ONR Announcement N0001426SF002
ARO Announcement W911NF26S1000
AFOSR Announcement NOFOAFRLAFOSR20260002

NOTICE OF FUNDING OPPORTUNITY (NOFO)

Fiscal Year (FY) 2027 Department of War Multidisciplinary Research Program of the University Research Initiative (MURI)

Deadlines

White Paper Inquiries and Questions
6 November 2026 (Friday)

White Papers must be received no later than
20 November 2026 (Friday) at 5:00 PM Eastern Time

Application Inquiries and Questions
12 March 2027 (Friday)

Applications must be received no later than
9 April 2027 at 5:00 PM Eastern Time

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(2) transparent; 11
(3) communicative of error and uncertainty; 11
(4) collaborative and interdisciplinary; 11
(5) skeptical of its findings and assumptions; 11
(6) structured for falsifiability of hypotheses; 11
(7) subject to unbiased peer review; 11
(8) accepting negative results as positive outcomes; and 11
(9) without conflicts of interest. 11
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Overview of the Research Opportunity

The Department of War (DoW) Multidisciplinary University Research Initiative (MURI), one element of the University Research Initiatives (URI), is sponsored by the DoW research offices. Those offices include the Office of Naval Research (ONR), the Army Research Office (ARO), and the Air Force Office of Scientific Research (AFOSR) (hereafter collectively referred to as "DoW agencies" or "DoW").

This publication constitutes a Notice of Funding Opportunity Announcement (NOFO) as contemplated in the Department of Defense Grants and Agreements regulations (DoDGARS) 32 CFR 22.315(a). The DoW agencies reserve the right to fund all, some, or none of the proposals received under this NOFO. The DoW agencies provide no funding for direct reimbursement of proposal development costs. Technical and budget proposals (or any other material) submitted in response to this NOFO will not be returned. It is the policy of the DoW agencies to treat all white papers and proposals submitted under this NOFO as sensitive competitive information and to disclose their contents only for the purposes of evaluation.

Hyperlinks have been embedded within this document and appear as underlined, blue-colored words. The reader may "jump" to the linked section by clicking the hyperlink.

A formal Request for Proposals (RFP), solicitation, and/or additional information regarding this announcement will not be issued.

DoW's MURI program addresses high-risk basic research and attempts to understand or achieve something that has never been done before. The program was initiated over 40 years ago and it has regularly produced significant scientific breakthroughs with far reaching consequences to the fields of science, economic growth, and revolutionary new military technologies. Key to the program's success is the close management of the MURI projects by Service Program Officers and their active role in providing research guidance.

IAW Executive Order 14332, all technical program descriptions contained in this BAA reflect the basic research priorities for the Department of War, specifically the interests of the Service Program associated with each Topic, and are defined to advance the administration and agency priorities (c.f., OMB memo M-25-34 "Fiscal Year 2027 Administration Research and Development Budget Priorities and Cross-Cutting Actions").

Awards will take the form of grants. FOR ARO SUBMISSIONS ONLY, awards will take the form of grants and/or cooperative agreements. Any assistance instrument awarded under this announcement will be governed by the award terms and conditions that conform to DoW's implementation of the Office of Management and Budget (OMB) circulars applicable to financial assistance. Terms and conditions will reflect DoW implementation of OMB guidance in 2 CFR Part 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards."

Please note the following important items:

- Applicants should be alert for any amendments that may modify the announcement. Amendments to the original NOFO will be posted to the Grants.gov webpage: https://www.grants.gov/
- A project abstract is required with the application and must be publicly releasable as specified in the section Project Summary/Abstract.
- Responses to the Certifications and Representations indicated in the section Administrative and National Policy Requirements of this NOFO are required with the application.
- The notice that advisors external to the U.S. government may be used as subject-matter-expert technical consultants in the evaluation of the proposals after signing non-disclosure statements is contained in the section Evaluation Panel.

The complete list of topics is below. See section "Other Information" for topic descriptions and more information.

AFOSR

Topic 1: Non-linear Mixing Processes for EUV and X-ray Radiation in Optically Thick Systems

Topic 2: Tunable Goniopolar Semiconductors

Topic 3: Robustness to Novel Queries in AI for Scientific Discovery

Topic 4: Unlocking the Potential of TEM Ptychography

Topic 5: Science with Optical Cycling Centers for Energy Redistribution (SOCCER)

ARO

Topic 6: Th-229 Enabled by the Solid State (TESS)

Topic 7: Reticular Qubit Assemblies

Topic 8: Design of Superomniphobic Materials via Development of Novel, High-throughput, Multi-scale Biological Assays

Topic 9: Some Like It Hot: Decoding the Biogeochemical Matrix of Fire and Smoke Borne Particulates

Topic 10: Interfacial Superconcentration in Extreme Multiphase Regimes

Topic 11: Atomic and Molecular Hybrid Quantum Solids

ONR

Topic 12: Distinguishing between AI generated content and human created content

Topic 13: Troposcatter Sensitivity to Atmospheric and Electromagnetic Conditions

Topic 14: Interface Mediated Control of Biofilm Function

Topic 15: High-Entropy Electrochemical Materials

Topic 16: Bio-Inspired Autonomous and Recurrent Self-Healing in Materials and Structures

A. Basic Information

1. Federal Agency Name

Office of Naval Research
One Liberty Center
875 N. Randolph Street
Arlington, VA 22203-1995

Army Research Office
800 Park Office Drive
Research Triangle Park, NC 27709

Air Force Office of Scientific Research
875 North Randolph Street
Arlington, VA 22203

2. Funding Opportunity Title

Fiscal Year (FY) 2027 Department of War Multidisciplinary Research Program of the University Research Initiative

3. Announcement Type

Initial Announcement

4. Funding Opportunity Number

ONR: N0001426SF002
ARO: W911NF26S1000
AFOSR: NOFOAFRLAFOSR20260002

5. Assistance Listing Number

ONR: 12.300
ARO: 12.431
AFOSR: 12.800

6. Funding Details

Funded Amount and Period of Performance

The total amount of funding for the five years available for grants resulting from this MURI NOFO is estimated to be approximately $170 million dollars pending out-year appropriations. MURI awards are contingent on availability of funds, the specific topic, and the scope of the proposed work. Typical annual funding per grant is

up to $1.5M. The amount of the award and the number of supported researchers should generally not exceed the limit specified for the individual topics in the section TOPIC DESCRIPTIONS.

It is strongly recommended that Applicants communicate with the Research Topic Chiefs listed with the topic descriptions in Section I regarding these issues before the submission of formal proposals. Depending on the results of the proposal evaluation, there is no guarantee that any of the proposals submitted in response to a particular topic will be recommended for funding. On the other hand, more than one proposal may be recommended for funding for a particular topic.

7. Key Dates

Anticipated Schedule of Events *		
Event	**Date (MM/DD/YEAR)**	**Time (Local Eastern Time)**
Questions Regarding Eligibility and Technical Requirements **	6 November 2026	
White Papers Due (optional)	20 November 2026	5:00 PM Eastern Time
Notifications of Initial Evaluations of White Papers*	8 January 2027	
Questions for Grants Officer Regarding Proposal Submission**	12 March 2027	
Proposals or Invited Proposals Due	9 April 2027	5:00 PM Eastern Time
Notification of Selection for Award *	July 2027	
Start Date of Grant*	August 2027	

*These dates are estimates as of the date of this announcement.
**Questions submitted after the Q&A deadline may not be answered.

IMPORTANT NOTE: White Papers are OPTIONAL but strongly recommended.

8. Executive Summary

Established in 1985, the Department of War Multidisciplinary University Research Initiative (MURI) program funds U.S. academic research teams to conduct high-impact basic research that addresses future challenges faced by the Department of War. The MURI program specifically supports U.S. university teams investigating complex, DoW-relevant problem sets at the intersection of multiple scientific disciplines. MURI teams bring together world-class faculty, postdoctoral researchers, and graduate students—helping to develop a technically advanced, defense-aware scientific workforce and strengthen the U.S. defense industrial base.

9. Agency Contact Information

All UNCLASSIFIED communications shall be submitted via e-mail to the Technical Point of Contract (POC) with a copy to the designated Business POC, as designated below.

Comments or questions submitted should be concise and to the point, eliminating any unnecessary verbiage. In addition, the relevant part and paragraph of the Notice of Funding Opportunity (NOFO) should be referenced. Questions submitted within 2 weeks prior to a deadline may not be answered, and the due date for submission of the white paper and/or full proposal will not be extended.

- **Questions of a technical nature:**
  One or more Research Topic Chiefs are identified for each SPECIFIC MURI TOPIC. Questions of a technical nature on a specific topic shall be directed to one of the Research Topic Chiefs identified in Section I entitled "TOPIC DESCRIPTIONS" of this NOFO.

- **Questions of a policy nature shall be submitted to:**

  MURI Program Points of Contact:

  Office of Naval Research: Dr. Amanda Netburn
  Email: Amanda.N.Netburn.civ@us.navy.mil

  Army Research Office: Dr. Sue Kase
  Email: usarmy.rtp.devcom-arl.mbx.aro-muri@army.mil

  Air Force Office of Scientific Research: Ms. Katie Wisecarver
  Email: afosr.rtb.muri@us.af.mil

- **Questions regarding Grants proposal submissions shall be submitted to:**

  Veronica Lacey
  OFFICE OF NAVAL RESEARCH
  Email: veronica.y.lacey.civ@us.navy.mil

  Ramila Century
  USARMY ACC
  Email: ramila.century.civ@army.mil

  Jorge Gallegos
  AIR FORCE MATERIEL COMMAND, AIR FORCE RESEARCH LABORATORY, CONTRACTING OFFICE (AFMC/AFRL RBKR)
  Email: jorge.gallegos@us.af.mil

B. Eligibility

1. Eligibility for Competition

Proposals for supplementation of existing projects are eligible to compete with applications for new Federal awards under this NOFO.

2. Eligible Applicants

This MURI competition is open only to, and proposals are to be submitted only by, U.S. institutions of higher education (universities) with degree-granting programs in science and/or engineering, including DoW institutions of higher education. To the extent that it is a part of a U.S. institution of higher education and is not designated as a Federally Funded Research and Development Center (FFRDC), a University Affiliated Research Center (UARC) is eligible to submit a proposal to this MURI competition and/or receive MURI funds. Ineligible organizations (e.g., industry, DoW laboratories, FFRDCs, and foreign entities) may collaborate on the research but may not receive MURI funds directly or via subaward.

To assess risk posed by Applicants, we review your application, proposal, and Office of Management and Budget (OMB) designated repositories of government-wide public and non-public data, including comments you have made, as required by 41 U.S.C. 2313 and described in 2 CFR 200.206 and 32 CFR 22.410 to confirm you are qualified, responsible, and eligible to receive an award.

When additional funding for an ineligible organization is necessary to make the proposed collaboration possible, such funds may be identified via a separate proposal from that organization. This supplemental proposal shall be attached to the primary MURI proposal and will be evaluated in accordance with the MURI review criteria by the responsible Research Topic Chief. If approved, the supplemental proposal may be funded using non-MURI or non-Government funds.

Disclosures of current and pending support made in this application may render an applicant ineligible for funding. Prior to award and throughout the period of performance, DoW may continue to request updated continuing and pending support information, which will be reviewed and may result in discontinuation of funding.

Limitations on Number of Applications – There is no limitation on the number of applications an applicant (organization) may submit under the announcement.

3. Gold Standard Science

3.A. Adherence to Gold Standard Science

Gold Standard Science (GSS): IAW EO 14303; GSS is science conducted in a manner that is:

(1) reproducible;
(2) transparent;
(3) communicative of error and uncertainty;
(4) collaborative and interdisciplinary;
(5) skeptical of its findings and assumptions;
(6) structured for falsifiability of hypotheses;
(7) subject to unbiased peer review;
(8) accepting negative results as positive outcomes; and
(9) without conflicts of interest.

The U.S. Department of War expects the highest standards of scientific rigor, integrity and adherence to appropriate tenets of GSS. For more on these standards and DoW expectations, see https://www.cto.mil/gold-standard-science-implementation-plan/. The DoW will prioritize institutions that have demonstrated success in implementing GSS, in accordance with EO14303 and EO14332.

By responding to this NOFO, you explicitly agree to the following statements:

1) Our institution understands the definition of Gold Standard Science as outlined above.
2) Our institution is committed to achieving Gold Standard Science, and all personnel involved in the proposed project will adhere to all administration policies, procedures, and guidance respecting Gold Standard Science in the execution of this project, if funded.

3.B. Expectations of Adherence to EO 14332

To meet EO 14332, applications/proposals shall include clear benchmarks for measuring success and progress towards relevant goals.

4. Funding Restrictions

Section 889 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2019 (Public Law 115-232) prohibits the head of an executive agency from obligating or expending loan or grant funds to procure or obtain, extend, or renew a contract to procure or obtain, or enter into a contract (or extend or renew a contract) to procure or obtain the equipment, services, or systems prohibited systems as identified in section 889 of the NDAA for FY 2019.

1. In accordance with 2 CFR 200.216 and 200.471, all awards that are issued on or after August 13, 2020, recipients and subrecipients are prohibited from obligating or expending loan or grant funds to:

   (1) Procure or obtain;
   (2) Extend or renew a contract to procure or obtain; or
   (3) Enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115-232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

      (i) For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).
      (ii) Telecommunications or video surveillance services provided by such entities or using such equipment.
      (iii) Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

2. In implementing the prohibition under Public Law 115-232, section 889, subsection (f), paragraph (1), heads of executive agencies administering loan, grant, or subsidy programs shall prioritize available funding and technical support to assist affected businesses, institutions and organizations as is reasonably necessary for those affected entities to transition from covered communications equipment and services, to procure replacement equipment and services, and to ensure that communications service to users and customers is sustained.

3. See Public Law 115-232, section 889 for additional information.

COVERED FOREIGN COUNTRY means the People's Republic of China.

5. Contracted Fundamental Research

With regard to any restrictions on the conduct or outcome of work funded under this NOFO, DoW agencies will follow the guidance on and definition of "contracted fundamental research" as provided in the Under Secretary of Defense (Acquisition, Technology and Logistics) Memorandum of 24 May 2010. The memorandum can be found at https://www.acq.osd.mil/dpap/dars/pgi/docs/2012-D054%20Tab%20D%20OUSD%20(ATL)%20memorandum%20dated%20May%2024%202010.pdf.

As defined therein the definition of "contracted fundamental research," in a DoW contractual context, includes research performed under grants and contracts that are (a) funded by RDT&E Budget Activity 1 (Basic Research), whether performed by universities or industry or (b) funded by Budget Activity 2 (Applied Research) and performed on campus at a university.

Pursuant to DoW policy, research performed under grants and contracts that are (a) funded by Budget Activity 2 (Applied Research) and NOT performed on-campus at a university or (b) funded by Budget Activity 3 (Advanced Technology Development) or Budget Activity 4 (Advanced Component Development and Prototypes) does not meet the definition of "contracted fundamental research." In conformance with the USD (AT&L) guidance and National Security Decision Directive 189 found at https://www.acq.osd.mil/dpap/dars/pgi/docs/National_Security_Decision_Directive_189.pdf. DoW will place no restriction on the conduct or reporting of unclassified "contracted fundamental research," except as otherwise required by statute, regulation, or executive order. The research shall not be considered fundamental in those rare and exceptional circumstances where the applied research effort presents a high likelihood of disclosing performance characteristics of military systems or manufacturing technologies that are unique and critical to defense, and where agreement on restrictions have been recorded in the contract or grant. For certain research projects, it may be possible that although the research being performed by the prime contractor is restricted research, a subcontractor may be conducting "contracted fundamental research." In those cases, it is the prime contractor's responsibility in the proposal to identify and describe the subcontracted unclassified research and include a statement confirming that the work has been scoped, negotiated, and determined to be fundamental research according to the prime contractor and research performer.

Normally, fundamental research is awarded under grants with universities and under contracts with industry. Non-fundamental research is normally awarded under contracts and may require restrictions during the conduct of the research and DoW pre-publication review of such research results due to subject matter sensitivity. Potential applicants should consult with the appropriate Research Topic Chiefs to determine whether the proposed effort would constitute fundamental or non-fundamental research.

6. Cost Sharing or Matching

Cost sharing is not expected and will not be used as a factor during the merit review of any application hereunder. However, the Government may consider voluntary cost sharing if proposed.

C. Program Description

The MURI program supports basic research in science and engineering at U.S. institutions of higher education (hereafter referred to as "universities") that is of potential interest to DoW. The program is focused on multidisciplinary research efforts where more than one traditional discipline interacts to provide rapid advances in scientific areas of interest to the DoW. As defined in the DoW Financial Management Regulation:

> Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high payoff research that provides the basis for technological progress (DoD 7000.14-R, vol. 2B, chap. 5, para. 050105. A.)

DoW's basic research program invests broadly in many fields to ensure that it has early cognizance of new scientific knowledge.

Detailed descriptions of the topics and the Topic Chief for each can be found in Section I., entitled, "TOPIC DESCRIPTIONS." The detailed descriptions are intended to provide the Applicant a frame of reference and are not meant to be restrictive to the possible approaches to achieving the goals of the topic and the program. Innovative ideas addressing these research topics are highly encouraged.

Proposals from a team of university investigators are expected when the necessary expertise in addressing the multiple facets of the topics may reside in different universities. By supporting multidisciplinary teams, the program is complementary to other DoW basic research programs that support university research through single-investigator awards. Proposals shall name one Principal Investigator (PI) as the responsible technical point of contact. Similarly, one institution shall be the primary awardee for the purpose of award execution. The PI shall come from the primary institution. The relationship among participating institutions and their respective roles, as well as the apportionment of funds including sub-awards, if any, shall be described in both the proposal text and the budget.

White papers and proposals addressing the following topics should be submitted to the respective agency following the submission instructions in section "Submission Instructions."

Please see detailed Topic Information under the section "Other Information."

1. Instrument Type

The authority for awards is 10 U.S.C. 4001 in accordance with 31 U.S.C. 63. The applicable regulations are 2 CFR 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards," as implemented by 2 CFR Chapter XI, Subchapter A and DoDGARs at 32 CFR Subchapter C.

a. *Grant:* A legal instrument that, consistent with 31 U.S.C. 6304, is used to enter into a relationship:

- The principal purpose of which is to transfer a thing of value to the recipient to carry out a public purpose of support or stimulation authorized by a law or the United States, rather than to acquire property or services for the Federal Government's direct benefit or use.
- Substantial involvement is not expected between the Federal Government and the recipient when carrying out the activity contemplated by the grant.
- No fee or profit is allowed.

b. *Cooperative Agreement*: A legal instrument which, consistent with 31 U.S.C 6305, is used to enter into the same kind of relationship as a grant, except:

- Substantial involvement is expected between the Federal Government and the recipient when carrying out the activity contemplated by the cooperative agreement. No fee or profit is allowed. (For information on the substantial involvement ONR expects to have in cooperative agreements, prospective applicants should contact the Technical Point of Contact identified in the research area of interest.)
- The term does not include "cooperative R&D agreement (CRADA)" as defined at 15.U.S.C. 3710a
- No fee or profit is allowed.
- In accordance with 10 U.S.C. §4021(i), as amended, the following information submitted during the solicitation and award process of Cooperative Agreement for performance of basic, applied, or advanced research authorized by section 4001 are exempt from disclosure requirements of 5 U.S.C. §552, the Freedom of Information Act (FOIA), for a period of five years from the date the Department receives the information. Offerors should mark the following documents with a legend asserting that they are submitted on a confidential basis:

  - A proposal, proposal abstract, and supporting documents;
  - A business plan submitted on a business proprietary basis;
  - Technical information submitted on a controlled basis, as outlined in DoDI 5230.24, Distribution Statements on Technical Documents.

D. Application Contents and Format

1. Content and Form of Application Submission

a. General Information

All submissions will be protected from unauthorized disclosure in accordance with applicable law and DoW regulations. Applicants are expected to appropriately mark each page of their submission that contains any proprietary information.

Titles given to the submissions should be descriptive of the work they cover and not be merely a copy of the title of this announcement.

The proposal submission process has two stages:

- Applicants are strongly encouraged to submit a white paper; and
- Applicants must submit a proposal through Grants.gov.

Prospective awardees are encouraged to submit white papers to minimize the labor and cost associated with the production of detailed proposals that have very little chance of being selected for funding. Based on an assessment of the white papers, the responsible Research Topic Chief will provide informal feedback notification to the prospective awardees to encourage or discourage submission of proposals. The Research Topic Chief may also, on occasion, provide feedback encouraging re-teaming to strengthen a proposal.

b. White Papers

i. Format

- Paper size – 8.5x11-inch
- Margins – 1 inch
- Spacing – single-spaced
- Font – Times New Roman, 12-point
- Page limit – **No more than four (4) single-sided pages** (excluding cover letter, cover page, references, and curriculum vitae). White paper pages beyond the 4-page limit may not be evaluated or read.

ii. Content

The white papers and proposals submitted under this NOFO are expected to address unclassified basic research. White papers and proposals will be protected from unauthorized disclosure in accordance with applicable laws and DoW regulations.

Applicants are expected to appropriately mark each page of their submission that contains proprietary information.

For proposals containing data that the Applicant does not want disclosed to the public for any reason, or used by the Government except for evaluation purposes, the Applicant shall mark the title page with the following legend:

"This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed--in whole or in part--for any purpose other than to evaluate the proposal or for program coordination. If, however, a grant is awarded to this Applicant as a result of, or in connection with, the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting award. This restriction does not limit the Government's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction is contained in (insert numbers or other identification of sheets)."

Also, mark each sheet of data that the Applicant wishes to restrict with the following legend: "Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this proposal."

Use of Principal Investigator (PI) Over Multiple Proposals/Topics:

Applicants contemplating the use of an individual as Principal Investigator (PI) for more than one proposal and/or topic are strongly encouraged to contact the Topic Chief(s) prior to white paper submission to determine if the Topic Chief(s) support PI participation in multiple proposals and/or topics. Support of the use of a PI over multiple proposals and/or topics is at the discretion of the Topic Chief(s).

PI participation in multiple proposals and/or topics shall be identified in all white paper submissions where the PI is proposed. The white paper should also document the amount of time the PI is available for the project(s) and how the PI will manage their time given the possibility of multiple awards.

Applicants that do not submit white papers, but wish to submit a proposal, shall document PI participation in multiple proposals and/or topics in all proposals where the PI is proposed. The proposal should also document the amount of time the PI is available for the project(s) and how the PI will manage their time given the possibility of multiple awards.

White papers shall include the following:

- The cover sheet shall include the NOFO number, proposed title, and proposer's technical point of contact, with telephone number, facsimile number, e-mail address, topic number, and topic title.
- The white paper shall provide:
  - Identification of the research and issues
  - Proposed technical approaches
  - Potential impact on DoW capabilities
  - Potential team and management plan
  - Summary of estimated costs
  - Curriculum vitae of key investigators (see Use of Principal Investigator (PI) Over Multiple Proposals/Topics)
  - Identification of any Organizational Conflict(s) of Interest (if any) – See section detailing Conflict of Interest.

The white paper should provide sufficient information on the research being proposed (e.g., hypothesis, theories, concepts, approaches, data measurements and analysis, benchmarks for success, etc.) to allow for an assessment by a technical expert. It is not necessary for white papers to carry official institutional signatures.

c. Full Proposals

Prospective applicants must complete the mandatory forms in accordance with the instructions provided on the forms and the additional instructions below. Files that are attached to the forms must be in Adobe Portable Document Format (.PDF); cannot contain macros; and cannot be password protected. **If any attachment is not a PDF, contains macros, or is password protected, it will not pass the automated acceptance check and will need to be resubmitted.** Note that Block 2, "Type of Application," on the SF 424 should be marked "New" on the resubmission.

i. Format for Technical Proposal

- Paper size – 8.5 x 11 inch
- Margins – 1 inch
- Spacing – single-spaced
- Font – Times New Roman, 12-point
- Page Limit – Technical Proposal: **25 pages***

  There are no page limitations for the budget.

***INCLUDED IN PAGE COUNT**	**NOT INCLUDED IN PAGE COUNT**
Technical Approach/Project Narrative	Budget, Cover Letter, Table of Contents
Management Approach	Everything else not listed in "included in page count"
Principal Investigator Qualifications	

Disclosure of Conflict of Commitment and Conflict of Interest

This announcement requires that **all** current and pending research support, as defined by Section 223 of the FY21 National Defense Authorization Act must be disclosed at the time of proposal, for all covered individuals. Such disclosure will be updated annually during the performance of any research project selected for funding, and whenever covered individuals are added or identified as performing under this project. Covered individuals are those who are listed as key personnel on proposals including but not restricted to the Principal Investigator or Co-Principal Investigator.

Any decision to accept a proposal for funding under this announcement will include full reliance on the Applicant's statements. Failure to report fully and completely all sources of project support and outside positions and affiliations may be considered a materials statement within the meaning of the federal False Claims Act and constitutes a violation of law.

The funding agency may conduct a pre-award conflict of interest/conflict of commitment review of any proposal selected for funding as described in the DoW Component Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions. Offerors are advised that any significant conflict of interest/conflict of commitment identified may be a basis for the rejection of an otherwise awardable proposal.

ii. Content

NOTE: The electronic file name for all documents submitted under this NOFO must not exceed 68 characters in length, including the file name extension.

Mandatory SF-424 Research and Related (R&R) Family Forms

The mandatory forms are found at https://www.grants.gov/forms.

i. SF-424 (R&R)

The SF-424 (R&R) form must be used as the cover page for all proposals. Complete all required fields in accordance with the "pop-up" instructions on the form and the following instructions for specific fields. Please complete the SF-424 first, as some fields on the SF-424 are used to auto-populate fields on other forms. Guidance can be found at https://www.grants.gov/forms/forms-repository/r-r-family.

The completion of most fields is self-explanatory with the exception of the following special instructions:

- Field 3 - Date Received by State: Leave Blank

- Field 4a - Federal Identifier:
  For ONR, enter "N00014"
  For ARO, enter "W36QYT"
  For AFOSR, enter "FA9550"

- Field 4b - Agency Routing Number:
  This field is used to route the proposal to the appropriate Research Topic Chief, as listed in the section Topic Descriptions. Where multiple Research Topic Chiefs are listed, please direct the proposal to the first person listed.

  For ONR, enter the three (3) digit Research Topic Chief's Code and the Research Topic Chief's name, last name first, in brackets (e.g., 331 [Smith, John]). Note: There is a space between the code and the first [and

between the , and the First Name. There is no space between the first [and the last name.

- Where the ONR Research Topic Chief Code only has two digits, add a "0" directly after the Code (e.g., Code 31 would be entered as 310). **Applicants who fail to provide a Research Topic Chief Code identifier may receive a notice that their proposal is rejected.**

For ARO, enter the name of the Research Topic Chief.

For AFOSR, enter the Research Topic Chief's MURI Topic Number (#) and Research Topic Chief's name (last name first) in brackets (e.g., 12 [Smith, John]).

- Field 4c - Previous Grants.gov Tracking ID: If this submission is for a Changed/Corrected Application, enter the Grants.gov tracking number of the previous proposal submission; otherwise, leave blank.

- Field 5 – Application Information: Email address entered by the grantee on the SF-424 application to create the EDA notification profile. DoW recommends that organizations provide a global business address.

- Field 7 - Type of Applicant. Complete as indicated: If the organization is a Minority Institution, select "Other" and under "Other (Specify)" note that the institution is a Minority Institution (MI).

- Field 9 - Name of Federal Agency: List the appropriate agency (i.e., ONR, AFOSR, or ARO) as the reviewing agency. This field is usually pre-populated in Grants.gov.

- Field 11 – Descriptive Title of Applicant's Project: Include "MURI:" at the beginning of your descriptive title. Include the ONR White Paper Tracking Number provided to the Applicant by ONR.

- Field 14 – Project Director/Principal Investigator: Email address entered by the grantee on the SF-424 application to create the EDA notification profile

- Field 16 - Is Application Subject to Review by State Executive Order 12372 Process? Choose "No". Check "Program is Not Covered by Executive Order 12372."

- Field 17 – Certification: All awards require some form of certifications of compliance with national policy requirements. By checking "I Agree" on the SF 424 (R&R) block 17 you agree to abide by the following statement: "By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties" (U.S. code, Title18, Section 1001). In addition, the Financial Assistance General Certifications and Representations must be completed in SAM.gov (https://sam.gov/content/home).

  For AFOSR, if you check "I agree" on SF424 block 17 and do NOT upload a completed SF-LLL Disclosure of Lobbying Activities, you are certifying that you do NOT have any lobbying activities to disclose. If you do have lobbying activities to disclose, you MUST check "I agree" on SF424 block 17 AND upload a completed SF-LLL.

- Field 19 – Authorized Representative: Email address entered by the grantee on the SF-424 application to create the EDA notification profile. Note: If the name in the signature field of Block 19 does not match the

name listed as the AOR, you **must** provide signature delegation authority in the form of written approval from the named AOR or an institutional memo granting delegated signature authority.

ii. PROJECT SUMMARY/ABSTRACT

The project summary/abstract must identify the research problem and objectives, technical approaches, anticipated outcome of the research, if successful, and impact on DoW capabilities. Use only characters available on a standard QWERTY keyboard. Spell out all Greek letters, other non-English letters, and symbols. Graphics are not allowed and there is a one page or 4,000-character including spaces limit whichever is less.

Do not include proprietary or confidential information. The project summary/abstract must be marked by the applicant as "Approved for Public Release." Abstracts of all funded research projects will be posted on the public Defense Technical Information Center (DTIC) website: https://discover.dtic.mil/public-access-search/.

iii. RESEARCH AND RELATED OTHER PROJECT INFORMATION

- Fields 1 and 1a – Human Subject Use: Each proposal must address human subject involvement in the research by completing Fields 1 and 1a of the R&R Other Project Information form. For proposals containing activities that include or may include "research involving human subject" as defined in DoDI 3216.02, prior to award, **the Applicant must submit the required documentation under the section "Use of Human Subjects in Research".**

- Fields 2 and 2a – Vertebrate Animal Use: Each proposal must address animal use protocols by addressing Fields 2 and 2a of the R&R Other Project Information form. If animals are to be utilized in the research effort proposed, **the applicant must submit the documents described under the section "Use of Animals".**

- Fields 4a through 4d – Environmental Compliance: Address these fields and briefly indicate whether the intended research will result in environmental impacts outside the laboratory, and how the applicant will ensure compliance with environmental statutes and regulations.

  Federal agencies making grant or cooperative agreement awards and recipients of such awards must comply with all applicable environmental planning and regulatory compliance requirements. The National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. § 4321 et seq. for example, requires that agencies consider the environmental impact of "major Federal actions" prior to any final agency decision. With respect to those awards which constitute "major Federal actions," as defined in 40 CFR 1508.18, federal agencies may be required to comply with NEPA and prepare environmental planning documentation such as an environmental impact statement (EIS), even if the agency does no more than provide grant funds to the recipient. Most field research funded by DoW, however, constitute activities covered by a NEPA categorical exclusion that do not require preparation of further environmental planning documentation. This is particularly true with regard to basic and applied scientific research conducted entirely within the confines of a laboratory, if the research complies with all other applicable safety, environmental, and natural resource conservation laws. Questions regarding NEPA or other environmental planning or regulatory compliance issues should be referred to the technical point of contact.

- Field 7 – Project Summary/Abstract: Leave Field 7 blank; complete Form SF 424 Project Abstract. If an error message occurs when leaving Block 7 blank, upload the Project Abstract.

- Field 8 – Project Narrative: Clearly describe the research, including the objective and approach to be performed, keeping in mind the evaluation criteria. Attach the entire proposal narrative to R&R Other Project Information form in Field 8. To attach a Project Narrative to Field 8, click on "Add attachment" and attach the technical proposal as a single PDF file. Save the file as "Technical Proposal" as typing in the box is prohibited.

The technical proposal must describe the research in sections as described below:

- **Cover Page (not included in page limit):** This must include the words "Technical Proposal" and the following:
  - ONR NOFO Number: N0001426SF002 or
  - ARO: W911NF26S1000; or
  - AFOSR: NOFOAFRLAFOSR20260002
  - Title of proposal;
  - Identity of prime applicant and complete list of subawardees, if applicable;
  - Technical contact (name, address, phone/fax, electronic mail address);
  - Administrative/business contact (name, address, phone/fax, electronic mail address); and
  - Proposed period of performance (identify both the base period and options, if included).

- **Table of Contents (<u>not</u> included in page limit):** An alphabetical/numerical listing of the sections within the proposal, including corresponding page numbers.

- **Technical Approach (included in page limit):** Describe the scientific or technical concepts that will be investigated, providing the complete research plan, emphasizing hypothesis-driven research that is falsifiable and testable. Describe what is innovative about the proposed approach. Provide the proposed approach compared to alternate approaches other researchers in the field have taken. Discuss the relationship of the proposed research to the state-of-the-art knowledge in the field and to related efforts in programs elsewhere and discuss potential scientific breakthroughs. Include appropriate literature citations/references. Given the successful completion, describe the results, new knowledge, or insights. The Technical Approach section should include:

  - **Future DoW Relevance:** A description of potential DoW relevance and contributions of the effort to the agency's specific mission.
  - **Project Schedule and Milestones:** A summary of the schedule of events and milestones.
  - **Goals and Benchmarks:** Describe the goals of the research and the benchmarks that will be used to measure the progress and success of those goals.
- **Management Approach (included in page limit):** Describe how and how often the Principal Investigator will communicate with the Co-Investigators, how data will be made available within the team, and how differences of opinion might be resolved. Describe the research and management responsibilities of the team members. Describe plans for the research training of students. Include the number of time equivalent graduate students and undergraduates, if any, to be supported each year. Discuss the involvement of other students, if any.

- **Principal Investigator Qualifications (included in page limit):** A discussion of the qualifications of the proposed Principal Investigator and any other key personnel.

- **Data Management Plan (<u>not</u> included in page limit):** All proposals generating scientific data are required to submit a data management plan. A data management plan is a document that describes which data generated through the course of the proposed research will be shared and preserved and how it will be done, explains why data sharing or preservation is not possible or scientifically appropriate, or why the costs of sharing or preservation are incommensurate with the value of doing so. See also: DoD Instruction 3200.12.

  - In no more than 2 pages, discuss the following:
    - The types of data, software, and other materials to be produced.
    - How the data will be acquired.
    - Time and location of data acquisition, if scientifically pertinent.

- How the data will be processed.
- The file formats and the naming conventions that will be used.
- A description of the quality assurance and quality control measures during collection, analysis, and processing.
- A description of dataset origin when existing data resources are used.
- A description of the standards to be used for data and metadata format and content.
- Appropriate timeframe for preservation.
- The plan may consider the balance between the relative value of data preservation and other factors such as the associated cost and administrative burden. The plan will provide a justification for such decisions.
- A statement that the data cannot be made available to the public when there are national security or controlled unclassified information concerns (e.g., "This data cannot be cleared for public release in accordance with the requirements in DoD Instruction 5230.09.") (DoD Instruction 5230.09 can be found at: https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/523009p.pdf?ver=nuEwULZ-197fNysiam2Mnw%3d%3d)

- Field 9 – Bibliography & Referenced Cited: Upload your Bibliography/Referenced cited as a single PDF.

  - AFOSR: While the use of GenAI Tools is not prohibited, AFOSR strongly encourages disclosure of the use of such tools in your proposal. Any use of GenAI tools is at your own risk, and you are responsible for ensuring the use of GenAI tools in your proposal does not result in plagiarism, unauthorized use of intellectual property, or presentation of misinformation.

- Field 10 – Facilities & Other Resources: Describe facilities available for performing the proposed research and any additional facilities the applicant proposes to acquire at its own expense. Indicate government-owned facilities already possessed that will be used. (Additional equipment will not be provided unless the research cannot be completed by any other practical means.)

- Field 11 – Equipment: Describe any equipment available or any additional equipment the application proposes to acquire at its own expense. Indicate government owned equipment that will be used. Justify the need for each equipment item and provide vendor quotes. (Additional equipment will not be provided unless the research cannot be completed by any other practical means.)

- Field 12 – Other Attachments: Optional, as necessary

Grants do not include the delivery of software, prototypes or other hardware deliverables.

iv. RESEARCH AND RELATED BUDGET

The applicant must use the Grants.gov forms (including the Standard Form (SF) Research and Related (R&R) Budget Form) from the application package template associated with the NOFO on the Grants.gov web site located at http://www.grants.gov/. If options are proposed, the cost proposal must provide the pricing information for the option periods; failure to include the proposed costs for the option periods will result in the options not being included in the award. The applicant shall provide a detailed cost breakdown of all costs, by cost category, and by the calendar periods stated below to include a 3-year base and 2-year option period. For budget purposes, use an award start date of 01 July 2027. Note that the budget for each of the calendar periods below should include only those costs to be expended during that calendar period.

For proposals to **ONR topics**, the Recommended Funding Profile is:

(1) FY27: Six months (01 Jul 27 to 31 Oct 27): $500,000
(2) FY28: Twelve months (01 Nov 27 to 31 Oct 28): $1,500,000
(3) FY29: Twelve months (01 Nov 28 to 31 Oct 29): $1,500,000
(4) FY30: Six months (01 Nov 29 to 30 Jun 30): $1,000,000
Three-year base subtotal: $4,500,000

(4) FY30: Six months (01 Jul 30 to 30 Oct 30): $500,000
(5) FY31: Twelve months (01 Nov 30 to 30 Oct 31): $1,500,000
(6) FY32: Six months (01 Nov 31 to 30 Jun 32): $1,000,000
Two-year option subtotal: $3,000,000
Five-year total: $7,500,000

For proposals to **ARO topics**, the Recommended Funding Profile is:

(1) FY27: Three months (01 Jul 27 to 30 Sep 27): $375,000
(2) FY28: Twelve months (01 Oct 27 to 30 Sep 28): $1,500,000
(3) FY29: Twelve months (01 Oct 28 to 30 Sep 29): $1,500,000
(4) FY30: Nine months (01 Oct 29 to 30 Jun 30: $1,125,000
Three-year base subtotal: $4,500,000

(4) FY30: Three months (01 Jul 30 to 30 Sep 30): $375,000 (Option)
(5) FY31: Twelve months (01 Oct 30 to 30 Sep 31): $1,500,000
(6) FY32: Nine months (01 Oct 31 to 30 Jun 32): $1,125,000
Two-year option subtotal: $3,000,000
Five-year total: $7,500,000

For proposals to **AFOSR topics**, the Recommended Funding Profile is:

(1) FY27: Four months (01 Jul 27 to 31 Oct 27): $500,000
(2) FY28: Twelve months (01 Nov 27 to 31 Oct 28): $1,500,000
(3) FY29: Twelve months (01 Nov 28 to 31 Oct 29): $1,500,000
(4) FY30: Eight months (01 Nov 29 to 30 Jun 30): $1,000,000
Three-year base subtotal: $4,500,000

(4) FY30: Four months (01 Jul 30 to 30 Oct 30): $500,000
(5) FY31: Twelve months (01 Nov 30 to 30 Oct 31): $1,500,000
(6) FY32: Eight months (01 Nov 31 to 30 Jun 32): $1,000,000
Two-year option subtotal: $3,000,000
Five-year total: $7,500,000

The available budget is subject to change based on the availability of funds. The funding profile may change based on the available budget.

NOTE: AFOSR will not consider any request for exception above $15,000,000 including additional funding and cost-sharing.

A separate Adobe.pdf document **must** be included in the application that provides appropriate justification and/or supporting documentation for each element of cost proposed and include a link to the current single audit report.

This document shall be attached under Section L. "Budget Justification" of the Research and Related Budget form. Click "Add Attachment" to attach.
The itemized budget should include the following. All costs should be rounded to the nearest dollar.

- Direct Labor – Individual labor categories or persons, with associated labor hours and unburdened direct labor rates. Provide escalation rates for out years.

- Administrative and Clerical Labor – Salaries of administrative and clerical staff are normally indirect costs (and included in an indirect cost rate). Direct charging of these costs may be appropriate when a major project requires an extensive amount of administrative or clerical support significantly greater than normal and routine levels of support. Budgets proposing direct charging of administrative or clerical salaries must be supported with a budget justification which adequately describes the major project and the administrative and/or clerical work to be performed.

- Fringe Benefits and Indirect Costs (Facilities and Administration (F&A), Overhead, G&A, etc.)
  The proposal shall show the rates and calculation of the costs for each rate category. If the rates have been approved/negotiated by a Government agency, provide a copy of the memorandum/agreement. If the non-Federal entity has never received a negotiated indirect cost rate, they may elect to charge a *de minimis* rate of 15% of modified total direct costs or provide sufficient detail to enable a determination of allowability, allocability and reasonableness of the allocation bases, and how the rates are calculated. See 2 CFR 200.414(f) regarding the use of a *de minimis* rate. Additional information may be requested, if needed. If composite rates are used, provide the calculations used in deriving the composite rates.

  Institutions of Higher Education (IHE) - The proposal shall show the rates and calculation of the costs for each rate category.

- Travel – The proposed travel cost **must** include the following for each trip: the purpose of the trip, origin and destination if known, approximate duration, the number of travelers, and the estimated cost per trip must be justified based on the organizations historical average cost per trip or other reasonable basis for estimation. Such estimates and the resultant costs claimed must conform to the applicable Federal cost principles. Applicants may include travel costs for the Principal Investigator to attend the peer reviews described in the section Peer Review of this NOFO. A sample Travel Estimate Spreadsheet with the required information is located at the following link: https://www.onr.navy.mil/work-with-us/how-to-apply/submit-grant-application

- Subawards/Subcontracts – Provide a description of the work to be performed by the subrecipient/subcontractor. For each subaward, a detailed cost proposal is required to be submitted by the subrecipient(s) using the R&R budget form. The same requirements for the individual categories identified in this section apply to the subaward/subcontract. **Include subrecipient(s) name at the top of the budget justification document.** A proposal and any supporting documentation must be received and reviewed before the Government can complete its cost analysis of the proposal and enter negotiations. DoW's preferred method of receiving subcontract information is for this information to be included with the Prime's proposal. However, a subcontractor's cost proposal can be provided in a sealed envelope with the recipient's cost proposal or via e-mail directly to the Program Officer at the same time the prime proposal is submitted. The e-mail should identify the proposal title, the prime applicant and that the attached proposal is a subcontract.

- Consultants – Provide a breakdown of the consultant's hours, the hourly rate proposed, and any other proposed consultant costs, a copy of the signed Consulting Agreement or other documentation supporting the proposed consultant rate/cost, and a copy of the consultant's proposed statement of work if it is not already separately identified in the prime applicant's proposal.

- Materials & Supplies – In the budget justification, indicate general categories (e.g., glassware, chemicals, animal costs, etc.) and if the total cost of all the items in the category is less than $1,000, itemization is not required, but include the basis for the estimate (e.g., quotes, prior purchases, catalog price lists). If the total cost for the category is greater than or equal to $1,000, provide an itemized list of all proposed materials and supplies including quantities, unit prices, and the basis of estimate (e.g., quotes, prior purchases, catalog price lists).

- Recipient Acquired Equipment or Facilities – Equipment and/or facilities are normally furnished by the Recipient. If acquisition of equipment and/or facilities is proposed, a justification for the purchase of the items must be provided. Provide an itemized list of all equipment and/or facilities costs and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists). Allowable items normally are limited to research equipment not already available for the project. General purpose equipment (i.e., equipment not used exclusively for research, scientific or other technical activities, such as personal computers, laptops, office equipment) should not be requested unless they will be used primarily or exclusively for the project. For computer/laptop purchases and other general purpose equipment, if proposed, include a statement indicating how each item of equipment will be integrated into the program or used as an integral part of the research effort. Applicants must provide vendor quotes for any proposed capital equipment costs.

- Other Direct Costs – Provide an itemized list of all other proposed other direct costs such as Graduate Assistant tuition, laboratory fees, report and publication costs, and the basis for the estimate (e.g., quotes, prior purchases, catalog price lists).

  The funds provided by DoW agencies generally may not be used to pay for food or beverages as a direct cost except in exceptional circumstances. The funds shall not be used for food or beverages unless

  a. The grant proposal contains a request for such funding that is fully supported factually in accordance with the cost principles of the relevant OMB Circular, and
  b. The Grants Officer determines that the funding is a reasonable, allocable, allowable expense under the relevant cost principles.

- Fee/Profit – Fee/profit is unallowable under assistance agreements at either the prime or subaward level but may be permitted on contracts issued by the prime awardee.

v. RESEARCH AND RELATED SENIOR/KEY PERSON PROFILE (EXPANDED)

To evaluate compliance with Title IX of the Education Amendments of 1972 (20 U.S.C. A§ 1681 Et. Seq.), the Department of War is collecting certain demographic and career information to be able to assess the success rates of women who are proposed for key roles in applications in STEM disciplines. In addition, the National Defense Authorization Act (NDAA) for FY 2019, Section 1286, directs the Secretary of Defense to protect intellectual property, controlled information, key personnel, and information about critical technologies relevant to national security and limit undue influence, including foreign talent programs by countries that desire to exploit United States' technology within the DoW research, science and technology, and innovation enterprise.

The R&R Senior/Key Person Profile (Expanded) form has inputs to collect both "Biosketch" and "Current and Pending Support" by using the common forms located at https://www.nsf.gov/bfa/dias/policy/nstc_disclosure.jsp. Use of the common NSF forms for the Biosketch and Current and Pending Support is required. The SciENcv format may be used.
NOTE: AFOSR requires **Senior/Key Personnel** and Covered Individuals to enter their ORCID ID into the "Credential, e.g., agency login" field within the R&R Senior/Key Person Profile (Expanded) form.

The Privacy Act and Burden Statement for the Common Form for Biographical Sketch and Current and Pending (Other) Support Information can be found at the following links:

- ONR - under How to Submit a Grant Application – Full Application Submission https://www.onr.navy.mil/work-with-us/how-to-apply/submit-grant-application.
- ARO - https://arl.devcom.army.mil/collaborate-with-us/opportunity/arrp/
- AFOSR- Form will be found as attachment in the full announcement folder on grants.gov.

vi. RESEARCH AND RELATED PERSONAL DATA

This form will be used by DoW as the source of demographic information, such as gender, race, ethnicity, and disability information for the Project Director/Principal Investigator and all other persons identified as Co-Project Director(s)/Co-Principal Investigator(s). Each application must include this form with the name fields of the Project Director/Principal Investigator and any Co-Project Director(s)/Co-Principal Investigator(s) completed; however, provision of the demographic information in the form is voluntary. If completing the form for multiple individuals, each Co-Director/Co-Principal Investigator can be added by selecting the "Next Person" button. The demographic information may be accessible to the reviewer, but will not be considered in the evaluation. Applicants who do not wish to provide some or all of the information should check or select the "Do not wish to provide" option.

E. Submission Requirements and Deadlines

1. Address to Request Application Package

This NOFO may be accessed from the sites below. Amendments, if any, to this NOFO will be posted to these websites when they occur. Interested parties are encouraged to periodically check these websites for updates and amendments.

- Grants.gov (www.grants.gov)
- ONR website (https://www.onr.navy.mil/work-with-us/funding-opportunities)
- AFOSR website: https://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282103/afosr-funding-opportunities/
- ARO website: https://arl.devcom.army.mil/collaborate-with-us/opportunity/muri/

2. Unique Entity Identifier (UEI) and System for Award Management (SAM)

All applicants submitting proposals or applications **must**:

a) Be registered in SAM prior to submission;
b) Provide a valid UEI number in each application or proposal it submits to the agency;
c) Obtain a CAGE Code; and
d) Maintain an active SAM registration with current information at all times during which it has an active Federal award or an application under consideration by a Federal awarding agency; and

SAM may be accessed at https://www.sam.gov/content/home.

A Federal awarding agency may not make a Federal award to an applicant/offeror until the applicant has complied with all applicable unique entity identifier and SAM requirements and, if an applicant/offeror has not fully complied with the requirements by the time the Federal awarding agency is ready to make a Federal award, the Federal awarding agency may determine that the applicant/offeror is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another applicant/offeror.

3. Submission Instructions

a. White Paper Submission Instructions

AFOSR White Paper Submissions (submissions to Topics 1-5):
White papers to AFOSR Research Topic Chiefs should be submitted electronically via https://afosr.gov1.qualtrics.com/jfe/form/SV_a66xjgBucxq4lXU. Detailed instructions are included on the submission page. For support, please contact Ms. Katie Wisecarver at 703-696-9544 or afosr.rtb.muri@us.af.mil.

ARO White Paper Submissions (submissions to Topics 6-11):
White Papers to ARO may be submitted via e-mail directly to the Research Topic Chief, or via the United States Postal Service (USPS), or via a commercial carrier to the agency specified for the topic.

ONR White Paper Submissions (submissions to Topics 12-16):
ONR utilizes the ONR Submission Portal for the submission of white papers. Through this portal, performers will be able to submit white papers and ask questions. To access the ONR Submission Portal go to https://submissions.nre.navy.mil/.

i. How to register for ONR Submission Portal

A registration and submission guide for the ONR Submission Portal can be found at https://submissions.nre.navy.mil/UserSupport/UserSupportPage.

ii. ONR Submission Portal Assistance

If you need assistance, the ONR Submission Portal Support Team is standing by to assist you.
Email: ONR.NCR.053.list.onedesk@us.navy.mil
Phone: 703-215-3003 option "0"
Hours: Monday – Friday, 6 a.m. to 6 p.m. ET. Closed on Federal Holidays.

ONR suggests you additionally email a copy of your white paper to the Research Topic Chief, with cc to MURI Coordinator, Dr. Amanda Netburn, Amanda.n.netburn.civ@us.navy.mil.

b. Full Proposal Submission Instructions

i. Grants.gov Application Submission and Receipt Procedures

This section provides the application submission and receipt instructions for the Department of War (DoW) program applications. Please read the following instructions carefully and completely.

(a) Electronic Delivery

DoW is participating in the Grants.gov initiative to provide the grant community with a single site to find and apply for grant funding opportunities. All applicants shall submit their applications online through Grants.gov.

(b) How to Register for Grants.gov

(1) *Instructions:* Read the instructions below about registering to apply for DoW funds. Applicants should read the registration instructions carefully and prepare the information requested before beginning the registration process. Reviewing and assembling the required information before beginning the registration process will alleviate last-minute searches for required information.

Organizations must have an active System for Award Management (SAM) registration, and Grants.gov account to apply for grants. If individual applicants are eligible to apply for this funding opportunity, then you may begin with step 3, Create a Grants.gov Account, listed below.

Creating a Grants.gov account can be completed online in minutes, but SAM registrations may take additional time. Therefore, an organization's registration should be done in sufficient time to ensure it does not impact the entity's ability to meet required application submission deadlines.

Complete organization instructions can be found on Grants.gov here:
https://www.grants.gov/applicants/applicant-registration/

1) *Register with SAM*: All organizations applying online through Grants.gov must register with the System for Award Management (SAM). Failure to register with SAM will prevent your organization from applying through Grants.gov. SAM registration must be renewed annually.
For more detailed instructions for registering with SAM, refer to:
https://www.grants.gov/applicants/applicant-registration/

2) Obtain an ORCID For All Key Personnel: All individuals listed on the Senior/Key Person form must have an Open Researcher and Contributor ID (ORCID).

As of September of 2024, the DoW is requiring all proposers to include a digital persistent identifier (DPI) for each senior or key person listed in a proposal. The DoW will require proposers to include the ORCID number for each senior or key person listed in a proposal for an assistance award for R&D. ORCID numbers will be used since ORCID is currently the only DPI provider that meets the requirements for DPI common or core standards in the NSTC NSPM-33 implementation guidance.

For ONR or ARO submissions: there is an option to include the ORCID in the NSF biosketch and C&P.
For AFOSR submissions: AFOSR requires **Senior/Key Personnel and Covered Individuals** to enter their ORCID ID into the "Credential, e.g., agency login" field within the R&R Senior/Key Person Profile (Expanded) form.

For more detailed instructions for obtaining an ORCID number, refer to: How do I register for an ORCID ID? | ORCID

3) *Create a Grants.gov Account*: The next step in the registration process is to create an account with Grants.gov. Follow the on-screen instructions provided on the registration page.

4) *Add a Profile to a Grants.gov Account:* A profile in Grants.gov corresponds to a single applicant organization the user represents (i.e., an applicant) or an individual applicant. If you work for or consult with multiple organizations and have a profile for each, you may log in to one Grants.gov account to access all of your grant applications. To add an organizational profile to your Grants.gov account, enter the UEI Number for the organization in the UEI field. For more detailed instructions about creating a profile on Grants.gov, refer to https://www.grants.gov/applicants/applicant-registration/ebiz-poc-authorizes-profile-roles

5) *EBiz POC Authorize Profile Roles:* After you register with Grants.gov and create an Organization Applicant Profile, the organization applicant's request for Grants.gov roles and access is sent to the EBiz POC. The EBiz POC will then log in to Grants.gov and authorize the appropriate roles, which may include the Authorized Organization Representative (AOR) role, thereby giving you permission to complete and submit applications on behalf of the organization. You will be able to submit your application online any time after you have been assigned the AOR role. For more detailed instructions about creating a profile on Grants.gov, refer to https://www.grants.gov/applicants/applicant-registration/ebiz-poc-authorizes-profile-roles

6) *Track Role Status*: To track your role request, refer to: https://www.grants.gov/applicants/applicant-registration/track-profile-role-status

(2) *Electronic Signature:* When applications are submitted through Grants.gov, the name of the organization's AOR that submitted the application is inserted into the signature line of the application, serving as the electronic signature. The EBiz POC must authorize individuals who are able to make legally binding commitments on behalf of the organization as an AOR; **this step is often missed and it is crucial for valid and timely submissions.**

ii. How to Submit an Application to the ONR, ARO, or AFOSR via Grants.gov

White Papers must **NOT** be submitted through the Grants.gov application process. White paper submissions must be submitted as described in the previous section.

All attachments to grant applications submitted through Grants.gov must be in Adobe Portable Document Format. Proposals with attachments submitted in word processing, spreadsheet, or any format other than Adobe Portable Document Format will not be considered for award.

Grants.gov applicants can apply online using Workspace. Workspace is a shared, online environment where members of a grant team may simultaneously access and edit different web forms within an application. For each funding opportunity announcement (NOFO), you can create individual instances of a workspace.

Below is an overview of applying on Grants.gov. For access to complete instructions on how to apply for opportunities, refer to: https://www.grants.gov/applicants/workspace-overview

1) *Create a Workspace*: Creating a workspace allows you to complete it online and route it through your organization for review before submitting.

2) *Complete a Workspace*: Add participants to the workspace, complete all the required forms, and check for errors before submission. The Workspace progress bar will display the state of your application process as you apply. As you apply using Workspace, you may click the blue question mark icon near the upper-right corner of each page to access context-sensitive help.

a. *Adobe Reader*: If you decide not to apply by filling out web forms you can download individual PDF forms in Workspace so that they will appear similar to other Standard or ONR forms. The individual PDF forms can be downloaded and saved to your local device storage, network drive(s), or external drives, then accessed through Adobe Reader.

   NOTE: Visit the Adobe Software Compatibility page on Grants.gov to download the appropriate version of the software at: https://www.grants.gov/applicants/adobe-software-compatibility

b. *Mandatory Fields in Forms:* In the forms, you will note fields marked with an asterisk and a different background color. These fields are mandatory fields that must be completed to successfully submit your application.

c. *Complete SF-424 Fields First*: The forms are designed to fill in common required fields across other forms, such as the applicant name, address, and UEI number. To trigger this feature, an applicant must complete the SF-424 information first. Once it is completed, the information will transfer to the other forms.

3) *Submit a Workspace*: An application may be submitted through workspace by clicking the Sign and Submit button on the Manage Workspace page, under the Forms tab. **Grants.gov recommends submitting your application package at least 24-48 hours prior to the close date** to provide you with time to correct any potential technical issues that may disrupt the application submission.

4) *Track a Workspace*: After successfully submitting a workspace package, a Grants.gov Tracking Number (GRANTXXXXXXXX) is automatically assigned to the package. The number will be listed on the Confirmation page that is generated after submission. Using the tracking number, access the Track My Application page under the Applicants tab or the Details tab in the submitted workspace.

For additional training resources, including video tutorials, refer to: https://www.grants.gov/applicants/applicant-training

c. Applicant Support

Grants.gov provides applicants 24/7 support via the toll-free number 1-800-518-4726 and email at support@grants.gov. For questions related to the specific grant opportunity, contact the number listed in the application package of the grant for which you are applying.

If you are experiencing difficulties with your submission, it is best to call the Grants.gov Support Center and get a number. The Support Center ticket number will assist DoW with tracking your issue and understanding background information on the issue.

4. Submission Dates and Times

See Section A.7 above, "Key Dates" for information.

a. Timely Receipt Requirements and Proof of Timely Submission

i. Online Submission

All applications must be received by **5:00 PM** Eastern time on **9 APRIL 2027**. Proof of timely submission is automatically recorded by Grants.gov. An electronic date/time stamp is generated within the system when the application is successfully received by Grants.gov. The applicant AOR will receive an acknowledgement of receipt and a tracking number (GRANTXXXXXXXX) from Grants.gov with the successful transmission of their application. Applicant AORs will also receive the official date/time stamp and Grants.gov Tracking number in an email serving as proof of their timely submission.

When the DoW agency successfully retrieves the application from Grants.gov, and acknowledges the download of submissions, Grants.gov will provide an electronic acknowledgment of receipt of the application to the email address of the applicant with the AOR role. Again, proof of timely submission shall be the official date and time that Grants.gov receives your application. Applications received by Grants.gov after the established due date for the program will be considered late and will not be considered for funding by the Office of Naval Research.

Applicants using unreliable internet connections should be aware that the process of completing the Workspace can take some time. Therefore, applicants should allow enough time to prepare and submit the application before the package closing date. Grants.gov will provide either an error or a successfully received transmission in the form of an email sent to the applicant with the AOR role attempting to submit the application. The Grants.gov Support Center reports that some applicants end the transmission because they think that nothing is occurring during the transmission process. Please be patient and give the system time to process the application.

DoW strongly recommends applications are submitted no later than two (2) business days ahead of submission deadline to ensure sufficient time for any corrections that may be required.

b. Proposal Receipt Notice

After a proposal is submitted through Grants.gov, the Authorized Organization Representative (AOR) will receive a series of three emails. It is extremely important that the AOR watch for and save each of the emails. You will know that your proposal has reached the DoW agency when the AOR receives email Number 3. You will need the Submission Receipt Number (email Number 1) to track a submission. The three emails are:

- Number 1 – The Applicant will receive a confirmation page upon completing the submission to Grants.gov. This confirmation page is a record of the time and date stamp that is used to determine whether the proposal was submitted.
- Number 2 – The Applicant will receive an email indicating that the proposal has been validated by Grants.gov within two days of submission (This means that all of the required fields have been completed). After an institution submits an application, Grants.gov generates a submission receipt via email and also sets the application status to “Received.” This receipt verifies the application has been successfully delivered to the Grants.gov system. Next, Grants.gov verifies the submission is valid by ensuring it does not contain viruses, the opportunity is still open, and the Applicant login and Applicant UEI number match. If the submission is valid, Grants.gov generates a submission validation receipt via email and sets the application status to “Validated.” If the application is not validated, the application status is set to "Rejected." The system sends a rejection email notification to the institution, and the institution must resubmit the application package. Applicants can track the status of their application by logging in to Grants.gov.
- Number 3 – The third notice is an acknowledgment of receipt via email from DoW within ten days from the proposal due date, if applicable. The email is sent to the authorized representative for the institution. The email notes that the proposal has been received and provides the assigned tracking number.

F. Application Review Information

1. Responsiveness Reviews

This section includes information on the criteria that make an application or project ineligible. These are sometimes referred to as "responsiveness" criteria, "go-no-go" criteria, or "threshold" criteria. Listed throughout this NOFO, are additional criteria that make an application ineligible.

Applicants should read all sections carefully but specifically are directed to the sections on eligibility, submission content and format, submission requirements and deadlines, and post award requirements and administration. In addition, all organizations applying must register with the System for Award Management (SAM) and will receive a unique entity identifier (UEI) number. SAM registration must be renewed annually. If you have not registered in SAM, go to https://www.sam.gov/SAM/. All submissions to ONR must be made through the ONR Submission Portal or grants.gov as indicated in the submission requirements section.

2. Review Criteria

Basic Research: The MURI Program is funded by a basic research appropriation. White papers and proposals, to be considered for funding, are therefore required to be of a basic, rather than applied or advanced technological, nature.

Note that basic research includes "scientific study and experimentation directed toward increasing fundamental knowledge and understanding" while applied research deals with the development of "useful materials, devices, and systems or methods" and "the design, development, and improvement of prototypes and new processes to meet general mission area requirements." The full definitions of these terms are contained in document: (DoD 7000.14-R, vol. 2B, chap. 5, para. 050105)

White papers will be evaluated to assess whether the proposed research is likely to meet the objectives of the specific topic, and thus whether to encourage the submission of a proposal. The assessment of the white papers will primarily focus on scientific and technical merits, potential for the research to significantly advance fundamental understanding in the topic area, and potential DoW interest.

Proposals responding to this NOFO in each topic area will be evaluated using the following criteria:

- Scientific and technical merits of the proposed basic science and/or engineering research;
- Potential for the research, if successful, to significantly advance fundamental understanding in the topic area;
- Potential DoW relevance and contribution to the DoW mission;
- Qualifications and availability of the Principal Investigator and other investigators;
- Adequacy of current or planned facilities and equipment to accomplish the research objectives, and the strength of the data management plan;
- Impact of interactions with other organizations engaged in related research and development, in particular DoW laboratories, industry, and other organizations that perform research and development for defense applications; and
- Realism and reasonableness of cost (cost sharing is not a factor in the evaluation)

The primary basis for selecting proposals for acceptance shall be technical merit, importance to agency programs, and fund availability. To the extent appropriate, cost realism and reasonableness will also be considered when selecting proposals. DoW agencies reserve the right to request and require any additional information and documentation after it makes the type of award instrument determination. DoW agencies reserve the right to remove Applicants from award consideration when the parties fail to reach agreement on award terms, conditions, and cost/price within a reasonable time, or when the Applicant fails to timely provide requested or required additional information.

(1) The availability of funds. *(Not applicable to white papers.)*

In addition, per NDAA 2021 Section 1062, beginning October 1, 2024, DoW may not fund institutions of higher education (as defined by 20 U.S.C 1002) that host a Confucius Institute, other than amounts provided directly to students as education assistance, unless a waiver is provided. A Confucius Institute is defined as a cultural institute directly or indirectly funded by the Government of the People's Republic of China.

3. Review and Selection Process

a. Evaluation

The ultimate recommendation for award of proposals is made by the DoW's scientific/technical community. Recommended proposals will then be forwarded to ONR, AFOSR, or ARO Contracts and Grant Awards Management office. Any notification received from the DoW agency that indicates that the Applicant's proposal has been recommended does not guarantee an award will ultimately be made. This notice indicates that the proposal has been selected in accordance with the evaluation criteria stated above and has been sent to the Grants Department to conduct cost analysis, determine the Applicant's responsibility, to confirm whether funds are available, and to take other relevant steps necessary prior to commencing negotiations with the Applicant.

b. Options

The Government will evaluate options for award purposes by adding the total cost for all options to the total cost for the basic requirement. Evaluation of options will not obligate the Government to exercise the options during contract or grant performance. The Government reserves the right to exercise options at time of award.

c. Evaluation Panel
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White paper submissions will be reviewed either solely by the responsible Research Topic Chief for the specific topic or by an evaluation panel chaired by the responsible Research Topic Chief. An evaluation panel will consist of technical experts who are Government employees or who are detailed under the Intergovernmental Personnel Act (IPA). Restrictive notices notwithstanding, one or more support contractors or advisors external to the US Government may be utilized as subject-matter-expert technical consultants. These individuals will sign a conflict of interest statement and a non-disclosure agreement prior to receiving proposal information.

Proposals will undergo a multi-stage evaluation procedure. The Research Topic Chief and other Government scientific experts will perform the evaluation of technical proposals first. Cost proposals will be evaluated by

Government business professionals. Restrictive notices notwithstanding, one or more support contractors or advisors external to the US Government may be utilized as subject-matter-expert technical consultants. However, proposal selection and award decisions are solely the responsibility of Government personnel. Technical and cost proposals submitted under this NOFO will be protected from unauthorized disclosure. Each support contractor's employee or external advisor having access to technical and cost proposals submitted in response to this NOFO will be required to sign a Non-Disclosure Agreement (NDA) for Contractor Support prior to receipt of any proposal submissions. This NDA includes third-party beneficiary language giving the submitter of proprietary information a right of direct action against the contractor employee and/or their employer in the event that the NDA is violated.

Findings of the evaluation panels will be forwarded to senior DoW officials who will make funding recommendations to the awarding officials.

Due to the nature of the MURI program, the evaluation panels and reviewing officials may on occasion recommend that less than an entire MURI proposal be selected for funding. This may be due to several causes, such as insufficient funds, research overlap among proposals received, or potential synergies among proposals under a research topic. In such cases, proposal adjustments will be agreed to by the Principal Investigator and the Government prior to final award.

4. Risk Review

The Grants Officer is responsible for determining a recipient's qualification prior to award. In general, a Grants Officer will award grant and cooperative agreements only to qualified recipients that meet the standards at 32 CFR 22.415. To be qualified, a potential recipient must:

- Have the management capability and adequate financial and technical resources, given those that would be made available through the grant or cooperative agreement, to execute the program of activities envisioned under the grant or cooperative agreement;
- Have a satisfactory record of executing such programs or activities (if a prior recipient of an award);
- Have a satisfactory record of integrity and business ethics; and
- Be otherwise qualified and eligible to receive a grant or cooperative agreement under applicable laws and regulations. Applicants are requested to provide information with proposal submissions to assist the Grants Officer's evaluation of recipient qualification.

a. Risk-based Security Review Process

All Covered Individuals proposed under all grants and cooperative agreements are subject to the DoW Fundamental Research Risk-Based Security Review Process. In accordance with applicable laws and regulations and as designated by DoW policy, Covered Individuals are individuals who contribute in a substantive, meaningful way to the scientific development or execution of a research and development project, including the principal investigator (PI) and co-PI(s).

This risk-based security review process provides consistency in policy and procedures across all DoW Components. Risk-based security reviews will be conducted for all fundamental research proposals that are identified as "selected for award based on technical merit." The risk-based security reviews will be conducted by reviewing the Standard Form (SF) 424, "Senior/Key Person Profile (Expanded)," its

accompanying or referenced documents, Common Disclosure Forms, and the Research Performance Progress Reports (when applicable), in concert with a risk decision matrix consistent with DoW's Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions.

University or non-profit research institution performance under this solicitation will be efforts categorized as fundamental research. In addition to Government support for free and open scientific exchanges and dissemination of research results in a broad and unrestricted manner, the academic or non-profit research performer or recipient, regardless of tier, acknowledges that such research may have implications that are important to U.S. national interests and must be protected against foreign influence and exploitation. As such, the academic or non-profit research performer or recipient agrees to comply with the following requirements:

i. On June 8, 2023, the Undersecretary of Defense for Research and Engineering (OUSD (R&E)) released a memorandum, "Policy on Risk-Based Security Reviews on Fundamental Research," directing Components to establish a risk-based security review program to identify and mitigate undue foreign influence in fundamental research consistent with the requirements mandated by National Security Presidential Memorandum (NSPM)-33. In accordance with these requirements, all Covered Individuals proposed under all fundamental research proposals that are selected for award will be assessed for potential undue foreign influence risk factors relating to professional and financial activities. This will be done by evaluating information provided via the SF-424 and any accompanying or referenced documents, as well as the Common Disclosure Forms and Research Performance Progress Reports, as applicable, to identify and assess any associations or affiliations the Covered Individuals may have with foreign countries of concern (FCOC) (i.e., The Peoples Republic of China, the Russian Federation, the Islamic Republic of Iran, and the Democratic People's Republic of North Korea) or FCOC connected entities.

ii. The University or non-profit research institution, performer, or recipient agrees to provide information on potential conflicts of interest and conflicts of commitment associated with foreign influence in their biographical sketch and current and pending support.

(a) The above-described information will be provided to the Government as part of the proposal response to the solicitation and will be reviewed and assessed utilizing a risk-based security review process prior to award. Generally, this information will be included in the Research and Related Senior/Key Personnel Profile (Expanded) form (SF-424) and Common Disclosure Forms required as part of the proposer's submission through Grants.gov.

1. Instructions regarding how to fill out the SF-424 and its biographical sketch and current and pending support can be found through Grants.gov.

(b) The risk-based security review process takes into consideration the entirety of the Covered Individual's SF-424, Common Disclosure Forms, current and pending support, and biographical sketch. Any identified potential risk factors, along with publicly or commercially available validation information, are then compared to a risk decision matrix consistent with the "DoW Component Decision Risk Matrix to Inform Fundamental Research Proposal Mitigation Decisions" to determine the level of mitigation that may be required to proceed, if possible.

(c) The risk-based security review process will leverage, among other things, publicly available lists or reports published by the U.S. federal government and cited in the "Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions": https://basicresearch.defense.gov/Portals/61/Documents/Academic%20Research%20Security%20Page/DoD%20Component%20Decision%20Matrix%20to%20Inform%20Fundamental%20Research%20Proposal%20Mitigation%20Decisions.pdf?ver=GQHK7CJBr8ks5GPnXKxabQ%3d%3d .

(d) Congress has explicitly stated that there are foreign influence risks that are not able to be

mitigated and thus would require denial of award. They are:

1. Beginning 1 October 2023, no U.S. institution of higher education that hosts a Confucius Institute* may receive DoW funding. Institutions hosting a Confucius Institute are automatically classified as "prohibited" under OUSD(R&E)'s "Policy on Risk Based Security Reviews on Fundamental Research," as required by law.
2. Beginning 9 August 2024, the DoW is prohibited from funding or making an award of a fundamental research project proposal in which a Covered Individual is actively participating in a malign foreign talent recruitment program, pursuant to section 10632 of the CHIPS and Science Act of 2022. Individuals participating in such a program are automatically classified as "prohibited" under OUSD(R&E)'s "Policy on Risk Based Security Reviews on Fundamental Research," as required by law.

* The term "Confucius Institute" means a cultural institute directly or indirectly funded by the Government of the People's Republic of China.

(e) Any changes to Covered Individuals will require submission of an SF-424 and its attachments, Common Disclosure Forms, a security-based risk assessment, and approval by the contracting officer and program manager.

(f) Security-based risk assessments will also be conducted if changes to Covered Individuals reporting criteria are reflected in the Research Performance Progress Reports.

(g) To the greatest extent practicable, the DoW will work with the proposing institution to ensure that if the risk is able to be mitigated, it will make every effort to do so. If the proposing institution refuses to, or is unable to mitigate the identified risks, it may result in a denial of award.

(h) Proposing institutions who have their technically acceptable fundamental research proposal rejected due to the risk-based security review process may challenge the risk-based security review decision. In that instance, the OUSD(R&E) will reconsider the project proposal as well as any additional documentation provided by the proposing institution to ensure that the risk-based security review was performed consistent with OUSD(R&E) policy.

(i) This process, to include negotiation of risk mitigation measures, is not to be considered as part of the time-to-award.

iii. Involvement of Covered Individuals in Malign Foreign Talent Recruitment Programs.

(a) If, at any time during performance of this research award, the academic or non- profit research performer or recipient should learn that it, its Covered Individuals, or applicable team members or subtier performers on this award are, or are believed to be, participants in a malign foreign government talent program or exhibiting behaviors/actions identified in the DoW Component Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions (i.e., funding from a FCOC or FCOC-connected entity, patents resulting from U.S. government funded research that were filed with a FCOC or on behalf of a FCOC-connected entity, and associations or affiliations with foreign government connected entities), the performer or recipient will notify the Government Contracting Officer or Agreements Officer within 5 business days.

1. This disclosure must include specific information as to the personnel involved and the nature of the situation and relationship. The Government will have 30 business days to review this information and conduct any necessary fact-finding or discussion with the performer or recipient.
2. Such disclosure could result in a termination of award at the government's discretion.

3. If the University receives no response from the Government to its disclosure within 30 business days, it may presume that the Government has determined the disclosure does not represent a threat.

(b) The performer or recipient must flow down this provision to any subtier contracts or agreements involving direct participation in the performance of the research.

iv. All analysis and assessment of affiliations and associations of Covered Individuals are compliant with Title VI of the Civil Rights Act of 1964. Information regarding race, color, or national origin is not collected and does not have bearing in the risk assessment. University or non-profit research institutions with proposals selected for negotiation that have been assessed as having potential undue foreign influence risk factors, as defined by the DoW Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions, will be given an opportunity during the negotiation process to mitigate the risk. The DoW reserves the right to request any follow-up information needed to assess potential risk factors or proposed risk mitigation strategies.

v. Definitions: Definitions can be found in the June 08, 2023 USD(R&E) memorandum, "Policy for Risk Based Security Reviews of Fundamental Research," or as it is amended.

AFOSR-SPECIFIC RISK REVIEW INFORMATION

Each proposal submission will be subject to a Risk-based Security Review prior to selection for award. The Risk-based Security Review is applied to federally funded research designed to help protect Department of the Air Force Science and Technology (S&T) by identifying possible vectors of undue foreign influence. AFRL will follow all policy and procedures outlined in Air Force Research Laboratory (AFRL) Instruction AFRLI 61-113, Science and Technology Protection for the Air Force Research Laboratory and Department of the Air Force Instruction DAFI 63-101/20-101, Integrated Lifecycle Management. The Risk-based Security Review will be conducted in accordance with OUSD(R&E)'s "Policy for Risk Based Security Reviews of Fundamental Research"

i. **Security risk review for these subject proposals will be developed for all proposed Senior/Key personnel and "Covered Individuals."** These risk reviews will be based on information disclosed in a Research and Related Senior and Key Person Profile. In addition, any accompanying or referenced documents, and publicly available information will be utilized in risk reviews. Nationality or citizenship is not a factor in the security risk reviews.

External Engagements. When considering all external engagements, AFRL incorporates a holistic decision-making process that encompasses technical and security factors. The security review method implemented by AFRL measures risk factors to identify the appropriate Risk Acceptance Level (RAL) within the organization. The objective analysis of the security risk factors is conducted to empower AFRL's S&T leaders to make risk-informed decisions. The review process looks at the risk factors indicated in the DoW Component Decision Matrix to Inform Fundamental Research Proposal Mitigation Decisions.

ii. **Actions Required by Applicants/Recipients at Proposal Submission**
In accordance with AFRLI 61-113, S&T Protection, Applicants/Recipients are required to submit the following documentation with their proposal:

- Standard Form 424, "Research and Related Senior and Key Person Profile (Expanded) (Included in Application Package), AND;
- Common Disclosure Forms for biosketch and current and pending support (to be submitted with SF-424), AND;

- "Privacy Act Statement" consent form for each Covered Individual that is also signed by the Applicants/Recipients as the Individual's Sponsors (See "Covered Individual" section below and Attachment 1)

In the event a security risk is identified, and the Government has determined the security risk exceeds the acceptable threshold and cannot be mitigated, the Applicant/Recipient will be notified and informed of the decline of award. The Government will provide an unclassified rationale for any rejection of a proposal due to security risks.

By submission of the Research and Related Senior Key Person Profile, the Applicant/Recipient agrees to comply with the following:

- To certify that each covered individual who is listed on the application has been made aware: 1) of all relevant disclosure requirements, including the requirements of 42 U.S.C. § 6605; and 2) that false representations may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802. See National Science and Technology Council Guidance for Implementing National Security Presidential Memorandum 33 (NSPM-33) on National Security Strategy for United States Government-Supported Research and Development (January 2022).

iii. **Actions Required by Covered Individuals**

- Covered Individual. An individual who contributes to a substantive, meaningful way to the scientific development or execution of a research and development project proposed to be carried out with a research and development award from a federal research agency; and is designated as a covered individual by the federal research agency concerned. See 42 U.S.C. § 6605, Definitions. (Note: For purposes of a Notice of Funding Opportunity (NOFO) solicitation, "covered individuals" are all Senior/Key Personnel.)
- Federal law requires that all current and pending research support, as defined by 42 U.S.C. §6605, must be disclosed at the time of proposal submission, for all covered individuals. The Government may require an updated disclosure during the performance of any research project selected for funding. The Government will require an updated disclosure whenever covered individuals are added or identified as performing under the funded project.
- Covered Individuals are also required to sign the "Privacy Act Statement" and provide such signed statement to the Applicant/Recipient for submission with the proposal. (See Attachment 1).
- Any decision to accept a proposal for funding under this announcement will include full reliance on the individual's statements. Failure to report fully and completely all sources of project support and outside positions and affiliations may be considered a material statement within the meaning of the False Claims Act, 31 U.S.C. 3729, and constitute a violation of Federal law.

iv. **Actions Required by Applicants/Recipients During Period of Performance**

- Applicant/Recipient will utilize a section of the Research Progress Performance Report (RPPR) to provide disclosure updates for Senior/Key Research Personnel. In addition, whenever a new covered individual(s) is to be added or identified as performing under the funded project, a new Research and Related Senior and Key Person Profile will be required prior to continued performance.

- If, at any time, during performance of this award, the Applicant/Recipient learns that its Senior/Key Research Personnel (including any sub awardee personnel who receive this designation) are or are believed to be participants in a Foreign Government Talent Program or have Foreign Components with a strategic competitor or country with a history of targeting U.S. technology for unauthorized transfer, the Applicant/Recipient will notify the Contracting/Grants/Agreements Officer within five (5) business days of awareness.
- This disclosure must include specific information as to the personnel involved and the nature of the situation and relationship. The Government will review this information and conduct any necessary fact-finding or discussion with the Applicant/Recipient. The Government's determination on disclosure may include acceptance, mitigation, or termination of the award.
- The Applicant/Recipient will be required to flow down this provision to all sub awardees who have personnel designated as Senior/Key Research Personnel as a result of their involvement in the performance of the research.

v. **No Guaranteed Award**

- AFOSR does not guarantee that any award will be made under this competition

vi. **Disclosure of Administrative Processing by Contractor Personnel**

- AFOSR use support contractor personnel to help it with administrative proposal processing. The contractor personnel are employees of commercial firms that have a contract with AFOSR. AFOSR makes sure all of its support contracts include nondisclosure agreements that prohibit disclosure of any information you submit to other parties.

b. **Integrity and Performance Information**

In accordance with Office of Management and Budget (OMB) guidance in parts 180 and 200 of Title 2, CFR, it is DoW policy that DoW Components must report and use integrity and performance information in the Responsibility/Qualifications section of SAM.gov, or any successor system designated by OMB, concerning grants and cooperative agreements as follows:

If the total Federal share will be greater than the simplified acquisition threshold on and Federal award under a notice of funding opportunity (see 2 CFR 200.88 Simplified Acquisition Threshold):

i. The Federal awarding agency, prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, will review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (see 41 U.S.C. 2313);
ii. An applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information about itself that a Federal awarding agency previously entered and is currently in the designated integrity and performance system accessible through SAM;
iii. The Federal awarding agency will consider any comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.205 Federal awarding agency review of risk posed by applicants.

G. Award Notices

1. Email

All applicants will receive a notification email advising if their proposal has been selected or not selected for recommendation for award.

Applicants whose proposals are recommended for award may be contacted by a Grant Specialist to discuss additional information required for award. This may include representations and certifications, revised budgets or budget explanations, and/or other information as applicable to the proposed award.

The notification e-mail must not be regarded as an authorization to commit or expend funds. The Government is not obligated to provide any funding until a Government Grants Officer or Agreements Officer, as applicable, signs the award document.

If pre-award costs are allowed, beginning performance is at the applicant's own risk.

The award document signed by the Grants Officer or Agreements Officer is the official and authorizing award instrument.

- For ARO: ARO emails their awards/modification documents to the awardees.
- For AFOSR: AFOSR emails their awards/modification documents to the awardees.
- For ONR: ONR award/modification documents are only available via the Department of War (DoW) Electronic Document Access System (EDA) within the Procurement Integrated Enterprise Environment (PIEE) (https://piee.eb.mil/piee-landing/).

H. Post-Award Requirements and Administration

1. Administrative and National Policy Requirements

Any assistance instrument awarded under this announcement will be governed by the award terms and conditions that conform to DoW's implementation of Office of Management and Budget (OMB) guidance applicable to financial assistance, as well as each respective agency's terms and conditions.

For ONR, ARO, and AFOSR: The DoD Terms and Conditions are located at https://www.onr.navy.mil/work-with-us/manage-your-award/manage-grant-award/grants-terms-conditions.

a. Export Control

Applicants are responsible for ensuring compliance with all U.S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR)(22 CFR Parts 120 - 130) and Export Administration Regulations (EAR) (15 CFR Parts 730 – 774), as applicable. In some cases, developmental items funded by the Department of War are now included on the United States Munitions List (USML) (22 CFR Part 121) and are therefore subject to ITAR jurisdiction. In other cases, items that were previously included on the USML have been moved to the EAR Commerce Control List (CCL). Applicants should address in their proposals whether

ITAR or EAR restrictions apply to the work they are proposing to perform for DoW. The ITAR and EAR are available online at https://www.ecfr.gov/.

Applicants must comply with all U.S. export control laws and regulations, including the ITAR and EAR, in the performance of any award or agreement resulting from this NOFO. Applicants shall be responsible for obtaining any required licenses or other approvals, or license exemptions or exceptions if applicable, for exports of hardware, technical data, and software (including deemed exports), or for the provision of technical assistance.

b. Requirements Concerning Live Organisms:

i. Use of Animals:

The DoW policies and requirements for the use of animals in DoW-supported research are described in the current version of DoD Instruction 3216.01, Use of Animals in DoD Conducted and Supported Research and Training and its implementing instruction, DHA-MSR 6025.02, "The Care And Use Of Animals In DoD Research, Development, Test, And Evaluation (RDT&E) Or Training Programs," the version of which is current at the time of award. If animals are to be utilized in the research effort proposed, the Applicant must submit a Full Appendix or Abbreviated Appendix (see Guidance link below) with supporting documentation (such as copies of Institutional Animal Care and Use Committee (IACUC) Approval, IACUC Approved Protocol, and most recent United States Department of Agriculture (USDA) Inspection Report) prior to award. For assistance with submission of animal research related documentation, contact the appropriate DoW Agency's Animal Use Administrator.

- ONR: Ms. Suzanne May, 948-215-2947, Suzanne.B.May.civ@us.navy.mil. Guidance: https://www.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections/animal-use
- AFOSR: Dr. Brett J. Taylor, Colonel, U.S. Army Veterinary Corps, 703-681-860, brett.j.taylor2.mil@mail.mil
- ARO: Ms. Theresa M. Straut, 240-517-1992, theresa.m.straut.civ@army.mil

ii. Use of Human Subjects in Research:

(1) Applicants must protect the rights and welfare of individuals who participate as human subjects in research awarded pursuant to this NOFO and must comply with the requirements of the Common Rule at 32 CFR part 219 (the DOW implementation of 45 CFR part 46) and applicable provisions of DoD Instruction 3216.02, Protection of Human Subjects and Adherence to Ethical Standards in DoD-Conducted and -Supported Research (Change 1, (June 29, 2022), the DON implementation of the human research protection program contained in SECNAVINST 3900.39E Change 1, (or its replacement), 10 USC 980 "Limitation on Use of Humans as Experimental Subjects," and when applicable, Food and Drug Administration (FDA) and other federal and state law and regulations.

(2) For proposals containing activities that include or may include "research involving human subjects" as defined in DoDI 3216.02, prior to award, the Applicant must submit documentation of:
   (a) Approval from an Institutional Review Board (IRB) (IRB-approved research protocol, IRB-approved informed consent document, documentation showing the IRB considered the scientific

merit of the research and other material considered by the IRB); proof of completed human research training (e.g., training certificate for the principal investigator, and institutional verification that the principal investigator, co-investigators, and research support personnel have received appropriate training to be considered qualified to execute the research); and the Applicant's Department of Health and Human Services (DHHS)-issued Federal Wide Assurance (FWA#), including notifications of any FWA suspensions or terminations.

(b) Any claimed exemption under 32 CFR 219.104), including the category of exemption, supporting documentation considered by the Applicant's institution in making the determination (e.g., protocol, data collection tools, advertisements, etc.). The documentation shall include a short rationale supporting the exemption determination. This documentation should be signed by the IRB Chair or IRB vice Chair, designated IRB administrator or official of the Applicant's human research protection program.

(c) Any determinations that the proposal does not contain activities that constitute research involving human subjects or contains only activities that are deemed not to be research under 32 CFR 219.102(1), including supporting documentation considered by the Applicant's institution in making the determination. This documentation should be issued by the IRB Chair or IRB vice Chair, designated IRB administrator or official of the Applicant's human research protection program.

(d) Documentation must be submitted to the appropriate Agency Human Research Protection Official (HRPO), by way of the DoW Agency Program Officer. The HRPO retains final judgment on whether the documentation satisfies the use of human subjects in research requirements. For assistance with submission of human subject research related documentation, contact:

- ONR: Ms. Suzanne May, Human Research Protection Official (HRPO), 948-215-2947, Suzanne.B.May.civ@us.navy.mil
- AFOSR: Ms. Sherrie L. Pryber, 937-656-5468, AFRL.IR.HRPO@us.af.mil
- ARO: Ms. Theresa M. Straut, 240-517-1992, theresa.m.straut.civ@army.mil

(e) Grant awards and any subawards or modifications will include a statement indicating successful completion of the HRPO review. Research involving human subjects must not be commenced under any contract award or modification or any subcontract or grant subaward or modification until awardee receives notification from the Contracting or Grants Officer that the HRPO has approved the assurance as appropriate for the research under the award or modification and that the HRPO has reviewed the protocol and accepted the IRB approval or determination for compliance with Federal and DoW research protection requirements. The Government will not reimburse or otherwise pay for work performed in violation of this requirement. For further guidance: http://www.onr.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections/human-subject-research

c. Biosafety and Biosecurity Requirements:

Applicants must comply with applicable provisions of the current version of DODM 6055.18, Safety Standards for Microbiological and Biomedical Laboratories, including ensuring compliance with standards meeting at least the minimum applicable requirements of the current edition of Centers for Disease Control and Prevention, "Biosafety in Microbiological and Biomedical Laboratories (BMBL)," and National Institutes of Health, "The NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines)" and any applicable FDA requirements.

d. Research Involving Recombinant (rDNA) or Synthetic Nucleic Acid Molecules:

Applicants must not begin performance of research within the scope of "The NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines)" until receiving notice from the Contracting or Grants Officer that the DoW Agency has reviewed and accepted the Applicant's documentation. In order for the DoW Agency to accomplish that review, an applicant must provide the Contracting or Grants Officer, generally as part of an original proposal prior to award, sufficient documentation to enable the review, including:

(1) A written statement that the Applicant is in compliance with NIH Guidelines or applicable FDA requirements. This statement should be made by an official of the institution other than the Principal Investigator and should be on university or company letterhead.
(2) Evidence demonstrating that the proposed research protocol has been approved (or determined exempt from the NIH Guidelines) by an Institutional Biosafety Committee (IBC); and a copy of the Department of Health and Human Services (DHHS) Letter of Approval of the IBC, or the most recent letter from DHHS stating the IBC is in compliance with the NIH Guidelines. For assistance with requirements involving countries outside the United States, please contact the ONR HRPO at (948)-215-2947 or suzanne.b.may.civ@us.navy.mil.

e. Institutional Dual Use Research of Concern:

As of September 24, 2015, all institutions and United States Government (USG) funding agencies subject to the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern must comply with all the requirements listed therein.
In 2024 a new U.S. Government Policy for Oversight of Dual Use Research of Concern and Pathogens with Enhanced Pandemic Potential (DURC/PEPP) was developed. In compliance with the Executive Order on "Improving the Safety and Security of Biological Research," federal departments and agencies will revise or replace the 2024 DURC/PEPP policy**.** The revised policy will be located at https://aspr.hhs.gov/S3/Pages/Dual-Use-Research-of-Concern-Oversight-Policy-Framework.aspx.

f. Department of War High Performance Computing Modernization Program:

The DoW High Performance Computing Modernization Program (HPCMP) furnishes the DoW S&T and RDT&E communities with use-access to very powerful high performance computing systems. Awardees of DoW Agency grants and other assistance instruments may be eligible to use HPCMP assets in support of their funded activities if the DoW Agency Program Officer Approval is obtained and if security/screening requirements are favorably completed. Additional information and an application may be found at https://www.hpc.mil/.

g. Project Review Meetings and Program Review Meetings:

Individual Project Review Meetings between the DoW sponsor and the performer may be held as necessary. Project Review Meetings typically last approximately one day. Typically, there are two in-person Project Review Meetings each year. Additional Project Review Meetings are likely, but these will be accomplished by video telephone conferences, telephone conferences, or web-based collaboration tools.

In addition to Project Review Meetings, Program Review Meetings may be held to provide a forum for reviews of the latest results from individual project experiments and any other incremental project progress towards major demonstrations. Program Review Meetings are generally held once per year and last two to three days.

For cost estimating purposes, applicants should assume 40% of the review meetings will be at or near ONR, Arlington VA, and 60% will be held at other government or non-government facilities within the continental United States.

The Government sometimes finds it advantageous to hold Program Review Meetings at a performer's facility. Applicants interested in hosting such meetings should include an estimated cost and the following language in their proposals, which become part of any award (note: if a contract is awarded, use of the facility will be included as an option):

[Name of entity] offers the use of its facilities for an ONR Program Review Meeting to discuss the status of programs related to the subject of this proposal. Such meetings may include attendees representing multiple research efforts. The meetings will discuss only "contracted fundamental research" as provided in the Under Secretary of Defense (Acquisition, Technology and Logistics) Memorandum of 24 May 2010, the results of which are open to the public. No fee will be charged for Program Review Meeting attendees. [Name of entity] understands it will not be asked to host a Performance Review Meeting more than once per year, if at all.

Applicants are not required to include the foregoing term in their proposals, and whether they do or not, will not affect their selection for award.

h. Federal Funding Accountability and Transparency Act of 2006:

The Federal Funding Accountability and Transparency Act of 2006 (Public Law 109-282), as amended by Section 6202 of Public Law 110-252 and expanded by the Digital Accountability and Transparency Act of 2014 (Public Law 113-101), requires that all agencies establish requirements for recipients reporting information on subawards and executive total compensation as codified in 2 CFR Part 170. Any company, non-profit agency, or university that applies for financial assistance (either grants or cooperative agreements) as either a prime or sub-recipient under this NOFO must provide information in its proposal that describes the necessary processes and systems in place to comply with the reporting requirements identified in 2 CFR Part 170 Appendix A. Entities are required to meet reporting requirements unless an exception or exemption applies. Please refer to 2 CFR Part 170, including Appendix A, for a detailed explanation of the requirements, exceptions, and exemptions.

i. Financial Assistance Certification:

The Federal Assistance Certifications Report is an attestation that the entity will abide by the requirements of the various laws and regulations; therefore, as applicable, you are still required to submit any documentation, including the SF LLL Disclosure of Lobby Activities (if applicable), and disclosure of any unpaid delinquent tax liability or a felony conviction under any Federal law.

Note for AFOSR: By checking "I Agree" on the SF 424 (R&R) block 17 you agree to fully comply with the Lobbying Disclosure Act of 1995, 2 U.S.C. § 1601 et seq. If your grant amount exceeds $100,000 you are certifying that you do not have lobbying activity to disclose. If you have lobbying activity that you must disclose under 31 U.S.C. 1352 as implemented by the DoW in 32 CFR Part 2 you must attach the completed SF-LLL Disclosure of Lobbying Activities. You can find instructions for completing this form at http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf.

Unpaid Delinquent Tax Liability or a Felony Conviction under Any Federal Law – DoW Appropriations

By checking "I Agree" on the SF 424 (R&R) block 17 you represent that you are not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in timely manner pursuant to an agreement with the authority responsible for collecting the tax liability; AND that you represent that you are not a corporation that was convicted of a felony criminal violation under any Federal law within the preceding 24 months.

Note: If you do not represent to this you are ineligible to receive an award unless a Federal agency suspension and debarment official (SDO) has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore should provide information about its tax liability or conviction to the agency's SDO as soon as it can do so, to facilitate completion of the required consideration before award decisions are made.

j. Certifications Regarding Restrictions on Lobbying:

Grant awards greater than $100,000 require a certification of compliance with a national policy mandate concerning lobbying. Grant applicants shall provide this certification by electronic submission of SF-424 (R&R) as a part of the electronic proposal submitted via https://www.grants.gov/(complete Block 17). The following certification applies likewise to each grant seeking federal assistance funds exceeding $100,000:

(1) No Federal appropriated funds have been paid or will be paid by or on behalf of the applicant, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the applicant shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
(3) The applicant shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

k. Certifications Regarding the Prohibition on Using Funds with Entities that Require Certain Internal Confidentiality Agreements (Grant Information Circular (GIC) 19-02 November 2019) (Supplement to SF-424 (R&R), block 17, Financial Assistance Certifications and Representations)

i. By checking "I Agree" on the SF 424 (R&R) block 17 you agree to abide by the following statement: "By signing this application, I certify (1) to the statements contained in the list certifications and (2)

that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. code, Title 18, Section 1001).

ii. The certification reads as follows:
By submission of its proposal or application, the applicant represents that it does not require any of its employees, contractors, or subrecipients seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting those employees, contractors, subrecipients from lawfully reporting that waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

l. Certification Regarding Disclosure of Funding Sources (Supplement to SF-424, block 17, Financial Assistance Certifications and Representations

By checking "I Agree" on the SF 424 (R&R) block 17 you agree to abide by the following statement: "By signing this application, I certify the proposing entity is in compliance with Section 223(a) of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 which requires that: (a) the PI and other key personnel certify that the current and pending support provided on the proposal is current, accurate and complete; (b) agree to update such disclosure at the request of the agency prior to the award of support and at any subsequent time the agency determines appropriate during the term of the award; and (c) the PI and other key personnel have been made aware of the requirements under Section 223(a)(1) of this Act. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. code, Title 18, Section 1001).

m. Certification of Gold Standard Science
By checking "I Agree" on the SF 424 (R&R) block 17, you agree to full comply with the administration policies, procedures, and guidance respecting Gold Standard Science, as specified in Executive Order 14303 "Restoring Gold Standard Science" and Executive Order 14332 "Improving Oversight of Federal Grantmaking."

n. Conflict of Interest

Applicants for assistance are required to comply with 2 CFR 200.318(c), Codes of Conduct, to prevent real or apparent conflicts of interest in the award and administration of any contracts by which a recipient or subrecipient purchases property or services, supported by federal funds.

(1) General Requirement for Disclosure

You and your organization must disclose any potential or actual scientific or nonscientific conflict of interest(s) to us. You must also disclose any potential or actual conflict(s) of interest for any identified sub recipient you include in your application. We may have to ask you more questions if we need more information.

At our discretion, we may ask you for a conflict of interest mitigation plan after you submit your application. Your plan is subject to our approval.

(2) Scientific Conflict of Interest

Scientific collaborations on research and development projects are generally the result of close collaboration prior to the submission of applications for support. Accordingly, these collaborations should be considered when considering potential conflicts of interest. Therefore, you must include in your list of current and pending support all collaborators, even if they did not formally provide support.

o. Code of Conduct

Applicants for assistance are required to comply with 2 CFR 200.318(c), Codes of Conduct, to prevent real or apparent conflicts of interest in the award and administration of any contracts supported by federal funds. This provision will be incorporated into all assistance instruments awarded under this NOFO.

p. Peer Review

In the case of proposals funded as basic research, DoW may utilize peer reviewers from academia, industry, and Government agencies to assist in the periodic appraisal of performance under the awards. Such periodic peer reviews monitor the quality of funded basic research efforts. The reviews are used in part to determine which basic research projects will receive continued DoW funding. Peer reviewers who are not U.S. Government employees must sign nondisclosure agreements before receiving full or partial copies of proposals and reports submitted by the basic research performers. Applicants may include travel costs for the Principal Investigator (PI) to attend the peer review. Peer reviews may consider information derived from individual project or program review meetings (see NOFO Project Review Meetings and Program Review Meetings for further guidance).

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q. Requirements for Operation and Procurement of Commercial off the Shelf Unmanned Aircraft Systems

(1) Commercial off the Shelf Unmanned Aircraft Systems (COTS UAS) may not be purchased pursuant to this grant or assistance agreement or contract or other transaction agreement for prototype until a Cyber Exception to Policy (ETP) is obtained by the cognizant Research Topic Chief.

(2) Exception. A Cyber ETP is not required when the research is supported via a grant award AND it is unclassified and funded with either basic research funds (i.e., 6.1) or applied research funds (i.e., 6.2) and performed on campus by a university. For all other grants and assistance agreements, a Cyber ETP must be obtained prior to purchase and/or flight operations.

(3) Notwithstanding (2) above, a Cyber ETP is required for all efforts (regardless of award or funding type) that involve interactions with military personnel, DoW property, or DoW facilities; work conducted by US Government laboratories, UARCs, or FFRDCs; or are Public Aircraft Operation (PAO), classified, or explore specific military utility. For these efforts, and depending on the UAS platform and Cyber Operating Environment, a Cyber ETP, FAA issued Certificate of Airworthiness or a NAVAIR Airworks Authority to Operate (ATO) must be obtained.

(4) Prospective or current performers are required to notify the cognizant Research Topic Chief of any anticipated COTS UAS purchase that may be subject to exception at time of white paper, proposal submission or award

changes. Performers shall provide documentation specifying the details including the type of drone, effort, location, etc.

(5) Performers will agree to cooperate and provide additional information as requested to support the cyber vulnerability assessment and other requirements identified above in (3).

Notwithstanding, procedures and requirements identified above, restrictions identified in Section 848 of the National Defense Authorization Act for Fiscal Year 2023, Pub. L. No. 116-92, 10 U.S.C 4871 note, as amended, continue to apply. Performers are notified that effective October 1, 2024 additional restrictions will apply to new awards, extensions or renewals of existing contracts. See 10 U.S.C. 4871 Note for additional information on restrictions.

In no event shall federal funding be expended or purchase made pursuant to any award subject to waiver requirement, unless and until performer is notified by DoW that the waiver, cyber vulnerability assessment, and other requirements have been met.

r. Research Integrity

Offerors and Performers must foster an atmosphere conducive to research integrity and comply with requirements concerning research misconduct that apply to federally funded research and to proposals submitted to DoW agencies for funding. The government wide policy published by the Office of Science and Technology Policy in the Federal Register (65 FR 76260, December 6, 2000) is implemented by DoW at DODI 3210.7 "Research Integrity and Misconduct".

Gold Standard Science (Supplement to SF424 (R&R), block 17, Financial Assistance Certifications and Representations)

By Checking "I Agree" on the SF 424 (R&R) block 17, you agree to comply with the administration policies, procedures and guidance respecting the Gold Standard Science in accordance with EO 14303 (https://www.federalregister.gov/documents/2025/05/29/2025-09802/restoring-gold-standard-science).

2. Reporting

If the Federal share of any Federal award may include more than $500,000 over the period of performance, the post award reporting requirements, Award Term and Condition for Recipient Integrity and Performance Matters (2 CFR Part 200 Appendix XII), is applicable as follows:

Reporting of Matters Related to Recipient Integrity and Performance

General Reporting Requirement. If the total value of your currently active grants, cooperative agreements, and procurement contracts from all Federal awarding agencies exceeds $10,000,000 for any period of time during the period of performance of this Federal award, then you as the recipient during that period of time must maintain the currency of information reported to the System for Award Management (SAM) that is made available in the designated integrity and performance system about civil, criminal, or administrative proceedings described in paragraph 2 of this award term and condition. This is a statutory requirement under 41 U.S.C. 2313. All information posted in the designated integrity and performance system on or after April

15, 2011, except past performance reviews required for Federal procurement contracts, will be publicly available.

Proceedings about Which You Must Report. Submit the information required about each proceeding that:

i. Is in connection with the award or performance of a grant, cooperative agreement, or procurement contract from the Federal Government;
ii. Reached its final disposition during the most recent five-year period; and
iii. Is one of the following:
    a) A criminal proceeding that resulted in a conviction, as defined in paragraph 5 of this award term and condition;
    b) A civil proceeding that resulted in a finding of fault and liability and payment of a monetary fine, penalty, reimbursement, restitution, or damages of $5,000 or more;
    c) An administrative proceeding, as defined in paragraph 5. of this award term and condition, that resulted in a finding of fault and liability and your payment of either a monetary fine or penalty of $5,000 or more or reimbursement, restitution, or damages in excess of $100,000; or
    d) Any other criminal, civil, or administrative proceeding if:
        1) It could have led to an outcome described in paragraph 2.c. (1), (2), or (3) of this award term and condition;
        2) It had a different disposition arrived at by consent or compromise with an acknowledgment of fault on your part; and
        3) The requirement in this award term and condition to disclose information about the proceeding does not conflict with applicable laws and regulations.

a. Reporting Procedures

Enter in the SAM Entity Management area the information that SAM requires about each proceeding described in paragraph 2 of this award term and condition. You do not need to submit the information a second time under assistance awards that you received if you already provided the information through SAM because you were required to do so under Federal procurement contracts that you were awarded.

b. Reporting Frequency

During any period of time when you are subject to the requirement in paragraph 1 of this award term and condition, you must report proceedings information through SAM for the most recent five-year period, either to report new information about any proceeding(s) that you have not reported previously or affirm that there is no new information to report. Recipients that have Federal contract, grant, and cooperative agreement awards with a cumulative total value greater than $10,000,000 must disclose semiannually any information about the criminal, civil, and administrative proceedings.

c. Definitions.

For purposes of this award term and condition:

i. Administrative proceeding means a non-judicial process that is adjudicatory in nature in order to make a determination of fault or liability (e.g., Securities and Exchange Commission Administrative proceedings, Civilian Board of Contract Appeals proceedings, and Armed Services Board of Contract Appeals proceedings). This includes proceedings at the Federal and State level but only in connection with performance of a Federal contract or grant. It does not include audits, site visits, corrective plans, or inspection of deliverables.

ii. Conviction, for purposes of this award term and condition, means a judgment or conviction of a criminal offense by any court of competent jurisdiction, whether entered upon a verdict or a plea, and includes a conviction entered upon a plea of nolo contendere.

iii. Total value of currently active grants, cooperative agreements, and procurement contracts includes—

1) Only the Federal share of the funding under any Federal award with a recipient cost share or match; and
2) The value of all expected funding increments under a Federal award and options, even if not yet exercised.

d. Post Award Reporting Requirements

For ONR: The post award reporting requirements can be found under the relevant ONR Addendum to the DoD R&D General Terms and Conditions and ONR Programmatic Requirements located at the following link: https://www.navy.mil/work-with-us/manage-your-award/manage-grant-award/grants-terms-conditions.

For ARO: For detailed submission and formatting instructions, see ARO Reporting Instructions (Form 18),"Reporting Instructions," found at: https://arl.devcom.army.mil/wp-content/uploads/sites/3/2022/09/Form18_Sep_2022.pdf

For AFOSR: Federal-wide Research Progress Performance Report (RPPR) for interim, annual, and final research performance reports. RPPRs should articulate the performer's substantial progress including a summary of work accomplished. Interim and Final Reports will be submitted via the reporting process specified in the award documents. . Additionally, reminder emails on all interim and final RPPRs may be sent out as a courtesy.

SPECIAL NOTE: Pending Federal-wide Research Progress Performance Report (RPPR) Format.

A Federal-wide Research Progress Performance Report (RPPR) for interim, annual, and final research performance reports is under development. Performers do not have to use the RPPR now but DoW plans to use the RPPR in the future.

We may issue an award modification that requires you to use the Government-wide RPPR after a final notice is issued in the Federal Register.

I. Other Information

Topic 1: (AFOSR) Non-linear Mixing Processes for EUV and X-ray Radiation in Optically Thick Systems

Background: Coherent spectroscopic or inelastic scattering techniques in the visible and infrared spectral regimes have been extensively exploited for probing chemical and biomolecular phenomena under chemically reactive, biologically active, and non-equilibrium conditions. These methods have been generally restricted to optically thin systems. With the advent of high-intensity extreme-ultraviolet (EUV) and X-ray light sources, there now exists the possibility of interacting with and observing inelastic scattering processes deep within optically thick systems[1]. For example, X-ray Raman scattering has proven to be a useful tool for measurements of the chemical bonding state of atoms with low atomic number (i.e., low-Z atoms), such as C and N, in energetic solids[2] and in flames. Current synchrotron based, spontaneous X-ray Raman techniques[3] rely on field effects,

which have a low cross section and are emitted into 4π steradians making the technique limited to nearly static samples. In contrast, for Stimulated and Coherent Anti-Stokes Raman Spectroscopy (SRS and CARS) techniques, the emitted radiation is directional, allowing for a drastic gain in signal strength and the ability to observe dynamics. The resulting electron configuration, in both SRS and CARS, is far from equilibrium and, consequently, the strength of the signals is strongly influenced by the electron configuration and molecular orbitals of the system, making it an ideal diagnostic tool to study evolving potential energy surfaces as a function of time. In its current form, there exist significant knowledge gaps in treating the theory surrounding dynamic interactions between multiple high-energy photons that prohibit the extension of spectroscopic theory into these non-linear process regimes.

In addition to theoretical modeling, experimental technique development is required to advance such models. Such efforts require the development of wavefront sensors, arrival time monitors, ultrahigh precision delay lines, and the ability to measure spatial and temporal overlap. Understanding the signal and background differences between colinear and phase matching geometries will also be critical to developing the tools for any non-linear light mixing process in the EUV and X-ray regimes. Significant progress has been made on the intensity and precision of coherent light sources over the last two decades, but more work needs to be done to improve the understanding of the interactions of molecules with intense X-ray fields and between multiple photons. These advances, when paired with advances in computational physical chemistry and computational power generally, will be enabling and allow, for the first time, the coupling of theoretical and experimental design to probe the photo physics of non-linear light-matter interactions at extreme power and energy densities. This MURI topic aims to integrate photo physics, physical chemistry, and computational science efforts to develop the theoretical framework for advanced diagnostic and manufacturing techniques for non-linear light-matter interactions that will be technologically realizable in the next several years.

Objective: The objective of the MURI is to explore the foundational physical interactions that underpin electron dynamics for non-linear mixing processes in optically thick matter from 100eV-10keV photon energies. Such an understanding would have profound implications on the corpus of knowledge surrounding catalysis, solid-state chemistry, materials manufacturing and process science, and quantum behaviors in condensed matter.

Research Concentration Areas: Research areas include: (1) developing an understanding of the theoretical underpinnings for calculating wave-mixing cross sections and susceptibilities; (2) understanding which quantum chemical calculations involving density functional or other procedures are required to calculate wavefunctions for atoms and molecules following core-level electron excitation in the EUV, soft, and tender X-ray regimes; (3) building frameworks for time-dependent density matrix theory[4,5] to incorporate effects of electron dynamics; (4) building realistic model systems to test theoretical predictions of non-linear mixing dynamics based on proposed physical frameworks; (5) implementing and integrating stimulated emission and other non-linear techniques into light source facilities to validate models for EUV/X-ray light-matter interactions. Competitive teams should identify anticipated light sources, demonstrate access to potential user facilities, and discuss how results from one light source will be generalized to other light sources.

Anticipated Resources: It is anticipated that awards under this topic will be no larger than $1.5M per year for five years and fund no more than six faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with the topic chiefs during the white paper phase of the solicitation.

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Topic 2: (AFOSR) Tunable Goniopolar Semiconductors

Background: Traditionally, most electronic materials are characterized as having a single majority carrier type, either electrons or holes, that leads to isotropic n-type or p-type conductivity. These p-type and n-type regions are integrated together to form virtually all modern electronic and energy harvesting devices. Recently, there have been numerous advances in the discovery of single crystalline, goniopolar materials that simultaneously exhibit n-type and p-type conduction behavior along different crystallographic directions. [1-3]. Goniopolar semiconductors exhibit distinct anisotropic properties, which can be used to design unique functionalities with tailored electronic, optical, and transport characteristics. This tunability arises from the unique crystal structures, and symmetries in these materials, which inherently allows precise control over carrier type and mobility. The ability to have directionally dependent channels for the flow of positive and negative charge carriers in a single material opens a multitude of possibilities for novel phenomena and applications in digital electronics, nanophotonics, energy harvesting, solid-state cooling, sensing, and quantum information systems. Unexpected properties have been observed in such materials including generation of intense THz radiation [4], enhanced thermoelectric performance in transverse architectures [2], and anisotropic thermo/magneto/electrical responses [5]. While nearly all studies of goniopolar semiconductors to date have focused on thermally generated intrinsic carriers, we have yet to fully understand and exploit extrinsic behaviors in these systems. It may be possible to rationally dope semiconductors (goniopolar or otherwise) to induce selective p x n conductivity. Likewise, the effect of external stimuli beyond temperature—light, strain, magnetism, etc.—on carrier generation and dynamics in goniopolar semiconductors is ripe for exploration. For example, strong magnetic responses in goniopolar semiconductors with magnetic cations could be leveraged to create new classes of spin caloritronic materials and devices. Finally, the microscopic origins of this phenomenon are also not fully understood, and there are key fundamental research opportunities to elucidate interplay between crystal symmetry and topology, anisotropic band structure, electron-phonon scattering, and p x n behaviors to enable goniopolar materials design. As these discoveries continue to unfold, there is a pressing need for a collaborative and multidisciplinary effort to understand the fundamental interactions governing the behavior of goniopolar semiconductors, to probe and control the dynamics of charge separation and anisotropic transport, and to study the influence of external stimuli such as light-matter interactions. Such an effort will involve extensive collaborations between chemists to create new goniopolar semiconductors materials with groundbreaking properties, researchers with expertise in thin-film growth for scalable integration, materials scientists and condensed matter physicists to understanding the fundamental interactions and structure/property relationships, and modeling experts to assist in the design, synthesis, and property prediction. This synergistic approach will not only elucidate the underlying mechanisms of goniopolar behavior but also establish design rules and strategies for exploiting these phenomena for unique technological applications.

Objective: The objective of this effort is to identify the interactions that control the unique and tunable transport properties in goniopolar semiconductors, influenced by electric, magnetic and other external fields. The overall objective is to develop the understanding needed to design, synthesize, and characterize these materials to exploit their directional charge transport properties. This effort will also create design rules to guide the optimization of the structure/property relationships of these materials and to explore their potential applications. The new understanding gained will guide the identification of other emergent anisotropic electronic, optical, and/or magnetic properties in these materials.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) Characterization of novel properties, including the electronic and spin transport properties of goniopolar semiconductors, with a focus

on their tunability by electric and magnetic fields, and the identification of the underlying mechanisms and dynamics of anisotropic and directional transport. (2) Develop theoretical and computational approaches to predict and optimize the transport properties of goniopolar semiconductors considering the effects of external stimuli, and to guide synthetic routes for their production. (3) Synthesize novel materials with axis dependent conduction polarity in both bulk crystal and thin film form, focusing on precise control over their composition and crystallographic orientation (4) Explore other emergent properties of these newly developed goniopolar materials, including their tunability by electric, magnetic, and electromagnetic fields and investigate their potential applications in advanced technologies such as quantum computing, sensing, spintronics, nanophotonics, and electronics.

Anticipated Resources: It is anticipated that awards under this topic will be no more than an average of $1.5M per year for 5 years, supporting no more than 6 funded faculty researchers. Proposal approaches should be discussed with the topic chief during the white paper phase of the solicitation.

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Topic 3: (AFOSR) Robustness to Novel Queries in AI for Scientific Discovery

Background: Artificial Intelligence (AI), including machine learning, is increasingly pervasive in scientific discovery. But a common question, echoing various refinements of the Turing test, is whether current AI systems are capable of scientific reasoning at the human level. In the focused but important sandbox of mathematical reasoning, where correct step-by-step justifications are required, the answer seems to be a resounding "No." While AI systems may excel at pattern matching, they struggle with long compositions of logical arguments or altering assumptions when faced with a truly unprecedented problem. This MURI aims to develop the theory of building AI systems capable of robustly answering novel scientific queries, thus accelerating the process of discovery.

Fundamentally new approaches to AI are needed to address this challenge. First, to overcome the fact that current neuro-symbolic AI models typically stitch together purely correlational reasoning (e.g., from neural nets) and purely symbolic reasoning (e.g., from expert systems) in *ad hoc* ways, next-generation models must embody *cognitive flexibility:* the ability (a) to interleave correlational, symbolic, causal/counterfactual, analogical, heuristic, intuitive, and other common types of reasoning; (b) to slide between them in a continuous, adaptive manner that quantifiably trades speed for reliability as the situation demands; (c) to update its own building blocks, such as architecture and even the programming language in which it is written; and (d) to provide an accurate stepwise chain of thought for its conclusions. The particular task (b) of choosing among parameterized types of reasoning would benefit greatly from an integrated mathematical framework for meta-reasoning, likely integrating structural concepts such as Markov categories, causal diagrams, and knowledge graphs. In addition, the ability to quickly determine whether a model can reliably answer within given time constraints will likely require novel characterizations of the in-distribution region of the training data—perhaps using recent developments in perturbation-resistant data representations, optimal transport, or property testing.

Successfully developing AI capable of robustly answering novel scientific queries will likely require new advances in practical algorithms, such as optimization, data embeddings, and regularization. These advances will be especially pertinent considering one of the principal constraints at work: the relative scarcity of training data embodying scientific reasoning compared to large-scale general language data. A broad implication of such advances in theory and practice is the prospect of AI systems that advance scientific areas like chemistry, meta-material discovery, aeronautics, quantum information theory, or mathematics in novel, unanticipated directions.

Objective: To develop mathematical/computational underpinnings of robustness to novel queries lying outside the training distribution, compositional step-by-step inference, self-updating architectures, structural knowledge representation, and data representations in AI for: (a) learning and reasoning; (b) bridging the learning-reasoning divide. These goals are aimed towards overcoming brittleness and lack of scope in the current AI frameworks for scientific discovery.

While the ultimate vision is applicability to multiple types of scientific reasoning, a practical initial focus on mathematics and programming is encouraged, due to the typical cheapness of experimentation and the correlation between outlier queries and well-defined concepts like computational hardness. This focus also allows methods to be tested in domains where formal structure and verifiability have various standard interpretations that make it easier to measure progress. As results mature, these techniques can then spiral outward to scientific areas where outlier queries are more difficult to define such as chemistry, physics, and biology, incorporating lessons learned along the way.

Research Concentration Areas: Suggested research directions beyond the background section's include but are not limited to:

(a) Enhancing robustness to novel queries using stepwise-composable and checkable causal, logical, and/or correlative explanations, and how to learn to produce such explanations dynamically through data exploration;

(b) Connecting various probabilistic, logical, causal, physical, heuristic, and other types of reasoning using a common mathematical framework, to provide an appropriate general language for learning theory; for example, connecting natural spaces of informal (syntactic) and formal (semantic) queries, such as statistical manifolds and the topological spaces of homotopy-type theory, using modern frameworks like probabilistic programming and/or effect handlers;
(c) Identifying and augmenting accurate data sets embodying the required scientific domain knowledge, such as various programming libraries, the Lean library in mathematics, or graphical libraries of chemical reactions;
(d) Developing methods to incorporate domain-specific constraints in architectures (e.g., symbolic grammars, axiomatic frameworks, conservation laws, etc.) without loss of performance;
(e) Developing a theory for self-updating cognitive architectures that continually improve the system's ability to learn, store knowledge, and meta-cognitively question and revise inferences and assumptions;
(f) Improving robustness, efficiency, and generalization by identifying sparsity in a learned function's compositional representation and designing novel modular architectures accordingly (e.g., how each activation in a convolutional neural depends sparsely on the previous layer).

Anticipated Resources: It is anticipated that awards under this topic will be no more than $1.5M per year for 5 years, supporting no more than (5) funded faculty researchers with multidisciplinary expertise. Exceptions warranted by specific proposal approaches should be discussed with the leading topic chief during the white paper phase of the solicitation.

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Topic 4: (AFOSR) Unlocking the Potential of TEM Ptychography

Background: Transmission electron microscopy (TEM) ptychography, a powerful computational imaging technique, surpasses the limitations of traditional TEM, offering significant advantages in resolution, electron dose efficiency, and a wide range of applications. Ptychography is a technique that aims to solve the diffraction-pattern phase problem (loss of information that can occur when making a physical measurement) by combining multiple diffraction patterns to infer their relative phase and reconstruct a high-resolution image. Recently, interest in TEM ptychography has been galvanized by iterative phase-retrieval algorithms and the development of multi-slice methods, enabling three-dimensional atomic structure reconstruction from two-dimensional projection. This technique now achieves resolutions that can exceed even aberration-corrected TEM. Advances in detectors, computational power, and scanning transmission electron microscope integration have propelled the rapid progress of TEM ptychography, establishing it as a transformative tool for quantifying microstructural details.

TEM ptychography has been described as the 4^{th} revolution in microscopy because of the potential to achieve resolutions approaching the fundamental limit, an order of magnitude improvement over the current state of the art. Its applications in materials science are rapidly expanding, enabling sub-atomic resolution imaging of a diverse range of materials. The ability to explore nanoscale phenomena *in-situ* in 3-D with picometer (10^{-12} m) resolution across a wide class of materials would enable tremendous breakthroughs in fundamental understanding of materials and their properties. This topic can lead to transformative advancements in imaging three-dimensional atomic responses in amorphous materials, biological systems, light element materials and functional defects in solid state systems. TEM Ptychography's game-changing ability to provide phase information and correct for aberrations makes it an *indispensable* tool for groundbreaking investigations into complex materials and biological samples.

Despite this excitement, significant challenges hinder the widespread adoption and full realization of TEM ptychography's potential. The large datasets and iterative reconstruction algorithms required for the technique result in computationally intensive and time-consuming image processing. While advancements in computing power and deep learning-based phase retrieval offer promising solutions, their full integration and exploration within the electron microscopy community remain nascent. Furthermore, electron dose requirements, especially for high-resolution imaging of beam-sensitive materials, often exceed damage thresholds, posing a critical bottleneck. Overcoming these limitations in dose, speed, and computational cost necessitates a concerted interdisciplinary effort encompassing computational imaging, applied mathematics, and materials science.

Objective: The objective of this topic is to gain understanding of the fundamental limits of resolution and speed for the TEM ptychography that leads to its application to complex, beam-sensitive and/or dynamical systems. This requires co-development of innovative and efficient TEM ptychography imaging and reconstruction techniques corresponding to the unique features of transmission electron beam (e.g. beam-sample geometry, beam energy). Ultimately, this topic aims to enable breakthroughs in capturing dynamic atomic structures and physical phenomena in solid state systems.

Research Concentration Areas: Research concentration areas include but are not limited to the following areas: (1) Develop and validate efficient algorithms for robust image reconstruction and phase retrieval; (2) Investigate approaches for reducing overall electron dose requirements in sensitive material systems. (3) Improve multi-scattering models of samples including the effect of beam damage (4) Design and model novel TEM techniques such as structured illumination or scanning or different detection mechanisms which may complement emerging algorithm development; (5) Investigate machine learning techniques for real time image reconstruction from large scale datasets.

Anticipated Resources: It is anticipated that awards under this topic will be no more than an average of $1.5M per year for 5 years, supporting no more than 6 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with the topic chief during the white paper phase of the solicitation.

Research Topic Chief(s): Dr. Michael Yakes, AFOSR (703) 835-6716, michael.yakes@us.af.mil; Dr. Jiwei Lu, AFOSR, (703) 835-6515, Jiwei.lu@us.af.mil; Dr. Ali Sayir, AFOSR, (703) 696-7236, ali.sayir.2@us.af.mil; Dr. Andrew Stickrath, AFOSR, (703) 426-9511, andrew.stickrath@us.af.mil

Topic 5: (AFOSR) Science with Optical Cycling Centers for Energy Redistribution (SOCCER)

Background: Quantum-level control over energy and matter has been a paradigm of critical significance for current and future science and applications. Over the last several decades, exquisite coherent control has been demonstrated in a vast array of basic platforms, spurring new fields like quantum information science, and applications spanning gravitational wave detection to ultra-precise timing. With the development of new tools, new opportunities have emerged. Recently, the breakthrough capability to optically cool and coherently control molecules of increasing size and complexity has been demonstrated by researchers. A particularly exciting set of prospects arises from the ability to use laser cooling of a metal atom attached to a molecule to cool the molecule to sub-Kelvin temperatures, resulting in highly controlled energy flow in the molecule, despite the large number of states present in the system. The use of such optical cycling centers (OCCs) attached to molecules provides a precise and controllable way to quickly remove energy from the molecular system by the repeated scattering of photons between two electronic states. This controllable energy pathway provides an interesting tool to help probe the fundamental and critical process of intramolecular vibrational redistribution and collisional energy transfer in the molecule, and provide insights into thermal, non-thermal, and non-equilibrium processes in these systems. Optical cycling centers used in recent work contain an atom that can be laser cooled and is bonded to a molecule in such a way that a valence electron centered on the metal still can undergo optical transitions without being strongly perturbed by the attached molecule. The localized electronic transition permits cooling, while the flexibility and tailorability of the ligand molecules opens great variety, control and complexity into systems that can be cooled by this method. Studies using these systems can illuminate the fundamental effects that control energy flow such as vibrational mode coupling, vibronic or non-adiabatic coupling, spin-orbit coupling, and accidental Fermi resonances, and help us understand and resolve the rates, mechanisms, and the limits of energy redistribution. These energy redistribution processes impact processes from selectivity in chemical reactions to energy transfer in proteins. Furthermore, understanding - and potentially controlling – energy transport in matter of increasing complexity may have deep implications for future materials and technologies.

Quantum-level control of energy in these systems also makes them attractive for use in quantum information processing and manipulation. To exploit such processes, one needs to create effective and stable molecular systems attached to OCCs, and develop methods to coherently address, manipulate, interrogate, and perhaps entangle such systems for participation in the processing of quantum information. Alternatively, a material may be considered a canvas on which a desirable geometry of OCCs, acting as qubits or qudits, is patterned, offering a pathway to scaling of these systems for useful quantum-enabled applications. The theory needed to describe and optimize such systems needs advancement due to the presence of relativistic effects, mode mixing, and the systems' open-shell, multireference character. Advances will guide computational modeling that is needed to determine the optimum binding sites, energy levels and transitions (Franck-Condon factors), and relationships between the OCCs and their molecular or material partner. Thus, a multidisciplinary effort requiring, amongst others, chemists to design and make these new OCC-molecule structures, physicists to apply laser cooling, coherent manipulation, and precision measurement techniques, electrical engineers to envision how to employ and address such systems for quantum information processing, and other computational and theoretical scientists to model and guide mechanistic thinking to drive the development and application of this exciting and emerging new scientific direction.

Objective: Explore experimentally and theoretically the opportunities afforded and the limits imposed by large molecules with optical cycling centers. Determine the mechanisms and rates of energy transfer and decoherence processes that could inform the use of OCCs in quantum information systems. Areas of particular interest include using these new systems and methods to study the fundamentals of energy redistribution in molecules and exploiting the precise quantum control these systems enable.

Research Concentration Areas: Potential inquiry areas can be but are not limited to 1) identifying and experimentally demonstrating new stable and resilient structures and configurations allowing quantum control of matter and energy redistribution; 2) elucidating the limits of the paradigm and developing and implementing theoretical methods to model and guide the optimization of these processes; 3) search for novel applications and

explore the feasibility of, or demonstrate the platform for applications in chemistry, QIS, and precision measurement.

Anticipated Resources: It is anticipated that awards under this topic will be no more than $1.5M per year for 5 years, supporting no more than 5-7 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with the topic chief during the white paper phase of the solicitation.

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Topic 6: (ARO) Th-229 Enabled by the Solid State (TESS)

Background: Thorium-229, the only nuclear isotope with a known isomer transition at laser-accessible energies, has recently had the frequency of this transition verified to 13 significant figures. This transition has been probed in several solid-state hosts including bulk crystals and thin films, but many open questions remain. For example, the lifetime of the nuclear transition appears to be roughly 4x shorter in Th thin films than in Th-doped bulk crystals. These recent results suggest an immediate scientific opportunity to explore cross-cutting physical phenomena at the intersection of atomic physics, nuclear physics, and materials design with enormous potential ramifications for future timekeeping, sensing, and quantum information technologies.

Reminiscent of efforts in doping rare-earth ions into solid-state systems, there are numerous open basic questions regarding the design, synthesis, and processing of different materials incorporating Th-229. Multi-objective design challenges include the need for large optical bandgaps, the ability to host Th-229 without phase separation, and accounting for the effects of lattice distortions and dissipation processes. It remains to be seen if and how incident UV excitation and/or isomeric decay processes may generate electronic or crystal defects in the host systems or otherwise cause aging in the host material. Furthermore, it is unknown how the host (and defects) influences Th's nuclear resonance or, conversely, how the nuclear transition couples to solid-state properties like electronic, phonon, or optical behaviors. Integrated materials theory and experiment is needed to identify potential host-Th combinations, model their physical properties, and synthesize and characterize them. The laser-accessible transition also provides a unique opportunity to apply atomic physics techniques to these studies.

From the atomic physics and nuclear physics sides, there are also many questions of interest. Because Th-229 has a uniquely low-energy nuclear transition, it would be interesting to see if traditional tools of atomic physics could help us to better understand the nuclear science at play here. Studying the transition frequency and lifetime in different materials hosts could also aid in our understanding of this state and the dynamic nuclear structure that produces characteristic lifetimes, transition polarizability, etc. In addition, the key promise of using a nuclear transition for quantum science applications is that nuclear transitions are expected to be strongly protected from environmental noise and perturbation, but detailed understanding of how this protection arises is still lacking.

Objective: The objective of this MURI is to investigate the optically accessible nuclear transition of Th-229 with a variety of solid-state systems, including new materials designed to host Th-229. It is expected a successful team will improve our fundamental understanding of Th-229's unique nuclear transition, the associated nuclear structure, its interactions with solid-state systems, and its potential uses as a future clock or quantum technology platform.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) screen material hosts though electronic structure methods such as first-principles calculations, DFT, or quantum chemistry tools and other computational methods; (2) synthesize and process candidate Th-doped materials; (3) develop materials characterization techniques; (4) perform nuclear structure calculations and/or nuclear pump-probe experimental methods; and (5) exploit atomic physics techniques to characterize the resultant qubits/clock sensitivity/stability.

Anticipated Resources: No more than an average of $1.50M per year for 5 years, supporting no more than 6 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with topic chiefs during the white paper phase of solicitation.

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Topic 7: (ARO) Reticular Qubit Assemblies

Background: Our evolving ability to exploit some of the more exotic properties of quantum mechanics is poised to reshape computing, sensing, communication, optics and more. Leveraging the fundamental unit of quantum information, the "qubit" is central to many approaches. There are numerous spin-bearing entities that can host a qubit, and molecular systems are intriguing because they can be made reproducibly in large quantities with control over structure and interactions through bottom-up rational design. However, current approaches often result in a random distribution of spin centers and discrete and tunable ordering within an array is crucial for optimizing coherence and tailoring inter-qubit interactions. There is an urgent need to develop new approaches for deterministic qubit ordering to realize the full potential of molecular spin qubits. Reticular chemistry, which utilizes geometrically pre-defined building blocks to form extended crystalline porous solids, was recently utilized to host discretely ordered arrays of qubits within a larger architecture. There is increasing interest in such ordering of solid-state color centers and cold molecules as well. Despite these advances, critical gaps remain in our understanding of fundamental decoherence processes and the leakage of excited states to nearby rotational or vibrational states of qubits within framework architectures. In addition, state preparation and readout in such architectures is often challenging.

We envision a concerted, synergistic, and multidisciplinary approach at the intersection of chemistry and physics to address these challenges. Here, the chemistry community can benefit by partnering with the atomic, molecular, and optical (AMO) and solid-state physics communities to leverage expertise in characterizing and manipulating energy levels in solid-state color centers or trapped optical cycling centers for creating spin-optical interfaces in frameworks. This is vital as molecular qubit assemblies generally lack ground state spins that can be initialized and readout optically. Synergistically, AMO could benefit from the atomic precision of reticular chemistry to finely tune electronic and optical transitions between ground and excited states that would be difficult to achieve in solid-state materials. Not only does reticular chemistry enable deterministic control over qubit spacing and orientation, but it can also imbue additional functionality such as precisely arraying non-identical qubits, hosting chiral environments to further control spin polarization, or generating dynamically tunable assemblies where interqubit distance can by modulated in response to external stimuli to control different interaction pathways. This unrivaled control over structure could enable a deep and exquisite understanding of how changing the spacing and orientation of qubits impacts the fundamental physical phenomena studied in the AMO cold molecule community. Critical to these efforts will be the integration and advancement of theoretical and measurement approaches to understand ultrafast spin dynamics as it relates to fundamental decoherence mechanisms.

It is evident that reticular qubit assemblies (RQAs) hold significant potential as quantum sensors because their pore size, shape, and chemical environment is highly tunable, unlike in solid-state color centers. Moreover, with inherently high surface area, they are ideal for hosting guest molecules with tailored interactions at controlled distances. They can be processed as free-standing structures and adapted for integration with other materials or biological processes. They are ideal candidates for sensing of energy fields, physical forces or chemical analytes with the potential for unprecedented spatiotemporal resolution, pushing the range of measurable physical quantities to new frontiers.

Objective: Utilize reticular chemistry for deterministic synthesis of precisely arrayed molecular spin qubits with predefined spin-spin distances, orientations, and tailored chemical environments. Investigate fundamental decoherence processes and probe complex interactions through integrated state preparation and control. Exploit their well-defined interactions to gain a deeper understanding of how these systems can be harnessed for quantum sensing applications.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) Probe how varying the reticulated network structure impacts fundamental decoherence processes, inter-qubit interactions and physical phenomena (2) Integrate spin-optical interfaces into ordered qubit arrays for reliable quantum-state preparation

and control (3) Advance theoretical approaches for electronic structure modeling to better understand decoherence processes while leveraging new machine learning, chemical informatics, and molecular simulations to guide the design of molecular qubits; (4) Develop new time, energy, and polarization-resolved high-resolution characterization and measurement techniques to probe energy levels and ultrafast spin dynamics and isolate quantum dynamics in molecules(5) Utilize bottom-up chemical synthesis to design quantum-sensing-application-specific RQAs

Anticipated Resources: No more than an average of $1.50M per year for 5 years, supporting no more than 6 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with topic chiefs during the white paper phase of solicitation.

Research Topic Chiefs: Dr. Robert Lambeth, ARO, (240) 499-6692, robert.h.lambeth2.civ@army.mil; Dr. Joshua Boschelli, ARO, (240) 762-0149, joshua.d.boschelli.civ@army.mil; Dr. Margaret Shea, ARO, (240) 941-4880, margaret.e.shea6.civ@army.mil

Topic 8: (ARO) Design of Superomniphobic Materials via Development of Novel, High-throughput, Multi-scale Biological Assays

Background: The ability of a surface to fully repel a wide range of liquids and substances is an important factor to both its usage scope and long-term durability. Inherent wetting from high surface tension liquids, such as water, is often achieved by coating the surface with a perfluorinated substance. Superhydrophobicity (contact angles >150° with water) is achieved but repellency against oils and organics is less effective, limiting their utility in repelling low surface energy substances such as petroleum-based fluids. Durability is also a challenge as performance is reduced after repeated usage or abrasion cycles, with generation of perfluorinated degradation products that bioaccumulate, resulting in significant toxicity. There is a substantial impetus to develop new material approaches to achieve superomniphobicity in films and fibers from both a performance and human health perspective. Developing materials that are super-repellant to both high- and low-surface tension liquids would be transformative for a wide range of DoW applications.

We envision the design, synthesis, and characterization of durable, superomniphobic materials through a tightly coupled approach that intersects chemistry, materials science, surface science, and molecular biology. Recent advances in surface science have implemented biomimetic springtail inspired hierarchical systems, where hierarchical microscale and nanoscale structures allow liquid droplets to reside on the surface in a non-wetting manner. While effective at repelling both high and moderately low surface tension liquids, the brittle nature of these systems cannot withstand harsh and abrasive environments. A more robust approach may take inspiration from the materials science community where complex nanostructures such as ZnO nanoflowers are designed for improved photocatalysis and could be harvested to create complex surface structures reminiscent of those found in biology. Furthermore, polymer grafting strategies could imbue the surface with orientated omniphobic functionality to further enhance repellency. Design of new super-repellent chemistries may also take inspiration from recent findings that suggest the wetting behavior of perfluoroalkyl substances is derived, in part, from a helical chain structure that is adopted, resulting in a net zero dipole when in aggregate. Strategic placement of functionalities or strained rings could promote a similar supramolecular structure to impart superomniphobicity. Siloxane polymers, which are known to decompose into toxic cyclic siloxanes, should be avoided.

A systematic characterization of degradation byproducts, coupled with mechanistic elucidation of associated cellular toxicity pathways, will be critical to guide the rational design of inherently non-toxic superomniphobic materials. We envision a material design cycle that is tightly integrated with the development and deployment of next-generation high-throughput bioassays capable of assessing both pristine materials and their degradation products for malignant transformation potential. However, assays used by the biological community are generally inadequate for superomniphobic materials due to challenges with solubility. Assimilating toxicity data has enabled machine learning to more accurately predict structural motifs that present toxicity issues. In addition, recent advances in high-throughput biological screening of materials for toxic effects include the use of integrated multi-omics, 3-D organoids, and alternative non-vertebrate and non-animal species. Extension of these advanced screening methodologies and analytical techniques to develop a systematic, high-throughput evaluation of emerging materials and their degradation byproducts is critical, with quantitative and mechanistic data driving the refinement of design parameters and their iterative implementation within a closed-loop materials development framework.

Objective: Creation of thermally and mechanically robust materials and surfaces with an unprecedented combination of superhydrophobicity and superoleophobicity through an iterative approach that implements both predictive computational screening tools and biological high throughput screening methods to assess for toxicity and bioaccumulation during the design phase.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) data driven design and synthesis of superomniphobic molecular and polymeric scaffolds (2) materials science to operate across

multiple length scales to identify and impart robust surface properties into the system; (3) characterization of material properties to assess the efficacy, stability, and durability of the novel materials produced; (4) development of computational screening tools to evaluate these materials for their propensity to interact with biological systems, with novel assays being developed to predict/determine bioaccumulation and mechanisms of toxicity; (5) development of new high throughput eukaryotic assays to rapidly screen for and identify biological impact and inform design of new materials.

Anticipated Resources: No more than an average of $1.50M per year for 5 years, supporting no more than 6 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with topic chiefs during the white paper phase of solicitation.

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Topic 9: (ARO) Some Like It Hot: Decoding the Biogeochemical Matrix of Fire and Smoke Borne Particulates

Background: Bacteria, fungi, and archaea and their metabolic by-products have recently been identified as a significant component of smoke particulate matter. There is increasing evidence that more than seventy percent of these organisms remain viable through fire emission and transport and are capable of colonizing new locations upon deposition, potentially due to biotic-abiotic interactions on the pyrolyzed material. The dissemination of microbes and biological material has important implications for plant, animal, and ecosystem resilience and stability. Similarly, pathogenic microbes in smoke and potable water sources are implicated in the rise in fungal and parasitic infections experienced by first responders and populations in urban centers after exposure to smoke. Though biological transport is recognized as a feature of fire- and smoke-borne particulates, there is little understanding of the biological, chemical, and physical features that promote the transport, protection, and survival of microbes and biological material across fire regimes.

Emerging fire management practices have combined physics-based models with controlled burn experiments and advanced sampling campaigns using novel sorbent technologies to comprehensively measure the biological content of fire particulates. However, an understanding of the coupled fire-atmospheric processes is needed to characterize the conditions that generate microenvironments within a fire that are amenable to life across spatiotemporal scales. Similarly, there is a critical need to explore the full spectrum of microbes capable of transport and survival under these extreme conditions and how these conditions affect survivability across a range of transported distances. Recent advances in omics-based and high-throughput approaches have revolutionized the ability to culture microbes and identify the functional attributes contributing to survival under extreme conditions. This new ability can be paired with biogeochemical work targeting interactions at biotic-abiotic interfaces at high-resolution to infer how the structure and function of the source microbial community promotes transport and survival on fire particulates. It has been hypothesized that pyrolyzed nanomaterials may have a profound role in biological viability by providing nutrients, UV and thermal protection, and pH regulation. Leveraging cutting edge techniques in nanomaterial imaging and synthesis has potential to shed light on these key phenomena, especially for artificial materials—polymers and mixed composite materials—prevalent in urban and other Army-relevant settings susceptible to fires.

Pursuing a combined fire-atmospheric-biological-materials approach to elucidate the biogeochemical matrix of fire- and smoke-borne particulates may ultimately provide the ability to predict, control, and leverage this vector of biological transport. These insights are expected to have broad implications across scientific and engineering fields with the potential to reveal a new paradigm for bioprospecting of microbes capable of surviving extreme temperature, oxygen, and UV conditions; to enable a new concept for forensic intelligence by rapidly characterizing the biological material produced during combustion; and to design materials for enhanced or reduced biological transport under extreme thermal forcings.

Objective: Develop a mechanistic understanding of the physiochemical, biological, and external factors that govern the protection and survival of viable cells within pyrolyzed material and determine the key mechanisms that enable fire-induced dispersal and establishment in new locales.

Research Concentration Areas: Suggested research areas include but are not limited to: (1) systematically exploring the spatial and temporal heterogeneity of fire and smoke plume dynamics to identify the microscale conditions responsible for biological viability; (2) characterizing the fuel and external sources responsible for the physical, chemical, and biological composition of fire- and smoke-borne particulates; (3) leveraging omics based and high-throughput approaches to identify and characterize the genetics, metabolic traits, and biochemistry of viable microbial organisms across a range of transported distances, and (4) elucidating the structure of nanomaterials formed during combustion events and capturing the biotic-abiotic relationships that enable fire survivability and protection.

Anticipated Resources: No more than $1.5M per year for five (5) years, supporting no more than six (6) faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with the topic chiefs during the white paper phase.

Research Topic Chiefs: Dr. Liz King-Doonan, ARO, (919) 549-4386, elizabeth.k.king-doonan.civ@army.mil; Dr. Robert Kokoska, ARO, (919) 549-4342, robert.j.kokoska2.civ@army.mil; Dr. Micheline Strand, ARO, (919) 549-4343, micheline.k.strand.civ@army.mil

Topic 10: (ARO) Interfacial Superconcentration in Extreme Multiphase Regimes

Background: Recently discovered synthetic superconcentrated electrolytes are enabling unprecedented voltages for energy storage; however, fundamental questions related to unique ion dynamics, coordination, and phase transfer events at a superconcentrated multiphase interface are only beginning to be investigated. Subsea brine pools represent a compelling natural analog, where density and salinity drive phase segregation of seawater and superconcentrated brine to form "underwater lakes". Within these extreme regimes, unique multiphase interfaces also arise between superconcentrated electrolytes and solids, for example, seabed minerals and biological membranes of extremophilic microbes. Parallel questions arise under natural and synthetic conditions: how do these systems coordinate ions to stabilize the interface, facilitate ion transport, drive (bio)chemical reactions, and, specific to the natural systems, how are structural and dynamic features mechanistically regulated by the halophilic microbial response to control charge accumulation along a cell surface? Unlocking interfacial structure, transport, and reactivity mechanisms in synthetic and natural superconcentrated systems would revolutionize our understanding of energy transformations, microbial resiliency, and dynamic minerology. A multidisciplinary approach involving electrochemists, microbiologists, geoscientists, condensed matter and/or bio-physicists could ultimately lead to new interfacial stability, ion transport, and (bio)chemical reactivity insights which create new paradigms for electrolyte, membrane, microbe, and materials design inspired by extreme regimes. The confluence of new advances in *in situ* spectroscopy and microscopy, microbial cultivation and omics-based techniques applied to halophiles, and advanced molecular dynamics models for superconcentrated ion systems may enable a first-of-its-kind consortium that deconstructs these complex chemical and biological interfaces at a fundamental structure/function level. For example, by dissecting the evolved molecular mechanisms and responses that enable halophilic extremophiles to stabilize their membranes under superconcentrated conditions while maintaining extracellular ion exchange, new design and assembly principles and control schemes capable of driving solid-electrolyte interphase (SEI) formation, stability, and ion shuttling in synthetic superconcentrated interfacial platforms can be discovered. If the dynamic behavior of superconcentrated interfaces can be understood for synthetic and natural systems, then the discovery of new stability, transport, and reactivity mechanisms may accelerate the design of battery and energy systems, biomanufacturing schemes, ionotropic computation, and applications yet unknown.

Objective: This MURI will seek to understand how superconcentrated electrolytes behave at extreme inorganic and biological interfaces, including the multi-scale structure of the interface; how ions dynamically traverse around and/or across it; and how these interfaces may be exploited to drive novel transformations.

Research Concentration Areas: Suggested research areas include but are not limited to (1) computational chemistry and bio-physical approaches toward modeling of ion aggregation effects at mineral/biological membrane interfaces to elucidate how charge coordination promotes metastable phase formation, passivation, and reactivity. (2) Electro- and geochemical examination of *in situ* interfacial ion transport processes, including electrical double layer formation, dynamic minerology, and ionotropic transport to understand ion coordination structure/function and equilibrium maintenance. (3) Microbiological cultivation and omics-based investigations to identify the genetic programming and responses within halophiles resulting in interfacial cell surface features that enable electrolyte aggregation and localization within superconcentrated environmental regimes. (4) Bio-, geo-, and electrochemical exploitation of interfacial transformations to provide materials-by-design principles for new resilient membrane, mineral, and electrolyte systems.

Anticipated Resources: No more than $1.5M per year for five (5) years, supporting no more than six (6) faculty researchers. Exceptions may be discussed during the white paper phase.

Research Topic Chiefs: Dr. Matthew Glasscott, ARO, (484) 883-5095, Matthew.W.Glasscott.civ@Army.mil; Dr. Robert Kokoska, ARO, (919) 549-4342, Robert.J.Kokoska2.civ@Army.mil; Dr. Joshua Boschelli, ARO, (240) 762-0149, Joshua.D.Boschelli.civ@Army.mil

Topic 11: (ARO) Atomic and Molecular Hybrid Quantum Solids

Background: Heterostructures and superlattices of crystalline solids are the platforms upon which modern semiconductor electronics and optoelectronics have been built. Conventionally, integrating solid state materials relies on covalent bonding of the constituent materials but suffers from disorder defects formed due to mismatch which degrades the electronic properties [1]. This restricts such integration into a narrow set of materials with compatible structures. Leveraging the bond-free van de Waals (vdW) forces in 2D layered materials, progress has been made in creating heterostructures with versatile properties enabled by their atomically clean and sharp interfaces [2]. Over the past decade, intercalation of the vdW materials with various species has yielded structures with novel properties. However, the placement of the intercalants in these systems occurred randomly in terms of adsorbed sites and concentration, resulting in arbitrary and uncontrollable properties [3]. It was recently demonstrated that the integration of solid-state atomic crystals with layers of ordered atomic/molecular intercalants is possible utilizing self-assembling properties of the intercalants. The covalently bonded vdW atomic layers provided a natural template to guide the self-assembly of the discrete molecular intercalants into ordered layers sandwiched between the crystalline atomic layers, forming superstructures with long-range ordering. With this approach, 2H-TaS_2 was intercalated with methylbenzylamine chiral molecules realizing unconventional chiral superconductivity which is uncommon in solid-state materials [4]. In addition, novel 3D Ising superconductivity was observed in a 2Sn-2$TaSe_2$ hybrid superlattice [5].

Building on these demonstrations, this topic envisions a synergistic multidisciplinary effort to create a platform where exceptional materials properties can be accessed in bulk-like layered hybrid superstructures with tunable novel phenomena. The combination of crystalline atomic layer and ordered atomic/molecular species offers vast flexibility for creating a new generation of designable artificial quantum solids with functions not available in conventional solid-state materials. This could be harnessed for probing the intricate electronic and spin interactions between vdW atomic crystals and intercalated layers of selected atomic/molecular species; for controlling the generation, confinement, and modulation of charge, exciton, and spin states in the atomically thin alternating layers; and for tailoring the emergent physical phenomena in the superstructures. Nevertheless, key challenges remain to be addressed including developing compatible chemistry for the diverse sets of functional intercalants, processing conditions that retain the sensitive organic phase, strategies to better synthesize and characterize the self-assembled interlayers with long-range ordering, theory/models able to handle the large unit cells in this system to predict and interpret emergent properties. The availability of a broad selection of inorganic atomic crystals combined with the synthetic adaptability of organic interlayers and long-range ordering in these hybrid superstructures allows for more intricate interactions of electrons and quasiparticles, resulting in quantum and electronic properties that are especially relevant for the world of quantum materials and could enable unprecedented device functionalities.

Objective: Create layered atomic crystals with ordered atomic/molecular species; elucidate fundamental intercalation processes and interactions between intercalants and the vdW host layers; exploit that knowledge to realize artificial hybrid superstructures with novel properties.

Research Concentration Areas: Include but are not limited to 1) Theory and modeling for materials design 2) Growth of hybrid superstructures with long-range ordered sublattices which leverage the flexibility of synthetic molecular systems for improved ordering and interfacial interactions; 3) Experimental characterization of the new materials properties; 4) Develop a framework to understand how intercalants organize within and interact with the vdW host layers to predict and interpret emergent properties; 5) Novel device concept leveraging the enhanced properties resulting from the hybrid superstructures.

Anticipated Resources: No more than an average of $1.50 M per year for five (5) years, supporting no more than six (6) funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with topic chiefs during the white paper phase.

Research Topic Chiefs: Dr. Tom Oder, ARO, (240) 967-1218, tom.n.oder.civ@army.mil; Dr. Robert Lambeth, ARO, (240) 499-6692, robert.h.lambeth2.civ@army.mil

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Topic 12: (ONR) Distinguishing between AI generated content and human created content

Background: Over the last few years, generative AI (GenAI) models made impressive advances. They can now solve complex problems and generate original content that we thought only humans could do. Most importantly, they can generate contents that are hard to distinguish from human created contents. For example, this year, a large language model (LLM) reached the level of gold-medal students in the International Mathematical Olympiad [1], and last year an LLM was able to generate novel research ideas that are apparently more creative than the ideas generated by human researchers. While these models can help accelerate scientific discovery, they also create challenges for schools, funding agencies, and publishing organizations. Students are increasingly using LLMs to do their homework, and some researchers use LLMs to help create grant proposals, generate journal/conference papers, and evaluate papers. Similar concerns exist in other domains, including image, video and speech generation where misuse of GenAI can result in creation of deepfakes, and voice cloning leading to impersonation scams. Recently, it has been shown [3] that the GPT-4.5 model can easily pass a Turing test. Ironically, in a blind test, the AI model passed as human more convincingly than the human did. This naturally raises a question: what tools can we use to detect if an online agent is a human, and to distinguish between human created and AI generated content? Is that even possible or should we just "learn to stop worrying and love the bot".

Research into detection of AI generated content generally falls into two categories: methods that detect statistical or learned features in the content, and methods that embed a signal (watermark) within the GenAI output. The first approach is often addressed by training machine learning (ML) models to learn human and AI generated features and then classify generated content based on detected features. While this approach showed promise in the early stages of GenAI development, current GenAI models create much more realistic (human-like) content and the differences between human and GenAI generated content are rapidly decreasing.

Recent advances in watermarking offer more reasons for hope. Importantly, watermarking is not affected by growing capabilities of GenAI models, and a watermark can be used to determine which model has generated the content. Watermarks have been successfully implemented in generative image models [4] but watermarking LLM's outputs is still challenging. Watermarked content is vulnerable to adversarial attacks including removing, obscuring, and stealing the watermark, and in some cases an attacker can generate malicious content under a fake watermark. Most existing watermarking methods are designed for closed models, and only the entity that created a watermark can detect it and make the attribution. However, open-source models (OSMs) are becoming more competitive and steadily gaining users. There is a growing need for designing watermarking methods for open-source models, and making watermarking process more transparent and verifiable.

Some governments requested that providers of GenAI models release publicly available tools to detect whether image, video, or audio content was generated or modified by their models [5,6]. Unfortunately, such tools still don't exist for some domains and there is an urgent need to develop new methods for authenticating AI generated content.

Objectives: The objective is to develop new methods for distinguishing between AI generated content and human created content. The content can include different domains such as text, audio, image, and video, and can be static (already generated), or dynamic such as content generated during online conversations between a human and an online agent. Furthermore, the objective is to develop a rigorous theory for determining under what conditions AI and human-generated content can be distinguished, and under what conditions it cannot be distinguished.

Research Concentration Areas: Suggested research areas may include but are not restricted to: 1) Open-source model (OSM) watermarking. Watermarking methods that have been developed for closed models are inapplicable to OSMs and new watermarking methods tailored to OSMs should be investigated. The new methods should be resistant to model modifications such as model merging, quantization, pruning, and finetuning. 2. New watermarking methods for LLMs. Develop methods that are robust to text rephrasing and editing, and methods for semantic paragraph or document-level semantic watermarking. 3. Model and data protection. Explore techniques for embedding watermarks within a model to prevent unauthorized use of the model (e.g. fine tuning, distillation, etc.), and for embedding watermarks (or poison pills) within data to verify if the data was used for model training. Similarly, investigate approaches based on instructional fingerprinting of LLMs. 4. Decentralized watermarking. Design a watermarking framework that can engage multiple parties to create and distribute the keys among model creators, and efficiently audit watermarks and provide public attribution. Investigate mechanisms for verifiable and transparent communication and verification among the parties and model creators, such as the blockchain. Explore approaches to build low-cost and statistically reliable auditing mechanisms to verify that the model creator has indeed embedded the assigned watermarks at a pre-determined strength for all generated content. 5. New methods for GenAI authentication. Explore new methods for authentication of GenAI content that go beyond watermarking and detection of learned features.

Anticipated Resources: It is anticipated that awards under this topic will be no more than an average of $1.5M per year for 5 years, recommend maximum of one lead PI and 5-8 co-investigators. Exceptions should be discussed with Topic Chief during the white paper phase of the solicitation.

Research Topic Chief:
Dr. Predrag Neskovic, ONR Code 311, (703) 696-4304, Predrag.Neskovic.civ@us.navy.mil

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[4] An undetectable watermark for generative image models, S Gunn, X Zhao, D Song, arXiv preprint arXiv:2410.07369, 2025.
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Topic 13: (ONR) Troposcatter Sensitivity to Atmospheric and Electromagnetic Conditions

Background: While many electromagnetic communication methods require line-of-sight propagation, the tropospheric scatter phenomenon facilitates beyond visual horizon transmission of signals via random scattering of radio waves (from around VHF to X-band) in the upper troposphere. Atmospheric turbulence and moisture layers refract much of the signal, causing only a small amount of energy to be received. Despite robust testing and application of the troposcatter phenomena to streamlining and improving microwave frequency communications since the 1950s, the specific atmospheric conditions which facilitate and modulate troposcatter are still not known (Teng et al 2024, Ramlall et al 2025), making it difficult to perform an assessment and prediction of microwave communication suitability. Further, signals measurements and atmospheric measurements are very rarely collocated, adding to poor causal attribution (Anderson 2025).

Ad hoc methods to understand strength of troposcatter phenomena include assumptions about turbulent structures, cloud particle fields, and common volume interactions – however, current state of the art understanding troposcatter relies on the assumption that a large number of "scattering centers," such as water droplets, dust particles, and atmospheric gases, all contribute to the total reflection and scatter of radio signal. This type of atmospheric particle analysis is already a traditionally difficult field to measure, but even more so for this topic due to electronic interference for measurement platforms (e.g., aircraft). As radio technology has also improved substantially in recent years (via software-defined radios, machine learning signals processing, component miniaturization, and improved power efficiency), the structure and intensity of troposcatter variations has seemingly changed, necessitating a better understanding of the radio technology contribution to the phenomena. As such, a comprehensive understanding of environmental controls and signal source characterizations are needed to better constrain the causes of troposcatter variability.

Objective: Conduct a robust and comprehensive state of the science analysis using current and newly developed theory, observations, and modeling on how environmental conditions, and their predictability, modulate radio link performance and optimal characteristics across different radio technologies via the troposcatter method of beyond line-of-sight communication.

Research Concentration Areas: A cross-disciplinary team of subject domain experts in microwave frequency signal processing, electrical engineering, meteorology, numerical prediction, and machine learning will be required to closely interact to improve the state of the science from a theoretical, field observing, remote sensing, and forecasting perspective. Basic research foci should include: 1) Cross cutting idealized simulation, modeling, and/or lab testing on a range of radio frequency patters and environmental conditions to inform a sensitivity analysis, 2) Multiple field campaigns in varied real world conditions that are representative of tropical to polar and seasonal variabilities using comprehensive radio communication and atmospheric measurement equipment, 3) Direct numerical simulation and/or large eddy simulations of microphysics and turbulence scale processes including radiative transfer modeling and ray tracing, 4) Process-based studies of operational weather forecasting models and their ability to resolve conditions that modulate troposcatter conditions, and 5) Meta-analysis of historical data, including by machine learning methods, to provide new theoretical perspective on relationships between atmospheric conditions and optimal radio propagation regimes.

Anticipated Resources: Awards under this topic will be no more than $1.5M per year for 5 years, supporting no more than five funded faculty researchers. Exceptions warranted by specific proposal approaches may be discussed during the white paper phase of the solicitation.

Research Topic Chiefs: Dr. Joshua Cossuth, ONR Code 322, (703) 696-0703, joshua.h.cossuth.civ@us.navy.mil; Ms. Katherine Mulreany, ONR, katherine.l.mulreany.civ@us.navy.mil, (948) 215-0068; and Dr. Daniel Eleuterio, ONR, (948) 215-2918, daniel.p.eleuterio.civ@us.navy.mil

Topic 14: (ONR) Interface Mediated Control of Biofilm Function

Background: Developing materials capable of guiding biofilm function offers a promising approach to address biofouling, corrosion, remediation, and biohybrid system design. However, we lack a comprehensive understanding of how specific material properties, at the molecular level, influence the recruitment, assembly, and emergent function of diverse biofilms. Current strategies focus on material and biological components separately rather than unraveling the complex interactions of material-biological interfaces. For instance, material solutions are primarily developed for biofilm deterrence, release, or as inert scaffolds to support biotic components. Biofilms—both genetically modified or wild type—can be engineered in a laboratory to demonstrate tailored functional properties but lack the stability to withstand natural environmental perturbations. Neither system fully integrates biotic and abiotic components to recapitulate the sophisticated strategies and innate adaptability found in nature. By inspecting the complex interplay between surface properties and cellular responses, we will be able to develop a new rationale for materials design.

Through precisely modifying material properties such as surface chemistry, topography, and mechanical stiffness at the nanoscale, it is possible to influence cellular behavior, including adhesion, proliferation, and differentiation. This capability enables the design of surfaces that can direct the assembly of biological systems, such as biofilms or tissue constructs, within an engineered material. For instance, materials with specific surface patterns can guide the spatial organization of cells. This was recently demonstrated with stamped hydrogels for multidirectional muscle fiber growth and is a well-known phenomenon in textured surfaces for antifouling. Materials with tailored chemical functionalities can modulate cellular signaling pathways such as the use of siderophores and quorum sensing molecules to alter biofilm formation and structure. Yet, the use of materials to guide biotic components towards a specific functionality has yet to be demonstrated. The ability to control biological function through material design could not only enhance the performance of these systems but also opens new avenues for innovation in creating adaptive and responsive materials that can interact dynamically with their biological counterparts.

Objective: To develop new models for emergent biofilm function and explore the fundamental mechanisms of synthetic material interfaces to act as "ecological conductors", selectively recruiting beneficial native biofilm communities and orchestrating their metabolic activity to achieve a specific function (e.g., macrofouling deterrence, material healing, corrosion protection, hierarchal structures, etc.).

Research Concentration Areas: The research should explore the temporal, spatial, and interfacial properties at the intersection of materials, biology, and their natural environment. Suggested research areas include but are not limited to (1) determining mechanisms of material-environment interactions across scales and time using theory, modeling, and simulation followed by experimental validation; (2) material selectivity for specific biofilms and biofilm development (initiation, propagation, and functional evolution); (3) synthesis of novel materials and their ability to regulate metabolic processes of biofilms for desired function; (4) the duration over which a material interface exerts functional control over recruited biofilms; and (5) the impact of the environmental perturbations on community function. Though work on model systems and with single species is acceptable for initial concept design, significant effort should be focused on natural communities with developed synthetic materials. Because of the distribution across scales and complexity associated with this topic, leveraging expertise from complex systems or system dynamics is encouraged.

Anticipated Resources It is anticipated that awards under this MURI will be no more than an average of $1.50M per year for 5 years, supporting no more than 6 funded faculty researchers. Exceptions warranted by specific proposal approaches should be discussed with topic chief(s) during the white paper phase of solicitation.

Research Topic Chiefs: Dr. Paul Armistead, ONR Code 332, (948) 215-0238, james.p.armistead2.civ@us.navy.mil; Dr. Thomas McKenna, ONR 341, (703) 696-4503, thomas.m.mckenna4.civ@us.navy.mil

Topic 15: (ONR) High-Entropy Electrochemical Materials

Background: This MURI will enable unprecedented electrochemical behavior by establishing a fundamental understanding of the multivariate properties that emerge from the interplay of disparate elements in high entropy (HE) materials. High entropy materials (HEMs) leverage enhanced configurational entropy to stabilize single-phase structures comprising ≥5 principal elements, and permit crystal phases to exist outside traditional stability conditions. Multi-element interactions give rise to exotic characteristics, including severe lattice distortion, diverse coordination environments, suppressed short-range order, and unique energy landscapes. High-entropy design has evolved beyond simple, first-generation metallic alloys to include multi-functional oxides, nitrides, carbides, and multi-anion materials. Recently, it was demonstrated that HEMs achieve unprecedented electrochemical behavior relative to their traditional counterparts, notably: 1) enhanced ion diffusion and superionic conductivity; 2) improved rate and capacity for faradaic and non-faradaic processes; 3) superior electro/chemo-mechanical stability; and 4) exceptional electrocatalytic activity, stability, and bifunctionality.[1]

These recent breakthroughs suggest that with tailorable structures and compositions, HEMs offer tantalizing prospects for use as energy conversion/storage materials with improved power, energy density, and lifetimes relative to state-of-the-art. However, the lack of fundamental understanding of how atomic arrangement and local structure dictate bulk electrochemical behavior stymies progress in electrochemical HEM design. For example, a constituent element can enhance faradaic capacity without directly participating in redox reactions. The poorly understood synergistic effects in HEMs are colloquially referred to as the "cocktail effect" wherein ensemble properties are not attributed to the presence or arrangement of individual constituents.[2] This MURI will generate the foundational understanding of how ensemble properties emerge from multi-element interactions necessary to move beyond the empiricism of property optimization that has thus far dominated HEM discovery.

Advances in synthesis, characterization, and modeling are required to derive essential mechanistic insights into the structure-function relationships of electrochemical HEMs. The staggering number of possible combinations of multi-component materials[3]—compounded by the variety of phases and sub-phases—far exceeds the practicality of brute-force synthetic methods, even if aided by computational down-selection. The computational burden of screening vast materials permutations is amplified by the imperative to predict *electrochemical function* in addition to stability. Traditional bottom-up synthetic routes are time/energy intensive and offer poor control over atomic mixing and morphology, both of which are essential to functionality. Traditional bulk characterization techniques do not capture the assortment of local phenomena that dictate bulk properties. The need to deconvolve local and long-range structural, chemical, and electronic contributions of multiple elements—often at low concentrations and with overlapping signatures—stretches the limits of state-of-the-art materials characterization.

Objective: The objective of this MURI is to establish a fundamental understanding of the origin of ensemble properties in HE materials that give rise to unprecedented electrochemical behavior and to exploit HE design to achieve targeted functionality for energy storage and conversion.

Research Concentration Areas: Successful teams will develop synthetic routes to electrochemical HEMs enabling synergistic atomic compositions to be produced in functional nano-, meso-, and micro-scale expressions. High-throughput, bottom-up synthesis with compositions informed by recent advancements in computational, data-driven, and AI-derived materials discovery will accelerate electrochemical HEM design. Successful teams will therefore leverage expertise in computational approaches, spanning a variety of multi-objective optimization and active learning approaches, as well as property prediction that is experimentally verifiable. Linking electrochemical function (ionic and electronic transport/storage, redox, electrocatalysis, mechanical stability, etc.) to atomic structure requires the application of high-resolution, multi-scale chemical, physical, and electrochemical

characterizations. Lessons learned should inform new approaches to exploit electrochemical function for high capacity/rate energy storage/conversion.

Anticipated Resources: Awards under this topic are anticipated to sum to no more than an average of $1.5M per year for 5 years (3 base + 2 option), supporting ≤6 funded faculty researchers. Exception warranted by specific proposal approaches should be discussed with the topic chief.

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Topic 16: (ONR) Bio-Inspired Autonomous and Recurrent Self-Healing in Materials and Structures

Background: Additive generation is prevalent in nature: growth from a single cell to a complex organism occurs one cell at a time. Throughout the typical life span of an organism, small and large damage to its structures is inevitable. Organisms have developed varying solutions to mitigate any loss in their structural integrity due to damage. The self-healing (repair) solutions, for example, range from regrowth or repair of damaged tissues in some animal species to growth around damage (compartmentalization) in some tree species. Similarly, to enable continuous supply of repair and sustenance materials, nature has developed features, such as venation in leaves and vascularization in animals [1]. The bio-structures have intrinsic sensing and triggering solutions to kick-start self-healing process utilizing stored nutrients and, especially in plants, leveraging ambient sources of energy and nutrients, such as sunlight and air. They enable recurrent and effective sustainment of structures in organisms. Further, a wide range of biomaterials are capable of self-healing, whether they are compliant (e.g., skin tissues) or stiffer (bone tissues). Meanwhile, fabrication of intricate, complex, and optimized, sometimes nature-like, structures in artificial (man-made) systems have seen a revolution using advanced manufacturing technologies, such as additive and convergent manufacturing. However, the self-healing aspect of such structures exploiting advanced manufacturing techniques is still limited in its application and efficacy. We have not been able to effectively leverage the intricate, multiscale, autonomous and recurrent aspect of the self-healing (repair) solutions as observed in the nature in artificial materials and structures even though the current state of manufacturing technologies and in situ characterization tools is advanced enough to fabricate detailed and complex features at nanoscale and up. State-of-the-art self-healing solutions implemented in certain materials systems in modern day manufacturing, such as microcapsules, vascular network, etc., come with limitations and challenges, including a limited number of self-healing cycles and complexity in fabrication [2]. In this context, it can be surmised that modern manufacturing has not yet been truly exploited to its full extent to impart autonomous and recurrent self-healing capability to materials and structures at multiscale level. Development of understanding and implementation of bio-inspired self-healing technology can address this gap. Considerable advancements in manufacturing technologies, engineered materials, material characterization, spectroscopy and sensing have been made, enabling us now to embark on this research topic. Examples include micro scale printing, ability to print structures with materials with wide ranges of mechanical properties (e.g., soft biological tissues to stiff metallic structures), 4-Dimensional (4D) printing that enables printed objects to react to external stimuli, smart materials, nanotechnology, etc. Similarly, there have been advancements in in situ spectroscopy, in situ characterization, high speed camera, sensors, interface mechanics, polymer science, etc. In parallel, there have been steady advancements in technologies, such as advanced microscopy, living cell imaging allowing observation of cells in their natural state, synthetic biology and regenerative study to help further our understanding of bio-healing in nature. These advancements combined with advancements in modeling and simulation and artificial intelligence (AI) allowing optimization, data processing and digital twins of manufacturing and self-healing processes, set a timely stage for the research community to embark on this novel exploration in understanding and developing autonomous and recurrent self-healing in artificial materials and structures with bio-inspired strategies.

Objective:

The objective of this MURI topic is to explore and develop fundamental mechanisms responsible for realizing autonomous and recurrent self-healing phenomena in a wide range of artificial materials and structures utilizing advanced manufacturing technologies, such as additive manufacturing, with inspiration derived from living materials. The self-healing aspect in materials and structures entails development and incorporation of autonomous self-healing (sensing damages and triggering repairing

process of damages) and understanding of mechanisms that allow recurrent self-healing (multiple cycle of repairs and supply of repair materials to the damage site).

Research Concentration Areas:

Multidisciplinary research is anticipated with the topics relevant to self-healing in a wide range of materials and structures manufactured with advanced methods, such as additive manufacturing, including but not limited to: (a) Exploration of various self-healing phenomena and understanding of relevant mechanisms in biological systems (cell, tissues, and organisms), and application of this knowledge to identify and develop effective repair strategies for self-healing structures that may be composed of materials, such as polymers, composites, metals, and ceramics; (b) Fundamental understanding of the initiation, termination and rate control mechanisms of healing in bio-structures to develop analogous damage detection and repair strategies in artificial novel structures; (d) Innovation and incorporation of in situ, real-time health monitoring of self-healing structures through embedded or in situ sensors along with exploration of relevant novel sensing mechanisms; (e) Development of intrinsic or external repair material supply systems for recurrent healing under various environmental factors, including temperature, humidity, strain, and pressure; (f) Design of novel materials and structures and development of manufacturing approaches (e.g., additive, convergent, etc.), to enable built-in, not add-on, autonomous, recurrent and self-healing attributes in them, and characterization of their behavior pre and post self-healing.

Anticipated Resources:

It is anticipated that awards under this topic will be no more than an average of $1.5M per year for 5 years with one lead PI and 4-5 co-investigators; exceptions warranted by specific proposal approaches should be discussed with Topic Chief during the white paper phase. Additional year (s) of funding may be added at the discretion of the topic chief and will be based on the availability of additional funds and team performance.

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