use of LEP, but exposure to real-world laser dazzle during daily operations is extremely limited due to the need to maintain eye safe exposures. Representative simulations can include much more impactful scenarios of laser glare and mitigation options without compromising eye safety, and provide a familiarization opportunity. By optimizing for realism, the VR Laser Glare Demonstrator will prepare pilots for real-world laser glare events that tie in the use of LEP without incurring negative transfer.

PHASE I: VR flight simulator systems are already being used by the Air Force and as part of pilot training programs. This topic is intended for technology proven to move directly into Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a “Phase I-like” effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. This study will create virtual reality scenarios of laser dazzle for an on-axis and off-axis laser beam incident upon a camera or NVG’s to 1) simulate laser glare over a variety of irradiance levels with and without LEP, 2) visual effects such as scotomas and eye damage when no LEP is worn, 3) visual effects with LEP to display glare mitigation, 4) development of a web-based VR familiarization application that incorporates the simulation scenarios outlined previously above, and 5) incorporation of VR scenarios and development as a stand-alone application to be utilized as a roadshow kit for VR demonstrations.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort at least in part separate from the SBIR/STTR Programs. Experience and demonstrated ability with VR flight simulators can suffice as a Phase-I type effort. Develop a VR Laser Dazzle Demonstrator relevant to one military application. Demonstrate and evaluate the system(s) ability to simulate laser dazzle under variety of conditions. Techniques should be used to overcome the limited brightness of the displays in VR headsets, so that the visual effect simulates real world visual effects on contrast. Laser dazzle effects may be cloud based or local system computer based.

PHASE III DUAL USE APPLICATIONS: PHIII could be follow-on efforts to incorporate laser dazzle into improved VR head sets and into mixed reality. In addition, Laser Dazzle might be included in the rapidly improving and expanding market of VR games with multiplayer options. Laser Dazzle could also be added to AFSIM simulations and incorporated into DOD flight simulators for training, analysis, and experimentation.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Craig A. Williamson and Leon. N. McLin, Determination of a laser eye dazzle safety framework,Journal of Laser Applications (2018);
2) Craig A. Williamson and Leon N. McLin, Nominal Ocular Dazzle Distance (NODD) Applied Optics 2 (2015);
3) Craig A. Williamson, Leon N. McLin, Michael A. Manka, J. Michael Rickman, Paul V. Garcia, and Peter A. Smith, Impact of windscreen scatter on laser eye dazzle, Optics Express (2018);
4) Craig A. Williamson, J. Michael Rickman, David A. Freeman, Michael A. Manka, and Leon N. McLin, Measuring the contribution of atmospheric scatter to laser eye dazzle, Applied Optics (2015);
5) Oliver J. Freeman and Craig A. Williamson, Visualizing the trade-offs between laser eye protection and laser eye dazzle, Journal of Laser Applications (2020);
6) JoÃo M. P. Coelho, JoÃo Freitas, and Craig A. Williamson, Optical eye simulator for laser dazzle events, Applied Optics (2016);
7) Craig A. Williamson, Simple computer visualization of laser eye dazzle, Journal of Laser Applications (2016)"

KEYWORDS: Laser Dazzle; Laser Glare; Scotomas; LEP; laser eye protection; virtual reality; mixed reality; augmented reality

AF224-D003 TITLE: Actionable Insights from Human Performance and Training Data Sets for Proficiency-Based Training

TECH FOCUS AREAS: Artificial Intelligence/Machine Learning; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Demonstrate novel methods for analyzing USAF pilot training and readiness data to deliver more effective and efficient training to Warfighters

DESCRIPTION: Data about pilot readiness, performance, and training is a strategic asset to the U.S. Air Force (USAF). Modern pilot training produces large volumes of data employing a variety of methods, modalities, and formats. Velocity, the rate at which the systems generate data, is also a challenge. For example, distributed training environments often provide radio communications, electronic chat, data links, video, network data between interoperable simulators, expert observers, self-report surveys, and readiness reporting. Air Combat Command's (ACC's) Proficiency-Based Training (PBT) initiative along with the Air Force Research Laboratory (AFRL, 711 HPW) are leveraging this data to deliver more effective and efficient training to Warfighters. Much of the available data is underutilized, and this topic seeks novel methods for organizing, analyzing, and deriving actionable insights from current and historic human performance data. In 2020, AFWERX and AFRL conducted a workshop with leading government, academic, and industry export to explore state of the art big data practices and potential applications to military pilot training and readiness. This topic is a continuation of that work more narrowly focusing on human performance data, data organization and management, and increased partnerships to explore state-of-the-art approaches.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. We expect to see evidence of previous product development and customer interaction in areas such as, (a) UX development to interpret analytics and insights in decision quality, user-oriented displays and dashboards; (b) descriptions of real world applications of the proposed technology and capability for the Phase II effort; (c) details on specific analytic tools, applications, and results data from use cases of the foundational technologies for this effort; and (d) documented customer feedback, outcomes, and commercial partnering interests that are leverageable for this effort.

PHASE II: Compare simulated performance against existing model(s) and/or predictions. Refine simulations as necessary. Design a VR environment to include a graphic user interface that provides a selection of scenarios for the end-user to choose from. For example; scenarios such as landing or take-off, variable laser powers, variable engagement distances, laser wavelengths, etc.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF

Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Kabudi, T., Pappas, I., Olsen D. H. (2021). AI-enabled adaptive learning systems, A systematic mapping of the literature. Computers and Education, Artificial Intelligence, vol 2. (2021).;
2) Monllao Olive, D. (2019). Automatic classification of students in online courses using machine learning technqiues. [Master's Thesis, University of Western Australia].;
3) Watz, E., Neubauer, P., Kegley, J., Bennett, W. (2018). Managing Learning and Tracking Performance across Multiple Mission Sets. Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC).

KEYWORDS: pilot training; proficiency; classification; data management; competencies; machine learning

SF224-D004 TITLE: Mixed Reality for Space Operations

TECH FOCUS AREAS: Artificial Intelligence/Machine Learning

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Develop and apply technologies and methods to visualize and understand the complex space environment in 3D augmented and virtual reality (AR and VR, or collectively extended reality - XR) to enhance space domain awareness (SDA) for operators and improve the quality of SDA decision making.

DESCRIPTION: Battlespace awareness within the space domain is a critical foundation for planning and choosing appropriate courses of action, responding to threats, protecting vulnerable assets, and executing safe and effective space missions. This demands a mastery and understanding of complex, often counterintuitive, orbital dynamics at LEO, MEO, HEO, GEO, and xGEO orbital regimes. These missions require integration of uncertain and incomplete data, and consideration of evolving multi-domain threats. Current tools are limited by traditional 2D displays and insufficient representative scenarios for interactive training. The next generation of space operators and analysts require more intuitive, engaging, and scalable tools to prepare for and execute successful missions. Recent advances in augmented and virtual reality (XR) hardware (e.g., MagicLeap, Microsoft HoloLens, Oculus, HTC Vive) show the potential for cost effective, self-contained, and secure solutions to understand, interpret and train complex space concepts within representative and interactive 3D environments.

PHASE I: This is a Direct to Phase 2 (D2P2) topic. The Government expects the small business would have accomplished the following in a Phase I-type effort via some other means, e.g., independent research and development (IR&D) or other non-SBIR funded work). It must have developed a concept for a workable prototype or design to address at a minimum the basic capabilities of the stated objective. Proposal must show, as appropriate to the proposed effort, a demonstrated technical feasibility or nascent capability to visualize and interact with the complex space environment at multiple orbital regimes in high fidelity XR. Proposal may provide example cases of this capability on specific applications. The documentation provided must substantiate that the proposer has developed a preliminary understanding of the technology to be applied in their Phase II proposal to meet the objectives of this topic. Documentation should include all relevant information including, but not limited to technical reports, test data, prototype designs/models, and performance goals/results.

PHASE II: Design and develop 3D visualizations showing remote space object (RSO) entities and their complex spatiotemporal relationships (e.g., the three body problem at xGEO, engagement zones, point to point visibility). Provide the ability to support collaborative, distributed planning using shared visualizations and custom operationally focused annotation with consistent temporal effects. Provide a flexible XR device networking architecture to accommodate variations of synchronous, asynchronous, one-to-one, and/or one-to-many networking, across devices (i.e., COTS XR HMDs, tablets, desktop computers) in unclassified and TS environments. Readily ingest relevant data sources (e.g., the satellite catalog) and provide accurate and representative XR visualizations, content, tools, and interaction methods to support development of dynamic scenarios for operational and classroom training. Demonstrate and deliver the XR tools and infrastructure to support development, editing, saving, and playback of dynamic XRbased spatiotemporal space scenarios to support existing (and future) operational training, curriculum and course content development workflows while improving human immersion and comprehension. No GFE will be provided.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for potential government applications. There are potential commercial applications in a wide range of diverse fields that include elementary, secondary, undergraduate, and graduate level STEM education with XR-based visualization and interaction with dynamic content in contexts such as astronomy and astrophysics, earth science, marine science, and physics.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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1) Chief of Space Operations Planning Guidance, General Raymond, 2020, https://www.spoc.spaceforce.mil/Portals/4/Documents/USSF Publications/CSO's Planning Guidance.PDF;
2) Out of this world, 50 OSS acquires Augmented Reality, Schriever Air Force Base, 2020, https://www.dvidshub.net/news/373500/out-world-50-oss-acquires-augmented-reality;
3) Toward Intuitive Understanding of Complex Astrodynamics Using Distributed Augmented Reality, Stouch, Balasuriya, et. al., 2021, Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS);
4) Challenges to Security in Space, DIA, 2019, https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Space_Threat_V14_020119_sm.pdf;
5) Spacepower, Doctrine for Space Forces, General Raymond, 2020, https://www.spaceforce.mil/Portals/1/Space Capstone Publication_10 Aug 2020.pdf;
(6) Virtual, Augmented Reality Tech Transforming Training, National Defense, 2021, https://www.nationaldefensemagazine.org/articles/2021/2/17/virtual-augmented-reality-tech-transforming-training. Space Domain Awareness, Space Education, Augmented Reality, Virtual Reality, Mixed Reality, Training, Space Operations"

KEYWORDS: Virtual/Augmented Reality in Space Operations; Complex Astrodynamics Using Distributed Augmented Reality; Orbit Determination in 3D; Space Threat Identification and Characterization using AR/VR

SF224-D006 TITLE: Persistent Wide-field Regional Geosynchonous Belt Surveillance

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Sensors

OBJECTIVE: The rise of commercial entities providing space domain awareness (SDA) data has been breathtaking to the point that the dedicated Space Surveillance Network, equipped by the U.S. Space Force, can leverage products so as to multiply the Network's capability for the space warfighter. Space Systems Command's (SSC) program of record (POR) for Ground-based Electro Optic Deep Space Surveillance (GEODSS, office symbol SSC/SCGO) could benefit from inserting at GEODSS-sites persistently-watchful electro-optic sensors that can track relatively bright objects near the earth's geosynchronous orbit (GEO) belt, thus freeing GEODSS's more-sensitive astronomically-pointing sensors to conduct search-based operations for dim objects and long-duration characterization. The currently available commercial products, however, require maturation in edge-processing, operationally-ready software, and availability before they are ready for low-rate production. This topic is aimed at accomplishing this maturation.

DESCRIPTION: Demonstrate a production prototype version of an existing ground-based electro-optic sensor that produces automated persistent surveillance of a wide swath of the geosynchronous-orbit regime (the GEO-belt). The prototype should be capable of 1) tracking near-GEO-belt objects as faint as 17 Mv in a region of the GEO-belt from a ground-based electro-optic sensor during night-time. 2) Collecting astrometric data from the electro-optic sensors with sufficient timeliness to detect a change in position of the near-GEO of less than or equal 100 micro-radian RMS and track the near-GEO during its orbital motion or maneuver, 3) performing edge processing; (that is, on computer-based equipment in very near proximity to the sensor) of the observations so that only the standard set of Space Surveillance Network messages need to be sent to the customer instead of the images. 4) Demonstrating compliance with 80% of SSC/SCGO's steps for operationalizing prototype software. Deliver the prototype to a location agreed by SSC/SCGO.

PHASE I: Criteria for substantiating that the proposer's technology is currently at an acceptable stage (thus bypassing Phase 1 development) consists of the following. 1) A description of a sensor demonstrated to fulfill at least these characteristics: Ability from a ground-based electro-optic sensor to persistently and frequently record positions the objects near to the geosynchronous earth orbits (GEO) belt to within 30 degrees of horizon all night long. Frequency of observations should exceed 1 Hz (i.e., integration time less than 1 second). Ability to routinely detect objects as faint as Mv 16.3. Ability to estimate astronomical position (such RA and Dec, celestial lat. and long., or equivalent) of a GEO from a single frame of around 50 micro-radians. Ability to show reliability and longevity of any moving parts, especially if a moving-mount is required to point towards an intended target field. Such description is expected to be included in the proposal. 2) Publication describing the product and providing results of the successful demonstration of the product. Publication can be in either government-reviewed or peer-reviewed article, such as reports logged into DTIC after successful completion of a previous SBIR contract or a peer-reviewed article in a publication from a professional on academic society. Citations of such are expected to be included in the proposal.

PHASE II: The performer will demonstrate performance of a production prototype version of an existing ground-based electro-optic product that produces automated persistent surveillance of a wide swath of the GEO-belt. The prototype should be capable of meeting the metrics in the Topic Description. The intent is to deliver the prototype to a location agreed by SSC/SCGO so that Ground-based Electro Optics Deep Space Surveillance (GEODSS) program of record (POR) can perform an assessment of the value added to the GEODSS POR.

PHASE III DUAL USE APPLICATIONS: If funded, the performer will deliver a second unit to a location agreed by SSC/SCGO. SSC/SCGO will determine if specifications lead to a copy of the first unit or slight modifications meeting standards for a 1st production-unit.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Persistent Wide Field Space Surveillance (PWFSS) also known as Persistent AND Optically Redundant Array (PANDORA), Final Report, 20 February 2020, DTIC

KEYWORDS: Space Domain Awareness; SDA; COTS camera; GEODSS

SF224-D007 TITLE: 24/7 geosynchonous belt Surveillance using Passive Radio Frequency

TECH FOCUS AREAS: Directed Energy

TECHNOLOGY AREAS: Sensors

OBJECTIVE: The rise of commercial entities providing space domain awareness (SDA) data has been breathtaking to the point that the dedicated Space Surveillance Network, equipped by the US Space Force, can leverage products so as to multiply the Network's capability for the space warfighter. Space Systems Command's (SSC) program of record (POR) for Ground-based Electro Optic Deep Space Surveillance (GEODSS) could benefit from inserting a capability to track objects in the earth's geosynchronous orbit (GEO) belt during daylight and through clouds, especially from outside the continental United States. SSC owns sites that can host such equipment and has developed mechanisms to purchase data-as-a-service for space domain awareness observations. The current commercial products that provide the quality of astrometric accuracy that add multiplicative value to GEODSS, however, have limitations preventing insertion in a POR. Among these limitations are the need for multi-node-networked sensors which are concentrated in North America, as well as single-satellite band collection feed-horns. In addition, commercial providers may lack cyber-hardening and thus risk having their collects degraded when they are needed most. This topic is aimed at overcoming these limitations and thus creating a suitable dedicated-like commercially-derived prototype ready for both low-rate production and to provide data-as-a-service at an affordable rate.

DESCRIPTION: Demonstrate a prototype version of an existing ground-based passive RF sensor that produces automated surveillance of a wide swath of the GEO-belt during night-time, daytime, and through clouds. The prototype should be capable of 1) tracking transmitting near-geosynchronous objects (GEOs) across a contiguous region of the GEO-belt, 2) combining data with that from a network of ground-based RF sensors that collectively can estimate the 3-dimensional position of the GEO with an RMS uncertainty of +- 5 micro-radians, 3) tracking satellite signals in multiple bands common to satellite communication bands, such as L, S, C, and Ku., 4) demonstrating compliance with 50% of SSC/SCGO's steps for operationalizing prototype software., and 5) providing data-as-a-service for space domain awareness data at affordable rates. Delivery of the prototype will be to a location agreed by SSC/SCGO with preference given to the western Pacific region.

PHASE I: Criteria for substantiating that the proposer's technology is currently at an acceptable stage (thus bypassing Phase 1 development) consists of the following: 1) A description of a sensor demonstrated to fulfill at least these characteristics; Ability to track RF-transmitting near-geosynchronous objects (GEOs) across a contiguous section of the GEO-belt from a ground-based sensor. Ability to convert measurements from the radio-frequency signal into an estimate the 3-dimensional position of the GEO with an RMS uncertainty around +-6 micro-radians (or the equivalent in meters at the range of the target). Ability to track satellite signals in at least two bands common to satellite communication, such as L, S, C, and Ku. Ability to maintain track custody of at least one-dozen GEOs 24 hours per day for greater than 15 days. Such description is expected to be included in the proposal. 2) Publication describing the product and providing results of the successful demonstration of the product. Publication can be in either government-reviewed or peer-reviewed article, such as reports logged into DTIC after successful completion of a previous SBIR contract or a peer-reviewed article in a publication from a professional on academic society. Citations of such are expected to be included in the proposal.

PHASE II: The performer will demonstrate performance of a prototype version of an existing ground-based passive radio frequency (RF) product that produces automated surveillance of a wide swath of the GEO-belt. The prototype should be capable of meeting the metrics in the Topic Description. The intent is to deliver the prototype to a location agreed by SSC/SCGO so that Ground-based Electro Optic Space Surveillance (GEODSS) program-of-record (POR) can perform an assessment of the value added to the GEODSS POR and whether fielding more sensors is warranted.

PHASE III DUAL USE APPLICATIONS: If funded, the performer will deliver a second unit to a location agreed by SSC/SCGO. SSC/SCGO will determine if specifications lead to a copy of the first unit or slight modifications meeting standards for a first production-unit. If funded, the performer will demonstrate using the proto-types, along with other passive RF sensors, to deliver space surveillance data-as-a-service.

REFERENCES:

1) 24/7 MONITORING OF ACTIVE SATELLITES USING PASSIVE RADIO-FREQUENCY (RF) SENSORS, Final Report, 25 June 2021, DTIC

KEYWORDS: Space Domain Awareness; SDA; Passive RF; GEODSS

AF224-D008 TITLE: Continuous Flow Recrystallization of Nitramines

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: Design, develop and demonstrate a continuous process for direct recrystallization of energetic materials and show the ability to control the shape, size, and morphology of the energetic. Such processes shall be capable of purifying materials from sub-quality feedstocks or for tuning particle size distributions of feedstock materials.

DESCRIPTION: Energetic materials are dual-use materials used in private industry, recreational sport, and military applications. Explosives used in many applications and those used in DoD munitions and are produced at the plant at a wide range of scales. Such explosives are usually separated by classes (particle granulation sizes) and are produced in accordance with various material specifications that include purity, particle size distributions, and morphology. The currently used batch process to produce these classes are time intensive, scale-dependent, costly, and of insufficient reproducibility to support the requirements of future DoD and civilian needs. Further, the US production capacity, of the finer grades in particular, ~~cannot keep up with DoD production demand required to replenish depleted inventories as a result of recent operations in Syria and is therefore affecting the production rate of critical weapon systems~~ cannot keep up with expected DoD production demand. The U.S.'s current batch-based production method for producing the various classes of explosives is slow and does not allow for easy or precise control of particle size, thereby limiting strategic production rates of munitions. In order to address this limitation, new methods must be acquired to accelerate the ability of the U.S. to synthesize and process explosives by particle size that meet required material specifications. In the last few years, continuous flow synthesis has been successfully applied to energetic materials, and have demonstrated several advantages including reduced waste, material in process, process control and product quality. In order to fully realize the potential of continuous flow synthesis it needs to be paired with complementary continuous flow technologies including filtration, recrystallization, extraction, and distillation. Continuous flow recrystallization presents one of the largest challenges and opportunities in continuous flow preparation of nitramines including CL-20 and HMX. The pharmaceutical industry has demonstrated use of continuous flow recrystallization to result in improved purity, particle size control and particle size distribution. This topic desires continuous flow recrystallization strategies for direct recrystallization to each of the CL-20/HMX class sizes (eliminating grinding steps) with tighter particle size, greater process control and improved process waste profiles while retaining the desired polymorph for each.

PHASE I: As this is a Direct to Phase II (D2P2) SBIR, proposers should provide evidence showing that their technology is mature enough for D2P2. This can come in the form of previous experimental data of continuous flow recrystallization using energetic materials or pharmaceutical/similar continuous recrystallization processes as long as proposers can also show experience with energetic materials.

PHASE II: Development and demonstration of one or more pilot scale processes for HMX and CL-20 continuous flow recrystallization. The process models generated should be validated, optimized for affordability and robustness, and developed into a physical pilot process. This pilot scale process should produce final product at a rate of at least 1 g/min demonstration should exhibit polymorph and particle size control to multiple HMX and CL-20 class sizes and be able to be transitioned to manufacturing environments. It should demonstrate a narrow particle size distribution as well as limit operator exposure, hazardous waste generation and show greater process control to include solvent recycling. A 20 g sample of each class size must be shipped to AFRL/RWME (HERD) for further evaluation of product quality. Phase 2 will conclude with a full process design and transition plan.

PHASE III DUAL USE APPLICATIONS: One or more of the processes developed in Phase 2 should be scalable to production capacity. These processes will demonstrate the ability to control and change particle size distributions of the nitramines. This capability will allow greater flexibility in meeting warfighter needs for nitramine-based end items in times of high demand with lower infrastructure costs than large scale batch recrystallization process equipment. It will also result in greater control of nitramine explosive properties (due to tighter control of particle size distribution) for improved end item reliability.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) K.A. Powell, A.N. Saleemi, C.D. Rielly, Z.K. Nagy. Periodic steady-state flow crystallization of a pharmaceutical drug using MSMPR operation.Chemical Engineering and Processing, Process Intensification, Volume 97, November 2015, pp 195-212;
2) P.B. Palde, T.F. Jamison. Safe and Efficient Tetrazole Synthesis in a Continuous-Flow Microreactor. Angewandte Chemie International Edition, Volume 50, 15, April 2011, pp 3525-3528;
3) DETAIL SPECIFICATION RDX (CYCLOTRIMETHYLENETRINITRAMINE).MIL-DTL-398D.1996;
4) S. Lawton, G. Steel, P. Shering, L. Zhao, I. Laird, X.W. Ni., Continuous Crystallization of Pharmaceuticals Using a Continuous Oscillatory Baffled Crystallizer. Org. Process Res. Dev., Volume 13, October 2009, pp 1357-1363;

KEYWORDS: Continuous Flow; Recrystallization; Nitramines; Process Analytical Technology; Energetics;

AF224-D009 TITLE: Dye-containing Sol-gel Glass Optical Elements

TECH FOCUS AREAS: Directed Energy; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Sensors; Materials; Air Platform

OBJECTIVE: The objective is to provide material and process options for sol-gel glass optical elements containing organic or organic/inorganic dyes. Efforts shall focus on development of new materials options and approaches, process improvement of existing but immature sol-gel materials, and manufacturing process development of well-established and new materials. The candidate material(s) should be validated through a range of mechanical and optical tests, at various times throughout the effort. To mature the material production process, validation should include a demonstration of the ability to fabricate representative sized components (e.g., a 3 minimum diameter and minimum one cm thick element containing an appropriate dye) by the end of the effort. The component should then be tested in a relevant environment. To facilitate manufacturing, processes for producing the optical elements must be developed that are robust, scalable, and reproducible, with yield sufficient to allow reasonable cost of the final articles. Development and testing in the optical elements of novel dyes is an important objective of this effort as well. The performer will be required to design, synthesize, and scale the production of both existing and novel light-absorbing dyes which are optimized for solubility, compatibility with the sol-gel glass production process, and cost/yield, with the objective of establishing a reliable domestic source of the dyes specified for the optical elements.

DESCRIPTION: The Air Force must be able to operate effectively in anti-access, area-denial environments with data collection from sensors which require protection from some wavelengths of light while operating at other wavelengths. This requires optical elements with the required optical transmittance as a function of wavelength, which can be attained by incorporation of appropriate dyes. It has been found that incorporation of dyes in sol-gel glasses is a promising approach to this requirement. However, production of dye-containing sol-gel glasses of the required size and optical quality is challenging. Depending on how the glasses are made, cracking or complete disintegration of the glass is common, and methods to produce the glasses of sufficient size that are of high optical quality and robust that can be performed at high yield and in a controlled, reproducible manner are lacking. The goal of this topic is to develop more robust production methods for such glasses, in particular to make larger optical elements and elements containing the necessary dyes. New and innovative material solutions may be proposed to provide new options for sol-gel glass production. Potential candidates include but are not limited to use of commercially-available or novel silanes and solvents. Processing approaches could include methods to control the rate of curing of the glass and the type, material, and shape of container used for the cure, as well as the cure temperature. The goal here is to develop a process that can make larger optical elements, more reliably. Well established materials and processes may be proposed with a focus on improving the manufacturability, producibility, and reliability for current and next generation optical elements. Increasing size, manufacturing yield, and reducing cost while at the same time reducing manufacturing variability is desired. Proposers must have experience in the production of dye-containing sol-gel glasses. A second requirement of the optical elements are dyes which have the required optical transmittance/absorbance properties while being compatible with the sol-gel materials and production methods and are reliably available from domestic sources. This is currently a challenge. The performer will be required to work with AFRL to identify suitable dyes for the optical elements and to design synthetic approaches to any dyes that are not commercially available from reliable domestic sources. The performer will synthesize any required dyes not commercially available from domestic sources in amounts exceeding 10 grams by the end of Phase II and have the capability to produce the dye(s) at batch sizes of at least 10 grams going forward, or to work with another domestic producer to do so, or both. Proposers should have documented experience in the design, synthesis, and production of novel and existing absorbing and fluorescing dyes in the visible and near-infrared regions of the spectrum, and must have demonstrated the ability to reliably and reproducibly synthesize, purify, and characterize light-absorbing dyes at greater than 10 gram batch size. The proposal should clearly identify the current state of the art of the sol-gel and dyes of interest including both technical and manufacturing readiness and how the proposed work will advance readiness for the proposed optical elements.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The effort should show; 1) Clear ability to prepare at least 1 inch diameter optically clear sol gel glass boules that are suitable for cutting and polishing. 2) Experience putting organic or organic/inorganic dyes into the sol gel and preparing 1 inch diameter optically clear sol gel boules that could be cut and polished into optical flats. 3) Provide description and photos of procedures utilized in "Phase I-like" effort that will carry into the Phase II proposal

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The proposer shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.
NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Zieba, R.; Desroches, C.; Chaput, F.; Carlsson, M.; Eliasson, B.; Lopes, C.; Lindgren, M.; Parola, S. "Preparation of Functional Hybrid Glass Materials from Platinum (II) Complexes for Broadband Nonlinear Absorption of Light", Adv. Funct. Mat., 2009, 19, 235.

KEYWORDS: Sol-Gel Glasses; optical elements; dye incorporation; dye synthesis

AF224-D010 TITLE: C-Band Reflectometer

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: To develop a tool capable of measuring the conductivity of materials on surfaces with complex curves.

DESCRIPTION: The current point inspection tool (Tier I) that is used to inspect electrically conductive materials on structures is a waveguide cavity probe. The probe is an open-ended wave guide of defined length that is excited on the feed end through a circular iris. When the open end of the waveguide is placed on a flat conductive surface, a cavity is formed. The Quality Factor (Q) of the cavity is measured and the conductivity of the terminating wall is calculated. Errors are induced when the surface being inspected is non-planar due to leakage around the gap created by the waveguide and the curved surface being inspected. It is desirable to have a device that can measure the conductivity of coatings on mildly curved compound surfaces. The measurement device should be capable of determining surface conductivity (ie: ohms per square) of conductive coatings. It is desirable to measure this within the 4-8 GHz frequency band. A single broad-band probe is highly desirable. The probe cannot damage the surface being measured. The device should pose no safety hazard to personnel or equipment. It shall be capable of being approved for flight line operation. The surface will not typically be flat and therefore should conform to the surface being tested. Assume that the probe must accommodate surfaces from flat to a compound radius of curvature of approximately 50 inches. The equipment should also have the ability to support higher radii of curvature. The probe should be capable of measuring small areas to support inspection. A smaller footprint is desirable. It is anticipated that the probe will work in conjunction with a government furnished vector network analyzer. The analyzer is a two port instrument and it is desirable that the probe not require additional ports. A standalone device or one that utilizes special test equipment is acceptable. It is expected that this probe will be transportable and operable by a single technician. Considerations during the design of any equipment used for this end should include: robustness, hand held use in the field, and Class I, Div II certification.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal, which demonstrates accomplishment of a “Phase I-like” effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should: 1) show ability of measuring surface conductivity of electrically conductive coatings, 2) provide technology maturation roadmap (or equivalent) that shows feasibility of measurements of test panels

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The proposer shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Design and construct system capable of non-destructive, in-situ evaluation of the electrical conductivity. The range of conductivity shall be between 0 to 10 ohms/square. It is be desirable for the technique performed through a thin dielectric coating. Demonstrate a measurable approach on a test panel Ruggedize equipment, workout commercialization issues, partner with any appropriate companies to ensure successful production, meet other needs of the user. Demonstrate hand-held, ruggedized version to be fielded.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

REFERENCES:

1) Kok Yeow You; Fahmiruddin Bin Esa; Zulkifly Abbas "Macroscopic characterization of materials using microwave measurement methods — A survey", 2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL), IEEE, (2017), DOI: https://doi.org/10.1109/PIERS-FALL.2017.8293135

KEYWORDS: Reflectometer; C Band; Electrically conductive coatings; waveguide cavity probe

AF224-D011 TITLE: VHF Embedded Resistive Materials Measurement System

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: Design and develop a field-level maintenance inspection capability to measure the impedance in the VHF range of 30-300 MHz.

DESCRIPTION: Current high impedance resistive materials inspection tools have many limitations and a requirement exists to measure the impedance of resistive materials. An innovative capability is desired to accurately measure in a flight line type environment the status of the performance of the resistive materials. The range of resistive material values may typically be between 1-5000 ohms/square inch. Therefore a requirement exists for a broadband measurement capability in a single sensor system with an accuracy and repeatability of 10% of nominal value. It is expected that technology demonstrations on commercially available materials to evaluate the efficacy of the proposed sensor technology shall be performed. The intended end user of the proposed sensor system is a 5-level maintainer or technician with approximately 3-5 years of aircraft maintenance experience. Therefore the proposed sensor system must be easy to set up, calibrate, collect data and analyze the results. This strategy is centered on developing a robust tool with advanced algorithms and processing for production, depot and field maintenance crews that only require entry level user training and knowledge to be successfully used and operated. New equipment and technology shall comply with security requirements, meet Class I Division 2 certifications for use around a fueled aircraft. The sensor system must be explosion proof and resistant against any harmful chemical or oil it could encounter in a hangar. The sensor system must also be ruggedized for use in an operational environment including exposure to light dust, moisture, humidity, low and high temperatures, and salt fog conditions as specified in commercially available testing documentation and standards. In-depth investigations shall be conducted to create confidence on new approaches and methods. These in-depth validation and verification activities shall address user requirements including but not limited to human safety, reliability, operator fatigue, reparability, and robustness of the equipment to survive in a high tempo maintenance environment. The developed capability is intended to be a common evaluation tool that can be used on multiple platforms and applications. An open software architecture is desired so that output data files are compatible with various field assessment systems for any platform. If the inspection system is battery-powered, the system must be able to complete an entire inspection on a single battery charge.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort would 1) show ability to measure resistive materials under thin topcoat, and 2) provide technology maturation roadmap (or equivalent) that shows feasibility for a single operator to use system.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The proposer shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations, including the following: 1. Fabricate an integrated prototype system capability. 2.

Demonstrate the prototype's ability to measure the impedance of resistive materials under thin topcoats. Tabulate and document test results in a detailed report to include any capability shortfalls, and recommendations for improvement to overcome said shortfalls. 3. Develop a manufacturing plan for a fully integrated ruggedized system capable of rapidly inspecting full scale aircraft in field or depot environments. 4. Rigorous technology demonstrations using commercially available materials and representative targets shall be performed. To that end, extensive test and evaluations of the novel prototype capability shall be carried out to include an optimized hardware and software system solution

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

REFERENCES:
1) "A Novel Method for Determining the R-Card Sheet Impedance Using the Transmission Coefficient Measured in Free-Space or Waveguide Systems," IEEE Transactions on Instrumentation and Measurement, 58 (7): 2228 – 2233, August 2009, Michael Havrilla, Milo Hyde, and Paul E Crittenden.
2) "Electromagnetic Scattering by an Impedance Sheet with a 1-D Inhomogeneity in a Rectangular Waveguide," Metamaterials 2009, 3rd International Conference on Electromagnetic Materials in Microwave and Optics, London, UK, 30 Aug – 4 Sept, 2009, Keith White

KEYWORDS: High Impedence Probe; High Impedance Material Measurements; Resistive Material Measurements Very High Frequency (VHF) Probe

AF224-D012 TITLE: Durable, Extreme Temperatures and Environments Rope Seals

TECH FOCUS AREAS: Directed Energy; Nuclear; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Ground Sea; Nuclear; Materials; Air Platform

OBJECTIVE: The topic requests that prospective proposers develop and demonstrate an advanced performance rope or pillow seal capable of repeated extreme temperature and load cycling operations in high heat flux, oxidizing environments that restricts the flow of hot gases at extreme temperatures thru static interfaces. The proposers are requested to apply existing, though perhaps not fully developed, fibers, metals, insulators etc in new and innovative ways to the fabrication of advanced performing static rope or pillow seals. The delivered seal should demonstrate some and or all of the following performance characteristics: 1) Exposure to hot gases of temperatures of at least 2200F to 3000F without exhibiting sealing property degradation. 2) Exposure to the above hot gases for at least 1 hour without exhibiting sealing property degradation. 3) Multiple (high single digits to low teens) exposures to the above hot gases for the 1 hour durations without exhibiting sealing property degradation. 4) Seal joint interfaces between a wide diversity of different component constituent materials such as various types of CMCs to various types of Metals, various types of CMCs to various types of CMCs, and or various types of Metals to various types of Metals. 5) Maximally impede the mass transport of Hot Gas and heat transport of thermal energy while also being capable of sealing against high pressure drops in the mid tens of Psi (ie 50s) across the joined interfaces. 6) Compensate for as large as possible component dimensional tolerance deviations without exhibiting sealing property degradation.

DESCRIPTION: Contracted advanced performance rope or pillow seal effort performers will be deemed to have met the topic objectives by conducting and demonstrating the following work tasks. The proposer shall provide an exhaustively detailed report documenting why the proposed material to be incorporated into the making of an advanced performance rope seal is likely to improve the performance of a rope seal over existing seals. The report shall incorporate substantiating previous experimental results and detailed technical explanations as to why the new material will accomplish the topic performance objectives. The proposer shall design, build and test advanced rope seals of various dimensions and lengths with the proposed material so as to demonstrate that the new rope seal is versatile and repeatably producible. The tests shall demonstrate that the new advanced rope seals can achieve the performance characteristics detailed in the topic's performance objectives and be documented as such in a detailed stand-alone report. The proposer shall design and build additional advanced rope seals using the proposed material for delivery to at least two test facilities for independent performance characterization testing conducted by government/onsite contractors and paid for by the proposer. The tests shall substantiate that the new advanced rope seals achieve the performance characteristics detailed in the topic objective and be documented as such in a detailed stand-alone report produced by the independent onsite contractor.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have 1) Exposure and performance data of a material in similar shape, function and operational environment exposure to those needed in an improved rope seal expected for use in hypersonic and Rotating Detonation Engine (RDE) systems. 2) Demonstrating manufacture of new material types into rope seal like sub component and its exposure to representative hypersonic and RDE operational environments and subsequent performance data. 3) Demonstrating manufacture, exposure to a representative hypersonic and RDE operational environment and performance data of a rope seal with one improved rope seal subcomponent / material with the remaining subcomponents made with conventional materials.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a “Phase I-like” effort predominantly separate from the SBIR Program. Under the Phase II effort, the offeror shall sufficiently develop a product or process, previously developed to meet an unrelated requirement or need, and conduct advanced manufacturing and/or sustainment relevant independent data base testing and demonstrations of the rope seal made with this product or process. The proposer shall design, build and test advanced rope seals of various dimensions and lengths with the proposed product material or material process so as to demonstrate that a rope seal made with it is versatile and repeatably producible. The tests shall demonstrate that the new advanced rope seals can achieve the performance characteristics detailed in the topic’s performance objectives and be documented as such in a detailed standalone report. The proposer shall design and build additional advanced rope seals using the proposed material for delivery to at least two government test facilities for independent performance characterization testing conducted by onsite contractors and paid for by the proposer. The tests shall substantiate that the new advanced rope seals achieve the performance characteristics detailed in the topic objective and be documented as such in a detailed standalone report produced by the independent onsite contractor. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, shall be documented.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Rope Seal; Hypersonics; Rotating Detonation Engine; Scramjet

SF224-D013 TITLE: Re-Usable High Area Ratio Nozzles for 5000 lbf Thrust Rotating Detonation Rocket Engines

TECH FOCUS AREAS: Network Command, Control and Communications; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: The topic will request offerors to propose and advance non-eroding nozzles and extensions/assemblies for re-usable upper stages of launch vehicles. Nozzles and Nozzle Extensions should be sized at nominally a range of 1.5-4.0 inches in throat diameter and able to withstand the elevated thermal and shock loads occurring during the detonation of fuels with flame temperatures ranging from 3500F to 5000F in oxygen-rich combustion.

DESCRIPTION: This request supports United States Space Force Tech Need 1186 - Launch Technologies, the goals of which are to (1) reduce launch costs by 30% and (2) to reduce new vehicle development time by 50%. Re-use primarily addresses cost from reduced procurement of future upper stages. Further, the use of pressure gain combustion (detonation) can produce the same specific impulse (ISP) at lower (mean) combustion chamber/turbo-pump discharge pressures relative to the state of the art; this enables substantial reductions in weight, complexity, and cost of subsystems including turbo-pumps, which themselves are the highest cost and longest-lead time elements in new engine development.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have 1) Exposure and performance data of material coupons or propulsion assembly sub-elements in environments with similar thermal loads and combustion chemistries (e.g. rocket/high-mach nozzles). 2) Simulation/Analysis of candidate material performance in a similar environment to screen material properties and designs for similar nozzles. 3) Previous nozzle designs that have been demonstrated as effective, but would need modification/scaling of existing materials for this more aggressive combustion environment.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. Proposed efforts should include or reference prior modeling work to aid in throat/extension material down-select and assembly design with previous sub-scale screening of materials highly desired. Nozzle and nozzle assemblies suitable for future thrust-vectoring tests are also highly desired and should be considered for future efforts, but are not required. Deliverables should include a nozzle/nozzle extension for test at an appropriate facilities such as the 1250 lbf (1.5 in. diameter) or 5000 lbf (4.0 in. diameter) engine demo testbeds at the Air Force Research Laboratory; if a non-government facility is proposed, costs for such tests should be included in the proposal. A separate deliverable of a manufacturing demo of a nozzle design evolution based on refinements from program test results should also be included.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Re-Usable; Space Access; Rotating Detonation Rocket Engine; Nozzle

AF224-D014

TITLE: Development of New Oxidation Resistant Coating Technology for Refractory Additively Manufactured (AM) Components

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: The program objective is to explore new coating technology to successfully coat additively manufactured (AM) refractory components that exhibit variability in surface roughness and geometrical complexity. Coatings are critical to the implementation of metallic refractory components in extreme environments. However, little is known regarding the interplay between as-built surface roughness, component geometrical complexity and the ability to implement commercial refractory coating methodologies. This is especially critical since complex geometries or small feature sizes produced through additive manufacturing (AM) may offer performance enhancement, but may not be directly amenable to existing coating technologies. This effort will assess the integration and performance of conventional oxidation resistant refractory coatings, address the prevalent failure mechanisms and develop a new industrially-relevant coating technology for AM refractory components with varying surface roughness and geometrical complexity.

DESCRIPTION: Niobium based refractory alloys are being explored for advanced aerospace applications where material requirements exceed the capabilities of Ni superalloys. In this realm, the emergence of AM refractory alloys has provided an innovative approach that enables complex geometries and/or graded microstructures for alloys that exhibit superior performance, but have been historically difficult to process. However, in all cases, refractory alloys require environmental coatings for protection to prevent chemical and structural degradation. Little is known regarding the compatibility of as-built AM surfaces with industry accepted coatings. This is especially relevant for cases where component geometric complexity makes surface preparation and machining extremely difficult. Conventional thermal-mechanically processed refractory alloy components are typically machined, chemically cleaned and slurry coated with commercial silicide coatings for environmental protection. Coating variabilities may be produced due the nature of the slurry and uneven application. Therefore, surface asperities and geometric complexities have the ability to detract from successful coating application. Thus, there is an apparent need to demonstrate explore how new coating technology will pair with AM processing techniques for refractory alloys. The envisioned program will explore this application space. It is recommended that the selected small business will partner with relevant alloy/coating/component OEMS, as needed, to select and produce additively manufactured refractory alloy representative coupon geometry and apply standard commercial refractory coatings for evaluation. Overall, this Phase II effort will 1) quantitatively assess the integration and performance of conventional refractory coatings on AM refractory components with varying surface roughness and geometrical complexity, 2) address the failure mechanisms of collective coating / substrate system through high temperature mechanical testing and exposure to oxidizing environments, and 3) develop a new industrially-relevant coating technology for successful refractory coating application.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should have 1) A demonstration of refractory coating process, 2) A process analysis or simulation of candidate material performance in similar environments to screen material properties, 3) A characterization of applied coating and substrate that informs process scaling

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: refractory alloy; oxidation resistant coating; additive manufacturing

AF224-D015 TITLE: Large Acreage Composite Bonded Joint Strength Non-Destructive Inspection Method

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: Advance the maturity of non-destructive composite bonded joint strength inspection technologies such as Laser Bond Inspection (LBI) to enable cost-effective production of large, structural composite critical hardware by allowing accurate assessment of the integrity of composite bonded joints and structures over large acreage and non-normal to the surface in complex, curved inspection areas. Simplify and expand the delivery of composite bonded joint strength inspection technologies such as LBI to hardware being inspected. Increase reliability, production uptime, and ease calibration burdens associated with current composite bonded joint strength inspection techniques such as LBI.

DESCRIPTION: The benefits of large, integrated bonded composite structures are not yet fully realized due to lack of confidence in bonded joints. Uncertainty in bond strength can be due to poor process control, manufacturing variability, environmental effects/aging, damage growth modeling, etc. Robust nondestructive inspection (NDI) techniques are needed to verify safety-of-flight-critical bonded structure for airworthiness certification. Current testing techniques involve statically loading the bonded structure to some specified load level to place the bondline under load. If the bond does not fail, it is determined to be acceptable and the structure is placed into service. This testing is costly and time consuming to undertake. There is a need to be able to proof test these bonds to quantify their strength with an efficient NDI method both during manufacturing and during depot level maintenance. Inspection technologies such as Laser Bond Inspection (LBI), through the use of well controlled stress waves to locally test the bondline, has shown promise to assess the relative bond strength between the adhesive and bonded structure and eliminate the need for expensive full-scale proof load testing. While NDI inspection technologies such as LBI is a demonstrated inspection technique, improvements to the overall coverage and access to complex, curved inspection areas will significantly increase such inspection technology's maturity. The current delivery is through an articulated arm, and an inspection head, which limits access to partially closed structures. The arm and inspection head also bring with them reliability and calibration issues, for example, optical elements that degrade through use and needs to be recalibrated frequently to maintain analysis reliability. As a result, a different laser beam delivery method is desired to eliminate the articulated arm and inspection head and be able to access internal structure of air vehicles and accurately interrogate the integrity/strength of the majority of bonded joints and structures (95% bonded areas). There are also reach limitations with the current composite bonded joint inspection methods such as LBI with the articulating arm providing only 4 foot radius semicircle which is significantly less than the desired reach for the acreage produced in large structural composite manufacturing. The new delivery method should expand the inspection envelope from the current limitations, inspection on substantially horizontal surfaces with the pulse required to be normal to the surface within a semicircle of about 4 foot radius. The new delivery method should substantially increase the inspection area compared to the current solution in composite structures with a thickness of up to approximately 2.54 cm or greater, and on any orientation of part surface.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should; 1. Define critical system requirements for inspection system hardware to increase the design space where NDI inspection technologies such as LBI could be employed. 2. Evaluate hardware concepts with the potential to non-destructively inspect the strength of composite bonded joints located in realistic vehicle confined spaces. 3. Develop a prototype concept and demonstrate feasibility to integrate into a NDI inspection technology such as LBI.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The current NDI inspection technology that interrogates the composite bond joint strength (LBI) includes an articulated arm and inspection head that provide a means for targeting the LBI laser pulse to a particular inspection location. Elimination of the LBI articulated arm and inspection head will require replacing their functionality with an alternate method. The laser pulse needs to be accurately delivered to a prescribed inspection point on the bonded structure and the necessary elements needed to generate the shockwave that tests the adhesive bond joint need to be demonstrated. In order to demonstrate readiness to proceed Direct to Phase II, proposer should provide data that demonstrates things such as the ability to locate a beam on the target and to create a shockwave to test the bond strength, evidence that precise targeting of the laser pulse is feasible using the proposed delivery method and data and evidence that proposed method interrogates and quantifies the strength of a composite bonded joint. Further mature and demonstrate system hardware to conduct inspections on specific areas in a Production Representative Environment. Perform NDI inspection technique technology maturation and refine requirements development with OEM consensus. Validate hardware reproducibility to accurately assess bonded joints. Incorporate safety features and redundancies to prevent delivering too high of threshold energy within a structure of varying thickness.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program. The contractor will further refine the NDI inspection technology to enable commercialization of the measurement of composite bonded joint strength and integrity using a technique such as laser bond inspection. This will include reduction in the overall size and footprint of the bond inspection system and the ability to seamlessly employ it in both a military and commercial aircraft production environment. Also, the system must be able to operate in a repeatable fashion over multiple surface variations to include contours and curvatures and over large acreage of composite bonded joints.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Laser; Bond; Inspection; Non-Destructive; Production;

AF224-D016 TITLE: ROC STAR (ROcket Cargo System Technology And Research)

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: This topic seeks to preform systems engineering, concept exploration, analysis, modeling and simulation, test and evaluation of point-to-point rocket transport of cargo.

DESCRIPTION: The commercial rocket industry is expected to have an evaluation of $1B over the next five years and the Department of the Air Force is interesting in examining how this new emerging market can be utilized for point to point transport of cargo. Rocket transport of cargo opens up a new capability by enabling the delivery of goods to any point on the earth within 90 minutes or less. While this capability provides a transformation in cargo transport, many challenges remain in making cargo transport via rocket a reality. A specific focus is how the Government can take advance of commercial capabilities without taking sole ownership or creating a unique aspect that is Government only, thereby driving up life cycle cost. Another aspect of interest to the Government is the ability to influence designs early on so that if there are unique Department of Defense (DoD) requirements, they can be incorporated into the commercial product enabling dual-use aspect. The Department of the Air Force is exploring rocket transportation capability for DoD logistics and the Air Force Research Laboratory (AFRL) is currently assessing emerging rocket capability across the commercial vendor base, and its potential use for quickly transporting DoD materiel to ports across the globe. The U.S. commercial launch market is building the largest rockets ever, at the lowest prices per pound ever, with second-stages that will reenter the atmosphere and be reused. These advances in the U.S. commercial launch market are presenting the need for assessment and maturation of system-of-systems concepts of rocket transportation for DoD (Department of Defense) logistics by the United States air Force and Space Force (USAF/USSF). A large trade space exists for the potential of rocket cargo for global logistics, to include improvements in delivery cost and speed compared to existing air cargo operations. The goal of this effort is to investigate concepts, and yet to be develop concepts for rock cargo to determine technical feasibility and risk, programmatic costs, and schedule. The information, test and evaluation (T&E) under this effort will be used to influence and guide rocket cargo efforts. While the goal is to enable up to 100 tons of cargo to be delivered anywhere on the planet within tactical timelines, there may be optimization techniques and process with smaller amounts of cargo and transportation modes other than rockets that can provide rapid delivery of materials. An objective of this effort is to grow AFRL's Rocket Cargo industrial base. This topic is intended to reach companies capable of completing a feasibility study and prototype validated concepts under accelerated Phase I and II type schedules. This topic is aimed at later stage research and development efforts rather than front-end or basic research/research and development. The focus is on emerging commercial capabilities to minimize cost and enable agile logistics through the entire span of responsive mission planning, rapid cargo logistics, ground launch operations and coordination with commercial airspace. The main deliverables will be modeling and simulation (M&S), T&E of concepts that advance the viability and utility of using commercial rockets and associated systems for Department of Defense global logistics to expanding capabilities of the USSF for combatant commanders.

PHASE I: This topic is intended for technology proven ready to move directly into Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. Relevant areas of demonstrated experience and success include, M & S, cost benefit analysis, risk analysis, concept development, concept demonstration and concept evaluation, laboratory experimentation and field testing. Phase I type efforts include the assessment of emerging commercial rocket capability and the potential to quickly transport DOD materiel to ports across the globe. Phase I type efforts would include agile global logistic concepts to deliver 1 to 100 tons of DoD cargo anywhere on the planet in less than one hour. The result of Phase 1 type efforts is to assess and demonstrate whether commercial rockets and associated systems can deliver DoD cargo anywhere on the planet in less than one hour.

PHASE II: Eligibility for a Direct to Phase Two (D2P2) is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR/STTR Programs. These efforts will include M & S, simulation of prototype concepts, cost benefit analysis, system-of-systems studies, experimentation and evaluation of rapid logistics concepts that enable quick transport of DoD material to ports across the globe. Prototypes, M & S and experimentation should explore a wide range of integrating commercial rocket capabilities and cargo platforms within the Air and Space Force logistics train. These capabilities should consider areas that are unique to military logistics such as mission planning and execution, transportation of quick reaction forces/humans, munitions, fuel, ground operations, loading and unloading of cargo and transportation of unloaded cargo other remote locations. Phase II efforts shall conduct analysis, M & S, sub-scale and if possible, full-scale experiments to address military-unique requirements that may not be otherwise met by commercial space transportation capabilities. No funding will be invested in developing commercial rocket systems.

PHASE III DUAL USE APPLICATIONS: Phase III shall include upgrades to the analysis, M&S, T&E results and provide mature prototypes of system concepts. Phase III shall provide a business plan and address the ability to transition technology and system concepts to commercial applications. The adapted non-Defense commercial solutions shall provide expanded mission capability for a broad range of potential Governmental and civilian users and alternate mission applications. Integration and other technical support to operational users may be required.

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KEYWORDS: Rocket Cargo; Cargo Systems; Connex Box; ISO-90; TEU (Twenty-Foot Equivalent Unit); Delivery Systems; Agile Logistics; Commercial Rockets

AF224-D017 TITLE: STABILIZE (Stabilization of Teu containers for Air-drop capaBilities and Internal LoadIng optimiZation Experiments)

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform; Electronics

OBJECTIVE: This topic seeks to preform concept exploration, Modeling and Simulation (M & S), prototype development, sub-scale experiments, test and evaluation of intermodal cargo containers that are suitable for space transport with internal capabilities to secure cargo of various types and be capable of air drop from sub-space. The ability to open the container during air drop and deploy the contents within is also an objective

DESCRIPTION: The US Transportation Command (USTRANSCOM) has been utilizing inter-modal containers to allow cargo to withstand the environments of transport by air, sea, rail, and land, and rapidly switch between the transport modes without repackaging. Inter-modal containers for use in point-to-point rocket cargo transport are a new and emerging mode of transport and the DOD is interested in energizing this area for research and development. In the past, the DoD optimized rocket payloads solely for mass, understanding the trade-space between mass-optimization and end-to-end speed of the logistics chain is desired. Relaxing the mass optimization for containers presents a vast array of concepts to greatly accelerate the speed at which crews can load and unload a rocket. Novel designs in mass optimized, inter-model containers for space could allow crews to move the cargo to other transport modes without having to repack materials in separate and distinct containers. The goal of this effort is to investigate and develop concepts for inter-modal containers that are suited for air drop of cargo from a rocket from low earth orbit to sub-space altitudes. The containers then need to stabilize in order to deploy systems to reduce speed, such as drogue chutes, then deploy systems to enable precision delivery of the container. Existing ISO-90 and TEU type cargo containers will need to be adopted to allow stabilization and delivery systems to their infrastructure. The addition of these stabilization systems need to consider how the containers are modified and how the modifications may impact loading and deployment during air drop. Another aspect of air drop is where the cargo container is ejected, stabilized and then the contents of the container are in-turn ejected. The ejected sub-containers themselves may need stabilization and systems to enable precision delivery. Cargo within the containers may be of a sensitive nature and may require vibration and shock isolation such as medical equipment/supplies, liquid fuel and even human transport needs. The information, test and evaluation (T & E) under this effort will be used to influence and guide container development that is suitable for rocket cargo efforts. An objective of this effort is to enable the commercial market to develop and manufacture inter-modal shipping container that meet the needs of the DoD for air drop via rocket transportation. This topic is intended to reach companies capable of completing a feasibility study, prototype or sub-scale experiment to validate concepts under accelerated Phase I and II type schedules. This topic is aimed at later stage research and development efforts rather than front-end or basic research/research and development. The focus is on emerging commercial capabilities of cargo containers to minimize cost and enable agile logistics through the entire span of responsive mission planning, rapid cargo logistics, ground launch operations and coordination with commercial airspace. 463L interfaces/materials handling system should be taken into consideration as that is cargo system used for military aircraft and a standard form factor to be considered is the ISU-90 and the TEU. The main deliverables will be modeling and simulation (M & S), T & E of concepts that advance the viability and utility of using commercial inter-modal container systems for rocket transport capabilities of the United States Space Force (USSF) for combatant commanders.

PHASE I: This topic is intended for technology proven ready to move directly into Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. Relevant areas of demonstrated experience and success include, M & S, cost benefit analysis, risk analysis, concept development, concept demonstration and concept evaluation, laboratory experimentation and field testing. Phase I type efforts include the assessment of emerging commercial inter-modal container systems that enable rapid transport of DOD materiel to ports across the globe. Phase I type efforts would include the addition of space as a new domain for inter-modal systems. In addition, Phase I-like efforts would include assessment of containers that can withstand high-g ejection and thermal loading in the case of air launched delivery. Novel methods for disassembly and/or prepping containers to re-enter the logistics chain should have also been addressed. The result of Phase 1 type efforts is to assess and demonstrate whether commercial container systems can support the DoD's goal of delivering cargo anywhere on the planet in less than one hour.

PHASE II: Eligibility for a Direct to Phase Two (D2P2) is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR/STTR Programs. These efforts will include simulation of prototype concepts, experimentation and evaluation of commercial shipping containers that enable air drop of DoD materials and the necessary supporting systems to stabilize and allow for the precision delivery of cargo. Prototypes and experimentation should explore a wide range of inter-modal systems that can be used for air drop on commercial rocket capabilities. The container systems should consider areas that are unique to military logistics such as mission planning and execution, transportation of quick reaction forces/humans, munitions, fuel, ground operations and precision delivery of cargo to remote locations. Efforts in this Phase II D2P2 should consider the capability to ejected smaller, sub-containers from the larger container during air drop. These sub-containers may require precision delivery to points on the earth or above earth LEO orbit injections. No funding will be invested in developing commercial rocket systems.

PHASE III DUAL USE APPLICATIONS: Phase III shall include upgrades to the analysis, M&S, T&E results and provide mature prototypes of system concepts. Phase III shall provide a business plan and address the ability to transition technology and system concepts to commercial applications. The adapted non-Defense commercial solutions shall provide expanded mission capability for a broad range of potential Governmental and civilian users and alternate mission applications. Integration and other technical support to operational users may be required.

REFERENCES:
1) V. Reis, R. Macario, Intermodal Freight Transportation, Elsevier, 2019;
2) R. Konings, H. Priemus, P. Nijkamp, Future of Intermodal Freight Transport, Operations, Design and Policy, Elgar Publishing, 2008;
3) C. Moore, S. Yildirim, S. Baur, Educational Adaptation of Cargo Container Design Features, ASEE Zone III Conference, 2015;
4) K. Giriunas, H. Sezen, R. B. Dupaix, Evaluation, modeling, and analysis of shipping container building structures, Engineering Structures, vol. 43, 2012;
5) ISO 90-2, 1997, Light gauge metal containers -- Definitions and determination of dimensions and capacities -- Part 2, General use containers 1997;
6) USTRANSCOM, Charter for the Joint Intermodal Working Group, https://www.ustranscom.mil/imp/docs/Charter_of_JIWG_20_Jun_12.pdf;
7) Defense Transportation Regulation part VI, Management and Control of Intermodal Containers and System 463L Equipment, https://www.ustranscom.mil/dtr/dtrp6.cfm, 2021;
8) Defense Transportation Regulation References, https://www.ustranscom.mil/dtr/dtr_references.pdf

KEYWORDS: Rocket Cargo; Space Transport; Intermodal Containers; Parachute Precision Delivery

AF224-D018 TITLE: Aerospace-Capable Pressure Sensitive Adhesives for Difficult-to-Bond Substrates

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: The end state of this project is to have a fully developed and characterized Pressure Sensitive Adhesive (PSA) material system that meets or exceeds air platform specific requirements. The PSA's bonding performance shall be demonstrated in an approved laboratory test rig and shall provide a repeatable 100% increase in bond strength over that of existing material system, in the most challenging of aerospace environments. This demonstration shall correspond to a Material Readiness Level of 5 or 6 (see Department of Defense Instruction (DoDI) 5000.02). The final product will be considered for future Program Office funding to qualify and transition the material system.

DESCRIPTION: Implementation of an aerospace-capable Pressure Sensitive Adhesive (PSA) material on air platforms will reduce maintenance man hours (MMH) and increase Mission Capability rates for the fleet by lowering the amount of unavailable time for each platform while inspection and maintenance tasks related to PSA-bonded items are being carried out. Lowering MMH will lower Air Combat Command's cost of ownership of 5th and 6th generation assets. Although there are a variety of existing market solutions for aerospace PSA's, none of these have demonstrated reliable bonding to the kinds of substrates being considered in this effort. Current materials suffer from low bond strength and undesirable failure modes under combinations of conditions commonly experienced over the entire flight envelope. The goal of this SBIR topic is to develop a truly capable PSA material that provides improved performance over OEM-qualified materials. This material shall also be demonstrated to be producible in multiple product forms and to not require increased inspection and/or on-aircraft repair time over existing materials. The PSA must meet all OEM requirements (Outer Mold Line material compatibility, fluid resistance, temperature range, bond-line thickness, peel strength…etc.,) and shall not require major changes to current application processes, including spraying.

PHASE I: Proposed solutions for this topic must have already shown phase 1 feasibility by developing a pressure sensitive adhesive (PSA) suitable for use on outer mold line (OML) coatings of aircraft. The PSA must have the capability to operate at the expected service temperature range of -65°F to 250°F even after exposure to aircraft fluids for 7 days. At room temperature it should be capable of cleanly removing from the aircraft surface without leaving difficult-to-remove residue and without damaging aircraft OML coatings. In accelerated aging tests the PSA should have a shelf life of at least 1 year (2+ years is preferable). In addition, production of PSA tapes from the proposed adhesive should have been demonstrated on commercial coating lines by way of partnership with other aerospace material suppliers. The PSA may require modification during the D2P2 effort to increase bond strength by 100% relative to the existing formulation for difficult-to-bond substrates under the most demanding test conditions. In addition, this formulation may need to be modified for spray application depending on OEM requirements. There are likely other platform-specific performance requirements not addressed in previous efforts, and these will must be assessed under the current D2P2 effort, including cold temperatures, high aero loads, different substrates and minimal inspection burden once applied. Additionally, D2P2 effort may require additional development/optimization of compatible surface treatments on the substrate material of interest.

PHASE II: The D2P2 effort should modify the candidate PSA material to meet or exceed existing requirements for difficult-to-bond substrates. The SBIR offeror shall coordinate with Lockheed Martin (LM) and others to develop and define material requirements and establish appropriate test methods to characterize material performance and compare this to the legacy PSA material system. A quantifiable goal of this D2P2 effort is to double the bond strength of current materials on difficult-to-bond substrates, with specific substrate materials to be finalized in consultation with LM and Others. Final demonstrations of the material performance shall be performed using an exposure test rig of a design approved by both OEM and the specific air platforms. The final specification of PSA shall be fully-characterized by the end of the program and cost and supply estimates shall be determined. The target Material Readiness Level (MRL) for the PSA shall be 5 or 6 (see Department of Defense Instruction (DoDI) 5000.02)

PHASE III DUAL USE APPLICATIONS: Phase III funding will be considered by the air platform System Program Offices. The intent of a Phase III effort will be to perform a flight test evaluation and to contract the appropriate Airframe OEM for material qualification and approval.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Cantor, Adam S. and Vinod P. Menon. Pressure-Sensitive Adhesives. Materials Science, 2010.

KEYWORDS: Pressure-Sensitive Adhesive; Bond Strength; 5th Generation Aircraft; 6th Generation Aircraft; Outer Mold Line;

AF224-D019 TITLE: Microstructural Fragmentation Control in Penetrating Munitions

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Ground Sea

OBJECTIVE: Develop a cost effective microstructural process to improve fragmentation in penetrating/perforating munitions without degrading impact survivability.

DESCRIPTION: Develop a process to create localized microstructural features (grain size, shape, size distribution) in a steel munition case (4340, ES-1, AF9628) with localized stress concentrations equivalent to machined notch stress concentrations (1-10mm deep v-notches), without degrading the case's impact survivability against hard targets. The process should be performed after the casting/forging process, and either before or after the machining and heat treatment processes. This topic excludes additive manufacturing techniques. The process should be cost effective for high volume manufacture. Generate a mechanical (static and fatigue) properties database for different microstructures to assist on-wing munitions structural durability analyses. Characterize the effect of these localized microstructural features on fragmentation performance in small scale testing. Develop and exercise a model to optimize the process to a Government-identified desired fragmentation performance. Conduct high-rate shock characterization tests and, if significant difference found between the performances of the different microstructures, develop mechanical response models for penetration and perform high-fidelity numerical simulations against a spectrum of hard targets to determine survivability robustness. Perform subscale arena tests with a treated case to characterize fragmentation. Perform subscale ballistic tests with a treated projectile at subsonic and supersonic velocities with monolithic and layered concrete targets to determine the survivability limits. Perform high-fidelity numerical simulations of the arena tests and the ballistic tests - both pre-test and post-test.

PHASE I: This is a Direct to Phase II (D2P2) SBIR and there will be no Phase I effort. Proposers should provide the following documentation to show that the proposer's technology is mature enough for a D2P2: (a) experimental data showing controlled fragmentation in small-scale explosive tests, (b) micrographic or other characterization data showing microstructural changes in the treated steel, and (c) mechanical property data of the treated steel.

PHASE II: Develop a process to create localized microstructural features (grain size, shape, size distribution) in a steel munition case (4340, ES-1, AF9628) with localized stress concentrations equivalent to machined notch stress concentrations (1-10mm deep v-notches), without degrading the case's impact survivability against hard targets. The process should be performed after the casting/forging process, and either before or after the machining and heat treatment processes. This topic excludes additive manufacturing techniques. The process should be cost effective for high volume manufacture. Generate a mechanical (static and fatigue) properties database for different microstructures to assist on-wing munitions structural durability analyses. Characterize the effect of these localized microstructural features on fragmentation performance in small scale testing. Develop and exercise a model to optimize the process to a Government-identified desired fragmentation performance. Conduct high-rate shock characterization tests and, if significant difference found between the performances of the different microstructures, develop mechanical response models for penetration and perform high-fidelity numerical simulations against a spectrum of hard targets to determine survivability robustness. Perform subscale arena tests with a treated case to characterize fragmentation. Perform subscale ballistic tests with a treated projectile at subsonic and supersonic velocities with monolithic and layered concrete targets to determine the survivability limits. Perform high-fidelity numerical simulations of the arena tests and the ballistic tests - both pre-test and post-test.

PHASE III DUAL USE APPLICATIONS: Develop manufacturing plan to apply microstructure-altering process to a Government-specified munition in a limited-run production environment. Develop a cost estimate for pilot production. Exercise the models to design a microstructure treatment plan for a full-scale Government-specified munition. Use high-fidelity numerical simulation to generate a synthetic Z-data file.

Use high-fidelity numerical simulation to predict penetration performance against Government-specified targets. Treat four Government-provided munitions and deliver to the Air Force for range testing.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) Gold, V.M., Baker, E.L., Ng, K.W., Hirlinger, J.M, A Method for Predicting Fragmentation Characteristics of Natural and Preformed Explosive Fragmentation Munitions, ARWEC-TR-01007, 2001
2) US Army Materiel Command, Engineering Design Handbook, Warheads-General, AMCP 706-290, AMC, 1964;
3) Johnson, C, Mosely, J.W., US Naval Weapons Laboratory, Preliminary Terminal Ballistic Handbook, Part I, Terminal Ballistic Effects, NWL Report No 1821, Defense Documentation Center for Scientific and Technical Information, 1964

KEYWORDS: penetrator; fragmentation; microstructural; steel; warhead; munition; ordnance; perforator;

AF224-D020 TITLE: Shape Stable Segmented Nozzles for Scramjets

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials; Air Platform

OBJECTIVE: The topic will require offerors to propose a material and manufacturing method for advanced non-eroding nozzles (monolithic, cladded or segmented) for near-term scramjet-powered vehicles. While it is intended that designs should be viable for both a single-use (threshold) and/or a multi-use application (objective); the nozzle should consist of flame-facing components that can minimize thermal stresses and oxidative recession. Proposed materials should have been screened in a Phase I effort or a similar project. Nozzle assemblies should be manufactured and sized at nominally 8 inches in diameter, radiative-cooled, and capable of maintaining shape stability in elevated exhaust temperatures consistent with high Mach combustion [5+] where flame temperatures nominally range from 4000 to 5000°F. The deliverable will be a nozzle assembly that will be tested in a scramjet test cell in the Air Force Research Laboratory. Note, the available scramjets may be cycled between high and mid temperature to achieve a 20 minute accumulated life time at the high temperature condition.

DESCRIPTION: Scramjet nozzle assemblies should be manufactured and sized at nominally 8 inches in diameter, radiative-cooled, and capable of maintaining shape stability in elevated exhaust temperatures consistent with high Mach combustion [5+] where flame temperatures nominally range from 4000 to 5000°F. The deliverable will be a nozzle assembly that will be test in a scramjet stand at AFRL/RQHP. Note, the available scramjets may be cycled between high and mid temperature to achieve a 20 minute accumulated life time at the high temperature condition.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have; 1.) Exposure and performance data of material coupons or propulsion assembly sub-elements in environments with similar thermal loads and combustion chemistries (e.g. rocket/high-mach nozzles). 2.) Simulation/Analysis of candidate material performance in a similar environment to screen material properties and designs for similar nozzles. 3.) Previous nozzle designs that have been demonstrated as effective, but would need modification/scaling of existing materials for this more aggressive combustion environment.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The proposer shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. The Phase II effort will require a team approach with several disciplines. [1.]Material fabricators to produce nozzle configurations. [2]. Modelers to help design the part/assembly geometry via thermostrucutrual and thermochemical analysis as a function of temperature and time, including fracture criteria. [3.] A laboratory-scale approach for screening subscale components/attachment schemes to show feasibility prior to test cell entry. [4.] Microstructural chaterization personnel to analyze the pre and post-test microstructures from both screening and firing.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) M.M. Opeka, Oxidation Performance Assessment of Inhibited Carbon-Carbon Materials for High-Temperature Oxidizing Environments, JDOC, Pub 0747, 1986.

KEYWORDS: hypersonics; scramjet; nozzles; ultra-high temperature materials;

AF224-D021 TITLE: Demonstration of Corrosion Monitoring Capability for the HH-60W

TECH FOCUS AREAS: Microelectronics; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Sensors; Electronics; Materials; Air Platform

OBJECTIVE: At the end of this project, have a software module for the HH-60W Integrated Vehicle Health Management System (IVHMS) module that communicates with Luna Labs' Acuity LS corrosion monitoring devices and demonstration of the software at the System Integration Lab (SIL) at Robins AFB.

DESCRIPTION: At the end of this project, a software module for the HH-60W Integrated Vehicle Health Management System (IVHMS) module that communicates with Luna Labs' Acuity LS corrosion monitoring devices and demonstration of the software at the System Integration Lab (SIL) at Robins AFB. This would include the cabling required to connect the Acuity devices with the IVHMS module located at the SIL. (Note, The IVHMS part number is 78600-02806-101 [CAGE 78286]; The part numbers for Luna's Acuity LS device are A0201 (NSN 66851021294100) and PA0203 (NSN 66851021294102) [CAGE 8JML8). Note that the IVHMS source code was written by Simmonds Precision Products, UTC aerospace company [CAGE 12511]. This project needs to test the Acuity LS sensor using the SIL to monitor the five areas of measurement (Temperature, Relative Humidity, Conductance, Free Corrosion Rate, and Galvanic Corrosion Rate) for input and output with the IVHMS and the software updates shall configure appropriate Built In Test (BIT) fault strings and accept inputs from the upgraded Acuity LS device. If possible within budget and time constraints, it is also desirable for the following task to be accomplished, 1. Update the Sikorsky Ground Based Application (SGBA) with trending capability using Condition Based Maintenance Plus (CBM+).

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have; Identified the prime potential AF end user(s) for the non-Defense commercial offering to solve the AF need, i.e., how it has been modified; Described integration cost and feasibility with current mission-specific products; Described if/how the demonstration can be used by other DoD or Governmental customers. ~~IVHMS and Luna Acuity LS have already been developed as independently-funded systems. Documentation demonstrating the IVHMS and Acuity LS device has passed HH-60W environmental requirements shall be supplied to help determine if Phase I feasibility has been met.~~ The applicant should be able to demonstrate that it has competency with software development for health monitoring systems (e.g. IVHMS) interfacing with other devices/systems (e.g. previous software development and/or integration projects.)

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a relevant demonstration of a software module for IVHMS using the Systems Integration Laboratory (SIL) at Robins AFB. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. Air Force sustainment stakeholder engagement is paramount to successful validation of the technical approach. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the technology by developing a full cost proposal for implementation of the IVHMS software module and installation of Luna Labs' Acuity LS devices for the HH-60W fleet. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

REFERENCES:
1) ISO 22858, 2020 Corrosion of metals and alloys Electrochemical measurements Test method for monitoring atmospheric corrosion;
2) AMPP TM21449-2021, Continuous Measurements for Determination of Aerospace Coating Protective Properties;
3) MIL-STD-1530, Aircraft Structural Integrity Program (ASIP);
4) MIL-STD-810, Test Method Standard, Environmental Engineering Considerations and Laboratory Tests;
5) MIL-STD-889, Standard Practice, Dissimilar metals;
6) J. Demo and F. Friedersdorf, Aircraft corrosion monitoring and data visualization techniques for condition based maintenance, 2015 IEEE Aerospace Conference, 2015, pp. 1-9, doi, 10.1109/AERO.2015.7119048

KEYWORDS: corrosivity; environment severity; environment spectra; condition based maintenance; atmospheric corrosion; maintenance; sustainment;

AF224-D022 TITLE: Scale-Up of High-Pressure Chemical Vapor Deposition for Non-Eroding Materials

TECH FOCUS AREAS: Nuclear; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Nuclear; Space Platform; Materials; Air Platform

OBJECTIVE: This topic will request offerors to support anticipated long-term Department of the Air Force needs for shape-stability in extreme environments like rocket nozzles, catalyst beds, shock-resistant structures and ballistic nosetips by scaling processes that can manufacture catalytic and transpiration-cooled assemblies of Non-Eroding Materials via a High-Pressure Chemical Vapor Deposition process that enables both fine features (a resolution of 50 microns) for transpiration but also enables ease of scaling of such features over a larger length-scale up to a nominal build volume of 6 x 6 x 6.

DESCRIPTION: High-Pressure Chemical Vapor Deposition can react gas-phase constituents to produce condensed carbides, nitrides, and intermetallic compounds in a manner similar to additive manufacturing but without the need for powder feed-stocks. This process can create fine features ideal for transpiration-cooled and catalytic structures that would find use in extreme environments such as rocket nozzles, catalyst-beds, shock-resistant structures, high-temperature transparencies, and hypersonic leading edges, all of which require materials capable of maintaining shape-stability under oxidizing conditions and very high saturation temperatures in excess of 5000 oF. In such cases, architectures that enable transpiration of a working fluid or enhanced catalycity can significantly suppress or eliminate the recession/shape-change of high-melting temperature substrate materials and greatly expand their range of operation.

PHASE I: "This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have 1.) Demonstration of a Laser/High-Pressure CVD or similar process. 2.) Process Analysis or Simulation of a Laser/High-Pressure CVD, or similar process. 3.) Characterization of material derived from a Laser/High-Pressure CVD process that informs process scaling.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. While this process has generally been demonstrated for small length-scales and limited-length fiber-like applications, there is a need for exploring and understanding the scaling potential of such a process as well as its effects on the processing and microstructure of materials of interest for shape stability in high strength or oxidation resistant materials. While the approach should be materials agnostic, resultant products of the process should compete favorably with 3DCC, such as Silicon Nitride (Si_3N_4), Silicon Carbide (SiC), cemented carbides, and and platinum group intermetallics and their carbides/nitrides.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

REFERENCES:
1) S. Harrison, UHTC Materials Systems Using R-LCVD Fiber Reinforcements, National Space Missile Symposium, 2019;
2) L. Cameron, Optically Transparent High Temperature Ceramic Fibers, National Space Missile Materials Symposium, 2021.

KEYWORDS: non-eroding materials; chemical vapor deposition;

AF224-D023 TITLE: Manufacturing of All-Weather Non-Eroding Nosetip for Ballistic Reentry

TECH FOCUS AREAS: Nuclear; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Nuclear; Materials

OBJECTIVE: The topic will require offerors to propose, fabricate, model and ground test materials and assemblies of non-eroding/shape-stable, all-weather nosetips for ballistic flight conditions.

DESCRIPTION: Offerors may have already identified material compositions of interest through previous efforts and modify these compositions through this work or they may produce new compositions using their prior processing methods to produce a similar microstructures and thermal-mechanical properties to their prior system. Material that shows shape stability under nosetip surface temperatures ranging from 5000-8000°F with recession rates around 25% of 3DCC under similar conditions. Additionally the material must have the strength, toughness, and hardness at temperature such that it can sustain shock-loading relevant to all-weather conditions consistent with potential ballistic and/or hypersonic trajectories. Transpiration cooling to achieve shape-stability in these environments is permissible as is geometric approaches to maintaining constant sharpness under flight. Offerors should identify, produce, and qualify candidate materials for advanced re-entry all-weather nosetips, through both experimental ground testing and modeling efforts sufficient enough to conduct a small number of advanced manufacturing and testing demonstrations.

PHASE I: "This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have 1) The manufacture and/or characterization of materials for similar applications (hypersonic leading edges, non-eroding rocket nozzles). 2) Exposure and performance data of material coupons for similar applications. 3) The development of weather databases and/or models that simulate non-linear effects of weather on materials. 4) Screening/Testing and analysis of hypersonic materials weather environments (gas-guns/rain-fields/modified wind tunnels).

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. It is anticipated that this program will require a team approach with several disciplines, [1] Material modelers that can use advanced methods to assess candidate materials that will have the thermal, physical, mechanical, dynamic, and environmental properties needed to survive the extreme conditions endured by candidate nosetips; [2] Process and performance modelers to build property and life models using different materials with various architectures to provide uniform distribution of pressure and temperature under potential use conditions; [3] Fabricators to produce the identified materials with various configurations. Selected materials/structures should be fabricated into articles ready for screening at a Government test facility, such as the arc jet facility at AFRL/RQ at AEDC or the sled track at Holloman AFB. Shape and size of the nosetips will be determined in coordination with the government program manager, test facility, and offeror. These screening test at appropriate government facilities should be proposed and paid for under the contract. [4] The offeror will have to conduct microstructural characterization of the nosecones both pre and post testing. The performance and microstructural data shall be used to validate and inform developed models. Test articles should be delivered to the Air Force upon completion of each task. [5] A demonstration articles will be a deliverable to the government.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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1) H. Minnich, J. Brunner, Thermostructural Assesment of Erosion Resistant Nosetip Constructions, AFWAL-TR-84-4191, 1985 ;
2) J. Brown, Erosion Performance of Carbon-Carbon Composite Materials, 1980 ;
3) M. Sherman, Hardened Reentry Vehicle Development Program - Erosion Resistant Nosetip Development, DNA 001-74-C-0033, 1975.;
4) R. Diriing, D. Eitman, Development of Highly Erosion Resistant Nosetip Materials, SAI-061-81-09-08/N60921-80-C-0068, 1981.;
5) M. Abbett, et. al, Passive Nosetip Technology Program, SAMSO-TR-74-96, 1975.

KEYWORDS: nosetips; reentry; all-weather; non-eroding;

SF224-D024 TITLE: Enabling Materials and Technologies for Surviving Landing Area Rocket Plume Interactions

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform; Materials; Air Platform

OBJECTIVE: The objective is to provide a rapid development of material and process options for extremely high temperature and harsh rocket plume environments via early rigorous screening testing in relevant environments.

DESCRIPTION: Although vertically landing a rocket on an improved, flat surface has been achieved by multiple launch vehicle companies (Masten Space, SpaceX, Blue Origin), landing a rocket vehicle on an irregular, unimproved surface has a number of challenges including, but not limited to the rocket sinking in the surface, the plume kicking up dust and creating an observable event, and the uneven footing causing the rocket to fall over. The terrain that the rocket vehicle may land in is also unpredictable and not known a priori. Any solution needs to be broad enough to handle multiple potential landing challenges and to be able to adjust to the situation seen at landing. The intent of this topic is to accelerate the development of technologies to vertically land a rocket on an irregular, un-improved surface. It is recognized that a number of different technologies are possible to achieve the overall objective. This can include (but is not limited to) sensor technology on the lander, nozzle technology to mitigate plume impingement, venting of gases and liquids from the vehicle as it is landing, as well as mitigating ground structures that can easily and quickly be applied to a surface. The proposed efforts may focus on rapid testing, development and incorporation of various material and technological options for landing and diagnostic sensing, attachment and approaches, process improvement for existing but immature landing materials/attachment, or manufacturing process development of lower cost of state-of-the-art materials with innovative combination of high temperature landing and seam materials as well as attachment concepts to satisfy requirements. The candidate material(s) and concept should be validated through a range of mechanical, thermal, chemical, and combined hot fire tests, at various times throughout the effort with early fire screening test to provide rapid feedback for materials development and concept improvement. For a material maturation focused effort, validation should include a demonstration of the ability to fabricate and fire test representative sized components (e.g., a 2â€™ x 2â€™) by the end of the effort. The component should then be tested in a relevant environment. For a manufacturing focused effort, manufacturing of a full-scale relevant size with integrated seams/attachment shall be performed to prove the process.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should 1) Exposure and performance data of material coupons or landing assembly sub-elements in environments with similar thermal loads and rocket plume chemistries. 2) Simulation/Analysis of candidate material performance in a similar environment to screen material properties and landing structural/attachment designs. 3) Feasibility of process manufacturing improvements, materials/attachment, diagnostic sensing that have been demonstrated for similar applications, but would need modification/scaling for this more aggressive environment.

PHASE II: "Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. It is anticipated that this program will require a team approach with several disciplines, [1] Material and process modelers that can use advanced methods to assess or to build property using different materials (cost-effective and logistically lean) with various architectures (multilayering of multiple materials, etc.) to provide thermomechanical and oxidation resistance of candidate materials and technical concept that will have the thermal, physical, mechanical, dynamic, and environmental properties needed to survive the extreme conditions during rocket landing (hot oxidizing plume, debris and dust); [2] Fabricators to produce the identified materials with various configurations. Selected materials/structures/technologies should be fabricated/inserted into articles ready for screening at a Government test facility, such as the Air Force Research Laboratory hot-fire testing facility, with their 500-1000 lb thrust stand for such demonstrations, or an equivalent with a 1 klbf, kerosene-oxygen engine plume impinging on a landing pad simulator or larger system (teaming with launcher or other test sites) shall be used. Shape and size of the test coupons and panels will be determined in coordination with the government program manager, test facility, and offeror. These screening test at appropriate government facilities should be proposed and paid for under the contract [3] The offeror will interact with computational fluid dynamics (CFD) model developers to ensure needs are met. The offeror have to conduct characterization of the test articles both pre and post testing. The performance and characterization data shall be used to validate and inform developed models. Test articles should be delivered to the Air Force upon completion of each task; [4] A demonstration articles will be a deliverable to the government. The Air Force Research Laboratory Aerospace Vehicles Directorate will provide one week of testing time, up to ten tests a day, and the rocket chamber and ground simulant to carry out such a demonstration. Efforts will demonstrate the materials and technical concepts on a landing pad simulator which will be located at a range of distances to be determined, but within the overall range of 18-72 inches.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will scale the materials and technological concepts to withstand a 10 klbf thrust engine or larger and provide demonstration of efficacy and/or field prototype system for demonstration with medium or large rocket landing (to include dust and other environmental factors). This demonstration will necessarily involve commercial partners since the military does not manufacture nor purchase rockets.

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2) G.P. Sutton O. Biblarz, Rocket Propulsion Elements, 7th Ed., John Wiley Sons, Inc., New York, 2001, ISBN 0-471-32642-9.;
3) D.K. Huzel D.H. Huang, Modern Engineering for Design of Liquid-Propellant Rocket Engines, Vol 147, Progress in Astronautics and Aeronautics, Published by AIAA, Washington DC., 1992, ISBN 1-56347-013-6.;
4) Yang, V et. al, Liquid Rocket Thrust Chambers, Aspects of Modeling, Analysis, and Design, Vol 200, Progress in Astronautics and Aeronautics, Published by AIAA, Washington DC, 2004, ISBN 1-56347-223-6, pp 403-436.;
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KEYWORDS: vertical landing; plume impingement; high temperature materials; liquid rocket engine;

AF224-D025 TITLE: Rapid Materials Development & Testing for High Speed Propulsion Systems (scramjet components)

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Materials

OBJECTIVE: To provide a rapid development of material and process options for extremely high temperature high-speed applications via early rigorous screening testing in relevant environments.

DESCRIPTION: Efforts may focus on development of new materials options and approaches, process improvement for existing but immature ceramic matrix composite (CMC) materials, or manufacturing process development of lower cost with better performance reproducibility of state-of-the-art materials. The candidate material(s) should be validated through a range of mechanical, thermal, and combined hot fire tests, at various times throughout the effort with early fire screening test to provide rapid feedback for materials development and performance improvement. For a material maturation focused effort, validation should include a demonstration of the ability to fabricate and fire test representative sized components (e.g., a 6 x 6 doubly curved panel, or 3 diameter hemisphere) by the end of the effort. The component should then be tested in a relevant environment (eg. scramjet inlet, isolator, combustion, and rotating detonation engine (RDE) engine components). For a manufacturing focused effort, manufacturing of a full-scale relevant geometry aperture shall be performed to prove the process.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should have 1) Exposure and performance data of material coupons or propulsion assembly sub-elements in environments with similar thermal loads and combustion chemistries (e.g. rocket/high-mach nozzles). 2) Simulation/Analysis of candidate material performance in a similar environment to screen material properties and designs for similar nozzles. 3) Previous scramjet component designs that have been demonstrated as effective, but would need modification/scaling of existing materials for this more aggressive combustion environment. 4) The manufacture and/or characterization of materials for similar applications.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. Offeror should conduct material and process development beyond initial feasibility demonstration through design, analysis, and experimentation; optimize processing parameters for yield and quality. Material testing should be conducted to validate material models and generate property databases; conduct material and process development beyond initial feasibility demonstration through design, analysis, and experimentation; optimize processing parameters for yield and quality. Material testing should be conducted to validate material models and generate property databases. It is anticipated that this program will require a team approach with several disciplines, [1] Material and process modelers that can use advanced methods to assess or to build property using different materials with various architectures (multilayered composites of multiple materials, etc.) to provide thermomechanical and oxidation resistance of candidate materials that will have the thermal, physical, mechanical, dynamic, and environmental properties needed to survive the extreme conditions endured by candidate scramjet flowpath materials; [2] Fabricators to produce the identified materials with various configurations. Selected materials/structures should be fabricated into articles ready for screening at a Government test facility, such as the Scramjet Test facilities at Wright-Patterson Air Force Base. Shape and size of the test coupons and panels will be determined in coordination with the government program manager, test facility, and offeror. These screening test at appropriate government facilities should be proposed and paid for under the contract. [3] The offeror will have to conduct microstructural characterization of the test articles both pre and post testing. The performance and microstructural data shall be used to validate and inform developed models. Test articles should be delivered to the Air Force upon completion of each task. [4] Demonstration articles will be a deliverable to the government.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: ceramic matrix composite; non-eroding materials; scramjet; extreme temperature;

SF224-D026 TITLE: Photonic Integrated Circuits for Optical Communications and PNT

TECH FOCUS AREAS: Quantum Sciences; Microelectronics; Network Command, Control and Communications

TECHNOLOGY AREAS: Space Platform; Air Platform; Information Systems; Battlespace

OBJECTIVE: Development of a low SWaP (size, weight, and power) photonically integrated laser system that outputs a 30 kHz carrier linewidth laser with 0.75 Watts of power in fiber, and the ability to phase and/or intensity modulate from 1 MHz to 50 GHz on a single packaged device to support high data rate communications and embedded PNT.

DESCRIPTION: Optical communications provides the capability to meet the future needs of DoD applications requiring high bandwidth, low-latency, and survivable links. Telecommunication networks, data center optical interconnects, and microwave photonic systems have already demonstrated in-fiber optical communications that support most of these needs [1, 2]. In addition, optical communication is unaffected by radio frequency (RF) interference, and has a high level of security through low probability of detection (LPD) and low probability of intercept (LPI). Recent advances in photonic integrated circuits show a path towards similar performance [3,4]. Small, compact laser terminals allow for proliferated integration into ground vehicles, aircraft, and spacecraft. The ideal transmitter for these applications should operate over a large bandwidth with a small driving amplitude at high optical power, high efficiency and be cost-effective. Furthermore, it should support multiple waveforms such as on/off keying, phase shift keying, and pulse position modulation. Photonic integrated circuits offer a potential solution to a low SWaP optical transmitter to meet these needs as well as the potential for mass production.

PHASE I: This is a Direct to Phase 2 (D2P2) topic. To qualify for this D2P2 topic, the Government expects that the small business would have accomplished the following in a Phase I-type effort via some other means (e.g. IRAD, or other funded work). It must have developed a workable prototype of each individual aspect of the system or design and simulation to demonstrate a system architecture that could address the phase 2 goals. The proposal must demonstrate the technical feasibility of such work and capability to fabricate, package and test such devices. Documentation should include relevant information, including but not limited to; technical reports, test data, and prototype designs and/or models.

PHASE II: Prototypes of a small platform consisting of an integrated laser and components to support phase and/or intensity modulation outputting at least 0.75 Watts in fiber. Although a specific size is not given, overall size will be a metric that is considered. The laser should be high efficiency, single mode with <30 kHz instantaneous linewidth with the potential to specify a wavelength between 1532-1560 nm. The phase and/or intensity modulation should be low driving power, low insertion loss with a bandwidth from 1 MHz to greater than or equal to 50 GHz. The output of the photonically integrated circuit should be near diffraction limited with high fiber coupling efficiency. Modeling and design of packaging including photonic integration technique as well as thermal, optical and RF power handling. The device should be able to support communication schemes such as on-off keying and phase shift keying. Pulse position modulation is also desirable, though not required. Fabricate a specified number of devices in small packaging that includes electrical connections, a single mode fiber output, and thermal control. Identify a potential terminal integration partner.

PHASE III DUAL USE APPLICATIONS: Space communications, PNT, free space optical time transfer, and LIDAR on low SWaP platforms would benefit the DoD community. From a commercial perspective, such as interconnected satellites, an advancement would enhance data capacity for increased communications bandwidth. Technology transition would occur as an exploration of potential to transfer the technology into an existing laser communication programs, and military applications would include enhanced communication and PNT. This potentially includes integration with a terminal identified in the first phase.

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2) K. Kikuchi, et al., J. Lightwave Technol. 34, 157 (2015);
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4) McKinzie, K. A., et al., Opt. Express 29, 3490-3502 (2021).

KEYWORDS: laser communications; position; timing and navigation; photonic integrated circuits

SF224-D027 TITLE: Additive Manufacturing of Imaging Cubesat with Lightweight Radiation Hardened Enclosure

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform; Materials

OBJECTIVE: Traditionally, the satellite community has produced large, complex imaging satellites that cost in excess of $1B per copy that are stationed throughout low earth orbit to Cis-lunar orbits. Individual components such as mirrors, optical field effect transistors, solar panels, and associated electronics have been hardened to survive this environment and increasingly emerging threats; further driving up the cost of these assets. In order to enable more resilient architectures the space community is considering distributed/proliferated constellations of cubesat satellites that are individually more affordable and that can be rapidly replenished if necessary from emerging launch architectures. Therefore, the topic objective for this effort is to demonstrate rapidly fabrication of a low-cost, very lightweight, radiation hardened cubesat enclosure and integration of a controllable, stable imaging telescope using commercial available materials and AM technology where feasible. This rad hard structure will allow for use of commercial electronics instead of very expensive radiation hardened electronics; drastically lowering the cost. This request supports United States Space Force Tech Needs (946) Develop Low TRL Technology that Support Reduced Mass, Smaller Volume, Decreased Power Consumption, or Lower Cost for Space Vehicles and could possible be used for TN (1188) Cis-Lunar Architecture Initial Look a scouts around the moon.

DESCRIPTION: In this effort; the offeror is to show that they can rapidly fabricate a low-cost, very lightweight, radiation hardened cubesat enclosure and integrate it with a imaging telescope and commercial control-communication electronics. Then tested the system to show that they can get both optical thermal stability and control of the telescope as well as radiation survivability of the controlling and communications electronics.

PHASE I: "This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should have, 1) Manufacture of a radiation shielding material or enclosure relevant to the space environment 2) Analytical modeling of radiation effects on materials and validation in appropriate test facilities 3) Manufacture of integral optical/telescope assemblies for the space environment.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. Proposed efforts should include or reference prior modeling work to aid in enclosure and telescope design. Electromagnetic simulation of the proposed structure and communication ports and/or integral antennas and electronics should be conducted prior to manufacture with a necessary design iteration to ensure sufficient radiation protection of internal components, which themselves should be Commercial-Off-The-Shelf. Similarly, optical performance of the telescope (including integral filters) and build conditions required for a relevant level of performance in the proposed orbit should be identified either through prior work, or as part of the effort, but before manufacture A government or a non-government testing facility needs to be proposed and the cost for should tests should be included in the proposal.

Deliverables should include the post tested CubeSat system. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. So in this project a team approach will probably be needed. [1.] A material scientist and a design engineer will be required to design and rapidly fabricate a Cubesat enclosure that needs to be very lightweight and radiation hardened. [2.] A modeler as disdused above. [3]. The offeror will need to build or buy the lightweight telescope with its controls as well as communication links (all using commercial off the shelf electronics) and have them integrate into the radiation hardened enclosure. [4.] The offeror will then need to have a Testing house show that the system is thermal as well as eclectically stable in an "over active" space type environment; so it can be related to a system lifetime.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Cubesat; optical telescope; radiation hardened; additive manufacturing;

AF224-D028 TITLE: Low Noise Magnetic Materials for Next-Generation Brain-Machine Interfacing

TECH FOCUS AREAS: Biotechnology Space; Microelectronics; Network Command, Control and Communications

TECHNOLOGY AREAS: Bio Medical; Sensors; Electronics; Materials; Information Systems; Air Platform; Battlespace

OBJECTIVE: There is a strong need for compact low noise magnetic sensors for Magnetoencephalography (MEG) imaging systems that are capable of establishing a strong brain-machine interface (BMI) in an operationally relevant environment. To achieve this feat, high sensor density is required to achieve the high spatial resolution required to implement advanced signal processing techniques to establish optimum performance and eliminate the effects of abient mangetic noise. To achieve this feat the goal of this program is to develop compact (~0.5 in3) magnetic sensors from materials with extremely low magnetic noise resulting in ultimate sensitivities of better than 5pT/Hz1/2.

DESCRIPTION: Brain-Machine Interface (BMI) technologies read-out information from the brain by establishing direct links to brain signals that are interpreted using mathematical algorithms called decoders. 1. The amount of usable information that can be extracted from these signals is therefore constrained by the BMI technologies and decoding algorithms used. MEG is a preferred non-invasive BMI due to the high spatial resolution, but suffers from the need for special magnetically shielded facilities to eliminate ambient magnetic noise. Recently, there have been a major advancements in compact magnetic sensing. 2. Signal processing that opens the door to MEG imaging in a magnetically noisy operational environment. In order to realize an operationally relevant MEG BMI technology advances in low noise magnetic materials are required to dramatically enhance the performance of these compact sensing technologies. In order to realize significant improvements in low-noise magnetic materials and the subsequent MEG sensor devices, an in-depth understanding of the source of the magnetic noise in the materials and novel materials-based strategies to decrease the noise are required. Furthermore, testing of the materials in MEG sensors to trace material performance to device performance is also required. Other novel device-level strategies to furthermore improve sensor noise should also be implemented.

PHASE I: "This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should, 1) Include work demonstrating that the team can deliver several compact (less than 1 in^3) magnetic sensors and/or gradiometers integrated together either magnetic sensors or gradiometers with competitive performance. 2) Define critical system requirements for an aspect of human monitoring using the integrated sensors. 3) Evaluate hardware concepts aimed at human monitoring with magnetic sensors. 4) Develop a prototype concept and demonstrate feasibility of generating the prototype concept within the program

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution. The proposer shall sufficiently develop the technical approach, product, or process in order to conduct a small number of advanced manufacturing and/or sustainment relevant demonstrations.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research & development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Brain-machine interface; magnetoencephalography; magnetic sensing;

AF224-D029 TITLE: Epitaxial Growth of Galium Oxide for Next-Gen Microwave Electronics

TECH FOCUS AREAS: Microelectronics; Directed Energy; Network Command, Control and Communications; 5G

TECHNOLOGY AREAS: Electronics; Space Platform; Materials; Air Platform; Battlespace

OBJECTIVE: The objective is to mature manufacturing technologies associated with next-generation Ultra Wide Band Gap materials for microwave applications, namely Gallium Oxide. Epitaxial growth of electronics grade Gallium Oxide has recently been demonstrated at the small scale in both government labs and academia. The aim of the proposed program is to develop and demonstrate industrially scalable manufacturing of these microelectronic-grade epitaxial thin films, including demonstrating the ability to scalability fabricate device-relevant doped epi-stacks.

DESCRIPTION: This effort is aimed at establishing the processes required for the industrial production of Gallium Oxide epitaxial thin films. The production of UWBG semiconductor devices requires the development of processes to industrially produce epitaxial materials with sufficient quality, purity, and size (4 or larger) and the processes to fabricate them into unique device architectures, at ever-decreasing features sizes. The objectives of this program include homoepitaxy and heteroepitaxy of gallium oxide and with device relevant epitaxial doping profiles. The work involves exploring various growth conditions while performing structure-property studies using x-ray diffraction, atomic force microscopy, hall measurements and other characterization methods to link film material characteristics to resulting device performance.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. It must have validated the product-market fit between the proposed solution and a potential AF stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility effort should, 1) Demonstrate that the team has the right equipment, knowledge and experience to perform the work required to generate GaOx epiwafers. 2) Demonstrate that the team can deliver Gallium Oxide epi-wafers with desirable doping profiles. 3) Include a work plan for creating gallium oxide based epi-wafers, including early work associated with planned characterization and deposition studies with an eye towards future industrial growth processes.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a Phase I-like effort predominantly separate from the SBIR Programs. Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of relevant demonstrations. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be provided with opportunities to receive Phase III awards for providing the government additional research, development, or direct procurement of products and services developed in coordination with the program.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts

730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: Ultra-wide bandgap semiconductor; microwave electronics; epitaxy; thin film electronics;

AF224-D031 TITLE: Fog and Edge Computing

TECH FOCUS AREAS: Network Command, Control and Communications

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Conduct proof of concept efforts to prove ability of Fog and Edge Computing technologies to progress DoD computing technologies specifically in areas of Human Computer Interfaces, Energy Efficient Computing and Architectures for Data Collection/Processing, and Collaborative Computing, Fusion and Networking. This will take feasibility study like efforts and provide data to prove out technology identified and begin work towards a demonstrator capability.

DESCRIPTION: Across the DoD enterprise, platforms are equipped with a grid of sensors that can collect massive amounts of data to carry out multi-domain missions. DoD needs transformational computing technologies to reduce communications latency and cost, increase human situational awareness, and enable human to make adaptive decisions. Edge computing is the collection of technologies and capabilities necessary to enable processing of the sensor data in real time, generate insights from that data, and interact with that data through applications in a distributed manner with varying levels of connectivity. Fog computing is a selective filter and additional data management and analysis between the Edge data and sending it back to the Cloud for additional processing. The Human Computer Interfaces (HCI) sub-area is focused on the design of computer technology to facilitate interaction between humans (the users) and computers in ways that result in enhanced task performance compared to humans or computers individually. Fog edge computing creates novel HCI challenges and opportunities for both proximal systems (edge nodes physically close to users where interaction can occur directly), and remote systems (edge nodes physically distant from the user where interaction must occur over a network connection). Fog and edge computing also creates challenges and opportunities with respect to the ability to leverage and exploit HCI for real time or near-real time tasks. The second sub-area is Energy Efficient Computing and Architectures for Data Collection/Processing. Computer architecture defines the interconnected hardware, including processing components and memory, and the data flow between components. Processing data on the edge/fog requires highly energy efficient and lower latency computer architectures to process the data with a reduced amount of cost, size, weight, and power consumed (C-SWaP). Inputs and outputs to/from the processor/system can be the environment through sensors (RF, EO, auditory, etc.), human interfaces, or other computing systems. The processing system can be collocated with the input/output system or connected through a communication link. Challenges to the edge processing field include (but are not limited to) reducing the latency and improving throughput, reducing the C-SWaP, improving interoperability for system scalability, ease of replacement/upgrade, and optimized system cooling. The third sub-area, Collaborative computing, fusion, and networking (CCFN), focuses on combing signals, features, data, and information across the network to enable decision making across all echelons at the speed of conflict. Future fog and edge computing capabilities must leverage collaborative computing, cutting-edge networking, and advances in artificial intelligence (AI) for fusion of multi-spatial, multi-signal, and multi-reports. Three key focus areas for DOD multi-modal, collaborative, and network edge computing include, (1) sensing, unsupervised learning, rapid modeling, and sensing tasking of new targets, (2) interoperable computing, use of open architectures to support decentralized execution, and (3) all-domain performance, tailored data flows for scalable performance. CCFN requires advances in hardware such as devices with reduced cost, size, weight, power and cost (C-SWaP) to enable use in various platforms to include airborne and man-portable systems. Advances in networking capabilities should provide resilient, high-bandwidth communications required for sensing and sense-making at the edge as well as advances in processors for fusion and AI/ML applications. CCFN is focused on advances in theoretical methods and architectures to exploit Edge-AI; however, the mission, hardware, and software should be designed together to enhance performance.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a "Phase I-like" effort, including a feasibility study on technology in areas of human computer interface, energy efficient computing and architecture, or collaborative computing/fusing network and data.

PHASE II: Eligibility for D2P2 is predicated on the offeror having performed a "Phase I-like" effort predominantly separate from the SBIR Programs. Focuses on a proof of concept and/or demonstration of the technology concept they identified in the feasibility studies in areas of human computer interface, energy efficient computing and architecture, or collaborative computing/fusing network and data.

PHASE III DUAL USE APPLICATIONS: The contractor will pursue commercialization of the various technologies developed in Phase II for transitioning expanded mission capability to a broad range of potential government and civilian users and alternate mission applications. Direct access with end users and government customers will be investigated with opportunities to receive Phase III awards for providing the government additional research, development, or direct procurement of products and services developed in coordination with the program.

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5) Lin, X., Li, J., Wu, J., Liang, H., Yang, W. "Making Knowledge Tradable in Edge-AI Enabled IoT, A Consortium Blockchain-Based Efficient and Incentive Approach" (2019);
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7) Yang, L., Yao, H., Wang, J., Jiang, C., Benslimane, A., Liu, Y. " Multi-UAV-Enabled Load-Balance Mobile-Edge Computing for IoT Networks" (2020);
8) Fan, Q., Ansari, N. "Towards Workload Balancing in Fog Computing Empowered IoT" (2020);
9) Hou, X., Ren, Z., Wang, J., Cheng, W., Ren, Y., Chen, K.-C., Zhang, H. " Reliable Computation Offloading for Edge-Computing-Enabled Software-Defined IoV" (2020), Sanchez-Gonzalez, P.L., Díaz-Gutiérrez, D., Leo, T.J., Núñez-Rivas, L.R " Toward digitalization of maritime transport?" (2019)

KEYWORDS: fog computing; Edge Computing; Computing Paradigm; Cloud Computing; adaptive computing; nodal collaboration; edge networking; edge storage; FOG control; FOG networking; FOG storage; energy efficient computing architecture; energy efficient wireless; human-machine interface; augmented reality; virtual reality; distributed information fusion; distributed sensor fusion; distributed data fusion

AF224-D033 TITLE: Improving Transparency of Object Tracking Technology for Intelligence Analysis

TECH FOCUS AREAS: Autonomy; Artificial Intelligence/Machine Learning; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Sensors; Electronics; Information Systems; Air Platform; Battlespace

OBJECTIVE: Develop and evaluate prototype controls, displays, and/or decision aids that help intelligence analysts calibrate trust in object trackers so that they can confidently monitor multiple tracked items and / or multiple types of intelligence data feeds.

DESCRIPTION: A common Air Force Intelligence, Surveillance, and Reconnaissance (ISR) mission involves monitoring multiple types of intelligence data, including, but not limited to Moving Target Indicator (MTI), Full Motion Video (FMV), and other FMV-like Geospatial Intelligence (GEOINT) data. The explicit goal of these missions is to be able to track as many mission relevant objects as needed in near real-time, and quickly summarize the combination of activity into higher-level intelligence events. One example of this type of mission is leveraging automation to enable a Remotely Piloted Aircraft (RPA) pilot to transition from controlling a single aircraft to managing the flight of multiple semi-automated RPAs. Leveraging similar automation could also enable an RPA sensor operator to manage the sensor payload from multiple RPAs. One type of automation already in use by sensor operators are optical object trackers which can automatically detect moving objects. Sensor operators can also designate a desired object of interest and the sensor can be slaved to maintain continuous view of the object whether moving or stationary. Object trackers can thus free the sensor operators from manually steering a single FMV sensor to keep designated objects in view. Under certain conditions, the sensor operator could become a supervisor of object trackers employed across two or more sensor feeds. In practice, however, object trackers are only selectively used by sensor operators due to their performance and usability limitations. Object trackers are significantly challenged by low quality FMV, viewing conditions (e.g., lighting changes, dropped video frames, object occlusions, non-linear object motion), and sensor operator actions (e.g., changing magnification levels, EO/IR switches, abrupt sensor slewing). Object trackers are also poorly designed from a usability perspective. Once the sensor operator selects which object to follow a virtual box is drawn around the object in the FMV, which can obscure the appearance of target. If the object tracker loses the object, the box simply vanishes without any prior warning or failure diagnosis. There is also no historical record generated of the object path or behaviors. Another example mission is an analyst in an AF Distributed Ground Station (DGS) who is interpreting Ground Moving Target Indicator (GMTI) data in hopes of identifying motion and intent of ground objects. These MTI dots are difficult to track in near real-time because of the frequency of collection of the sensor. This frequently leads to confusing tracks with other non-mission tracks, or losing the tracks outright. Object trackers in this context are a new concept, but could conceptually be used in a similar manner. Similarly conceptual, analogous object tracker techniques could be used in higher collection frequency GEOINT data interpretation. Techniques for these data types are still at the conceptual level, but could be high-payoff as GEOINT collection continues to proliferate. The intent of this topic is to improve the transparency of object tracker automation so that intelligence analysts and sensor operators can better understand the automation performance and can assess when the object tracker can be trusted and relied upon. Successful human-autonomy teaming would reduce the attention demands on the analyst. Automation transparency can include the current intentions, the automation reasoning or logic process, environmental constraints, self-assessment of performance (current, history, future), and level of uncertainty with judgments. Applied to object trackers, automation transparency could include information cues the object tracker is using to identify the designated object, machine confidence in following the correct object, and diagnoses of visual processing problems. Future projection of object tracker performance would also help analysts anticipate when engagement with object trackers is needed. In addition to the content of automation transparency, the method of display is also important. The choices of simple or complex visual, auditory, or multi-modal displays and alarms should be designed based on a deep understanding of the automation capabilities and limitations, analyst tasks and functions, as well as human factors considerations. The transparency display should inform without overwhelming the sensor operator or obscuring the observed activity within the intelligence data. Effective transparency displays would equip the sensor operator to shift from a continuous operator of a single sensor to a supervisor of several semi-automated sensors, or allow an analyst to move up or down in number of simultaneous objects tracked while interacting with MTI data. To scope this effort, real or simulated object tracking technology are allowable. Simulated automation should incorporate representative capabilities and limitations. Thus, a valid object tracker transparency display should be based on a realistic model of object tracker performance under operational viewing conditions. Any system employed should maintain data at an unclassified level. No government furnished materials, equipment, data, or facilities will be provided.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of a Phase I-like effort, including a feasibility study. This included design/evaluate displays, controls, and/or decision aids to improve analyst awareness of automated object tracking capabilities and limitations while processing FMV, MTI, or other motion implied GEOINT data.

PHASE II: Develop a prototype and iteratively test and refine, culminating in a proof-of-concept interface that provides increased visibility into object tracker automation performance, improving the automation delegation decisions and attention management of a sensor operator managing two or more FMV feeds, or an intelligence analyst managing similar GEOINT data. Validate the solution in a high-fidelity human-in-the-loop simulation or experiment. Required Phase II deliverables include final report and software/hardware to integrate into a USAF simulation.

PHASE III DUAL USE APPLICATIONS: Object tracking intelligence tasks are found across all DOD services. Object tracker transparency displays may also be usefully applied to other monitoring tasks used throughout the military, government, law enforcement, and commercial sectors.

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KEYWORDS: Intelligence, Surveillance, and Reconnaissance (ISR); Sensor Operator; Moving Target Indicator (MTI); Geospatial Intelligence (GEOINT); Distributed Ground Station (DGS); Object Tracker; Situation Awareness; Human Factors; Autonomy; User Interface; Human Systems

SF224-D034 TITLE: Cis-lunar and X-GEO Space Weather Model Development

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: The increasing importance of future operations in CIS-Lunar and X-GEO orbits highlights the need for improved space weather models in these regimes. Current space weather models are not well developed and need to be updated to reflect the growing strategic dependence in these orbits.

DESCRIPTION: Current space weather models have not focused on CIS-lunar or X-GEO operations and this work would examine, improve, and integrate existing space weather models to current operational space weather models for enhanced now and forecasting.

PHASE I: The community has done outstanding work developing requirements for cis-lunar and X-GEO sensing, which includes matching space weather models to sensors that can continuously measure solar energetic particles for both long periods of time to get total dose as well as particles fluxes that lead to single event effects. Successful applicants for this Direct-to-Phase II effort will demonstrate feasibility by providing demonstrated experience in using either existing space weather data drawn from deployed sensors to update and enhance space weather models, or demonstrated experience with enhancing space weather models to capture physics that will be measured by the next generation of deployed sensors, as detailed in the reference. In both cases, the detailed new sensing modalities as described in the phase II description below are the main focus of this effort.

PHASE II: This effort is focused on improving the state of the art in space weather models to take advantage of new sensors that provide continuous measurement of the total ionizing dose from MeV electrons and multi-MeV protons over the time scale of hours to years in both the near equatorial plane and LEO polar orbits. Additionally, continuous monitoring of multi-MeV particles that cause single event effects are advancing. This topic looks for innovative space weather models to handle this radically disparate time scales and building on modeling system level effects on space craft. These models should be developed with an eye toward providing verification, validation, and uncertainty quantification against widely deployed, low-cost spacecraft charging/monitoring diagnostics as well as diagnostics suitable for measuring radiation belt electron flux, proton flux, ring current energy distribution, and plasmaspheric electron populations.

PHASE III DUAL USE APPLICATIONS: Beyond USSF operations beyond GEO and cis-lunar, we anticipate that this will also assist new space assets developing the new space economy of mining asteroids and other celestial bodies.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: space weather; radiation effects; single event effects; modeling and simulation; diagnostics

SF224-D035 TITLE: Ultra-Lightweight Materials for Space Structures through Novel Geometric Design

TECH FOCUS AREAS: General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Space Platform

OBJECTIVE: Conceptualize, optimize and demonstrate ultra-lightweight materials using triply periodic minimal surface (TPMS) geometric designs for structural applications in space environment.

DESCRIPTION: Triply periodic minimal surfaces (TPMSs) are 3D non-self-intersecting surfaces that are precisely described by mathematical functions. The continuous, smooth surfaces suggest diminished stress concentration and potentially enhanced load-bearing capability. Indeed, TPMS structures have been shown to exhibit superior structural efficiency to conventional porous structures, including high stiffness and high impact energy absorption. In the meantime, the availability of additive manufacturing capabilities open a path forward toward inexpensive fabrication of TPMS structures. In this solicitation, we seek innovative concept on 1) optimizing TPMS geometry for extraordinary property-to-weight ratios, 2) demonstrating TPMS design via advanced fabrication techniques such as additive manufacturing, and 3) validating the design via experimental characterization. Of particular interest is to establish quantitative correlation between TPMS characteristics and mechanical/physical properties. This way one can utilize the established TPMS optimization algorithms for ultra-lightweight structure design according to the boundary conditions and/or operational requirements. As this solicitation concerns load-bearing capability, it is desirable that relevant mechanical behaviors such as stress distribution, fracture behavior, crack propagation, and fatigue be addressed. The complex geometry and intricate architecture are a challenge to fabricate. The quality and efficiency of the manufacturing technique(s) should be optimized appropriately. The preferred material for this solicitation is metallic material or composite material. While neat polymers and ceramics are not excluded, strong justification for the selection must be provided. The proposer may choose a specific application for the project, but the design goals must be clearly stated and tangible metrics for project success must be clearly defined. As the topic aim is for space applications, the research concept must consider the harsh space environment. Factors include, but are not limited to, extreme temperature, impact from space debris, and radiation damage. Consequently, damage mechanisms, lifetime/degradation prediction, and mitigation strategy are of interest.

PHASE I: At the completion of Phase I, the performer is expected to have developed the mathematical model and analytical tool for TPMS topologies and successfully fabricated prototype TPMS structures via a scalable manufacturing method. The potential for significant enhancement of mechanical property-to-weight ratio must be demonstrated to provide a clear pathway for Phase II development.
PHASE II: Establish effective methodology for the design of ultra-lightweight TPMS structures and the necessary fabrication techniques while addressing the space environment. Demonstrate scale-up feasibility.

PHASE III DUAL USE APPLICATIONS: Demonstrate mass production capability; Numerous space applications exist in which lightweight structure is required. Applications could include support structure (for antenna, sensors, solar arrays, etc.), impact protection, various structural components, fuel storage, and hot/propulsion structures.

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2) Qin, Z. et al., The mechanics and design of a lightweight three-dimensional graphene assembly, Sci. doi, 10.1126/sciadv.1601536, Adv., 2017.

KEYWORDS: Triply periodic minimal surface; gyroid; lightweight structure; additive manufacturing; stiffness; mechanical strength

AF224-D036 TITLE: Environmental Performance Prediction of Ceramic Matrix Composites in Extreme Environments

TECH FOCUS AREAS: Nuclear; General Warfighting Requirements (GWR)

TECHNOLOGY AREAS: Nuclear; Materials; Air Platform

OBJECTIVE: Predicting failure of ceramic matrix composites in extreme environments requires analyses of high local velocities, temperatures and forces together with oxidative, ablative, and strength-reducing material evolutions and local strains. This D2P2 should model the material degradation of a surface-morphing high speed aircraft, and support critical predictions with measured data.

DESCRIPTION: The need for understanding performance of materials in extreme environments has exploded over the last few years, particularly with the push for operational high speed systems; however, models capable of providing this information have been limited. As a result, performance of these systems is primarily determined through expensive experimental programs, which have limited the pace of development in this area despite the fact it is a current national defense priority [1]. Recently, the Air Force Research Laboratory executed a benchmarking study, “Enhanced Physics-based Prognosis and Inspection of Ceramic matrix composites (EPPIC),” [2] to assess the current ability of progressive damage models to capture behavior of ceramic matrix composites (CMCs) in service relevant conditions. While this program was highly successful, the lack of ability to address the environmental degradation aspects of the expected extreme service environments was a major issue. In particular, the ability to analyze high local velocities, temperatures and forces is needed to properly predict oxidative, ablative, and strength-reducing material evolutions and local strains required for failure. AFRL has been developing environmental damage models for CMCs capable of addressing this current gap in capability. Specifically, a SiC/BN/SiC oxidation damage micromodel was recently published [3].This topic seeks to formulate an environmental damage model for silicon carbide (C/SiC) CMCs and transition it to industry to address the current challenges in modeling the complex thermo-mechanical behaviors of C/SiC CMCs in extreme high speed relevant environments. The model should consider the following processes in C/SiC: (i) diffusion of oxygen and moisture across the surface boundary layer and through the cracks in the matrix, including Knudsen effect; (ii) oxidation of SiC crack walls to form SiO2 and associated gradual closure of the crack opening; (iii) volatilization of coating (SiC in this case at extreme temperatures); (iv) oxidation of SiC fibers and matrix surrounding them; (v) out-diffusion of (several in-common) gaseous oxidation products, such as CO, CO2, SiO(g), Si(OH)4, etc., through the cracks and fiber/matrix gaps in the silicon carbide matrix. The present topic addresses C/SiC materials and structures applicable to high speed vehicles and emphasizes corresponding boundary conditions & strains, damage of the more oxidation-resistant SiC matrix, and subsequent oxidation and weakening of carbon tows leading to failure. Data gathered in relevant environments (arc-jet, heated wind tunnel, etc.) is recommended to develop confidence in the predictive capabilities of proposed models in high-speed vehicles. Unstressed and stressed oxidation experiments on C fibers and C/SiC show rapid consumption of the C phases [6,7]. Different C and SiC materials may have significant differences in oxidation behavior due to microstructure and processing (e.g., [8]). Previous C/SiC oxidation models assume strength loss due to the reduced cross-sectional area of the C fibers and do not consider thermal degradation of fiber strength [9,10]. Additional experimentation exploring the strength loss in carbon fibers due to thermal degradation may be required for the model. Data from in-situ micro-tensile experiments monitoring cracking behavior at elevated temperatures may be useful as inputs for the model.

PHASE I: This topic is intended for technology proven ready to move directly into a Phase II. Therefore, a Phase I award is not required. The offeror is required to provide detail and documentation in the Direct to Phase II proposal which demonstrates accomplishment of “Phase I-like” capabilities, including a feasibility study. Existing capabilities can be established via prior reports and/or journal publications on subjects such as related materials development and testing in harsh environments; CFD modeling accounting for vehicle- and/or component-level aerothermal environments including such features as mass loss, surface reaction systems, oxidation, sublimation, and spallation in extreme environments; related relationships with high-speed

DoD air vehicle integrators evidenced by prior reports and/or publications. This includes determining, insofar as possible, the scientific and technical merit and feasibility of ideas appearing to have commercial potential. The D2P2 proposal should show direct benefit to a potential AF operational system, evidenced by endorsement of an associated stakeholder. The offeror should have defined a clear, immediately actionable plan with the proposed solution and the AF customer. The feasibility study should identify the prime potential AF end user(s) of the final modeling and/or material improvements; estimate integration cost and capability improvements vs current mission-specific products; describe if/how the demonstration can be used by other DoD or Governmental customers, and possibly non-governmental customers.

PHASE II: Under the phase II effort, the offeror shall sufficiently develop the technical approach, product, or process in order to conduct a small number of performance/life prediction-relevant demonstrations. These demonstrations should include relevant environment testing in relevant high-enthalpy environments such as arc jet, wave rotor, plasma torch, heated wind tunnel, etc. Vehicle-level performance improvements and limitations associated with morphing surfaces should be assessed for relevant maneuvers of a high speed vehicle. Identification of manufacturing/production issues and or business model modifications required to further improve product or process relevance to improved sustainment costs, availability, or safety, should be documented. Air Force sustainment stakeholder engagement is paramount to successful validation of the technical approach. These Phase II awards are intended to provide a path to commercialization, not the final step for the proposed solution.

PHASE III DUAL USE APPLICATIONS: A phase III program should involve a relevant AF command in partnership with the small business, to build and test morphing component parts of a relevant model aircraft. Prime contractor integrators involved with military high speed vehicle development would be examples of appropriate partners. Boeing, Hermeus and other commercial companies are engaged in building hypersonic passenger planes. The U.S. Air Force has awarded the Hermeus Corporation a contract to support its work on a hypersonic aircraft powered by an advanced combined-cycle jet engine. The service says that the deal could be a stepping stone to fielding a high-speed plane for VIP transport and other missions in the future. Such companies may be able to leverage the analytical developments across future military and commercial platforms.

NOTES: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the proposed tasks intended for accomplishment by the FN(s) in accordance with section 5.4.c.(8) of the Announcement and within the AF Component-specific instructions. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws. Please direct questions to the Air Force SBIR/STTR HelpDesk: usaf.team@afsbirsttr.us

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KEYWORDS: morphing; high speed; enthalpy; testing; arc jet; wave rotor; plasma; oxidation; sublimation; spallation; ablation; modeling; performance;