NSF 21-625: Materials Research Science and Engineering Centers (MRSEC)

Program Solicitation

Document Information

Document History

- **Posted:** September 21, 2021
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National Science Foundation
Directorate for Mathematical and Physical Sciences
Division of Materials Research

Preliminary Proposal Due Date(s) *(required)* (due by 5 p.m. submitter's local time):

June 21, 2022

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 22, 2022

By invitation only

Table Of Contents

Important Information And Revision Notes

1. New priority areas for DMR are listed, including topical areas that broaden the portfolio of the MRSEC Program; high-risk/high-impact research proposals and proposals addressing topical areas of national importance will be given priority.
2. Proposals must address a limited number of well-chosen education and outreach activities, and delineate a targeted roadmap to address a single, clear, and measurable goal, with long-term verifiable impact that extends beyond the Center itself.
3. Proposers no longer need to identify the main topical materials research program that aligns with each proposed Interdisciplinary Research Group.
4. Additional proposal-preparation requirements have been included related to the Data Management Plan. Accompanying reviewer guidance is provided on evaluating Data Management Plans.
5. Minor clarifying changes in wording have been made in Sections II-V.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 22-1), which is effective for proposals submitted, or due, on or after October 4, 2021.

Summary Of Program Requirements

General Information

Program Title:

Materials Research Science and Engineering Centers (MRSEC)

Synopsis of Program:

The Materials Research Science and Engineering Centers (MRSECs) program provides sustained support of materials research and education of the highest quality while addressing fundamental problems in science and engineering. Each MRSEC addresses research of a scope and complexity requiring the scale, synergy, and multidisciplinarity provided by a campus-based research center. The MRSECs support materials research infrastructure in the United States, promote active collaboration between universities and other sectors, including industry and international organizations, and contribute to the development of a national network of university-based centers in materials research, education, and facilities. A MRSEC

may be located at a single institution, or may involve multiple institutions in partnership, and is composed of two to three Interdisciplinary Research Groups, IRGs, each addressing a fundamental materials science topic aligned with the Division of Materials Research, DMR.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Serdar Ogut, MPS/DMR, telephone: (703) 292-4429, email: sogut@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.049 --- Mathematical and Physical Sciences

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 8

Anticipated Funding Amount: $25,000,000

The number of MRSEC awards will depend on the quality of the proposals and available funds. An estimate of $25M will be available for the FY 2023 competition for funding up to 8 MRSEC awards.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 1

Only one MRSEC preliminary proposal may be submitted by any one organization as the lead institution in this competition. An institution proposing research in several groups should submit a single MRSEC proposal with multiple Interdisciplinary Research Groups (IRGs). A MRSEC proposal must contain a minimum of 2 IRGs and a maximum of 3 IRGs. The IRGs in a Center may be thematically related, or they may address different aspects of materials science typically supported by DMR. A single Center at an organization allows efficient usage of resources, including common infrastructure, and better coordination of education and other activities of the Center.

Institutions that were awarded a MRSEC in the FY 2020 competition as the lead institution are **not** eligible to submit a MRSEC proposal as a lead institution in this competition.

MRSEC full proposals may be submitted by invitation only.

Limit on Number of Proposals per PI or co-PI: 1

An individual may be the Principal Investigator (PI) or co-PI for only one preliminary proposal, i.e., no investigator, PI or co-PI, can be listed on the NSF proposal Cover Sheet on more than one proposal.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposals:**
    - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
    - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Preliminary Proposal Due Date(s) *(required)*** (due by 5 p.m. submitter's local time):

  June 21, 2022

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  November 22, 2022

  By invitation only

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

I. Introduction

The nature of materials research demands mechanisms to support cross-cutting collaborations for the conception and execution of ideas, and for developing the capabilities to sustain our nation's competitiveness in the production of new technology and products based on advances in materials research. Materials Research Science and Engineering Centers (MRSECs) are expected to contribute to the development of a diverse and globally competitive scientific workforce for increased economic competitiveness of the United States.

MRSECs support multidisciplinary materials research and education of the highest quality while addressing fundamental problems in materials science of a scope and complexity requiring the scale and synergy provided by a campus-based research center. MRSECs require outstanding research quality, intellectual and disciplinary breadth, flexibility in responding to new research opportunities, support for research infrastructure, and are strengthened by interdisciplinary approaches. MRSECs additionally foster the integration of research and education in the materials field, while implementing best practices for growing diversity, and actively promoting inclusion of participants from underrepresented groups. They are expected to have strong links to industry and other sectors, as appropriate, and to contribute to the development of a national network of university-based Centers in materials research.

The NSF's mission is to promote and facilitate the progress of science, engineering, and related education in the United States. Its role in supporting research and education is particularly important in creating physical and human resources infrastructure in both traditional and emerging areas. NSF also promotes partnerships, including collaboration with other US IHEs, industry, national and government laboratories, for projects of mutual interest. International collaborations are also encouraged.

The MRSEC program reinforces NSF's commitment to excellence in research and education; it is national in scope and significance, requiring coordination of the overall effort among Centers. The MRSEC program complements, but does not substitute for, NSF support for individual investigators, small groups, national user facilities, and instrumentation in materials research.

Aiming to preserve balance in the nation’s materials research portfolio, proposals are sought that address fundamental, timely and complex materials problems that are intellectually challenging and important to society. In 2016 the NSF launched the 10 Big Ideas, which have served since then to align and grow a significant portion of the MRSEC Program’s portfolio. DMR is now seeking to further expand the boundaries of the MRSEC Program, by supporting new opportunities in materials research that address timely and complex materials problems and are also of strategic priority. Such proposals should aim to broaden the current MRSEC research portfolio (see https://www.mrsec.org/ for a detailed description) or, where appropriate, align with new opportunities that stand to bolster collaborative research in materials science.

While historically the MRSEC Program has supported research that is of predominantly experimental nature, the Program is now strongly encouraging submission of proposals that are *purely of theoretical and/or computational nature*. In such cases, IRG teams should retain topical and disciplinary diversity to the greatest extent possible. It is anticipated that purely/primarily non-experimental IRGs are likely to include IRG members from departments such as Mathematics, Computer Science, Data Science, etc., to enable the synergistic development of new abstract theories; development of new mathematical, computational, and simulation tools, as well as new data-intensive approaches for materials research; and to advance deep understanding of complex materials phenomena widening the aperture of fundamental materials research.

All proposals, whether experimental or non-experimental in nature, are strongly encouraged to align with principles of the Materials Genome Initiative (MGI, see https://www.mgi.gov/ and https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505073 for additional information,) where the combination of approaches (*e.g.*, experiment, theory, computation) in a tightly integrated, high-throughput manner creates scientific synergies leading to more rapid development, while minimizing costs. To this end, sharing of data is required and must align with FAIR (findable, accessible, interoperable, and reusable) principles.

One opportunity of interest to DMR is the new paradigm for the *Industries of Tomorrow* – a suite of emerging and critically important technologies, inherently powered and driven by advanced materials and fundamental materials advances that underlie needs in biotechnology, quantum information science, telecommunications, future sustainable clean energy technologies, advanced manufacturing, and future semiconductors. At the frontier of science and technology, these Industries of Tomorrow are poised to have the greatest impact in advancing and securing a competitive leadership position for the United States. DMR is predominantly interested in *high-risk/high-impact* proposals that are mapping out new paths for discovery and new areas of research in materials science that will have substantial long-term impact on the *Industries of Tomorrow*. Proposals comprising partnerships and participants that expand the disciplinary makeup of the MRSEC portfolio beyond its current composition are strongly encouraged. IRG teams are urged to go beyond traditional collaborative partnerships, to pursue topic areas and research questions that require essentially new exploratory environments to be addressed successfully. Proposals addressing fundamental materials research problems in the following areas are of particular interest:

- ***Artificial Intelligence* (AI)**, including use of machine learning, deep learning, computer vision and other emerging data-centric approaches to address complex problems in materials science, and in particular as applied to traditional materials science problems in *ceramics, metals, metallic alloys*, and other materials classes. The use of AI and machine learning to enable advanced manufacturing, and using predictive design to program materials' composition, structure, and function are also of interest.
- ***Biotechnology and Synthetic Biology***, including addressing materials challenges that hinder the advancement of incorporating synthetic biology techniques to the development of next-generation materials and living (functional) materials relevant to biotechnology; and fundamental materials research at the intersection of synthetic biology and abiotic materials and technologies, and of engineering biology and materials science. Efforts may include, but are not limited to, the development of materials, living materials, and/or materials systems that have the potential to impact the way we grow, store, and preserve food; to explore new materials that sustain the well-being of humans, non-human animals, and populations; development of knowledge of how to manufacture new biological materials for information storage and processing; development of new materials that are pluripotent and autonomous that can sense their environment and change properties; and new approaches to manufacture at scale materials that are safer, more sustainable, and novel (see https://roadmap.ebrc.org/2021-roadmap-materials/ for more information.)
- ***Advanced Manufacturing***, including new strategies for creating composite materials across materials classes (*e.g.*, combining digital- and self-assembly), new tools for modeling and monitoring processing (*e.g.*, in situ characterization), and developing the ability to print functionality, such as spatially resolved mechanical/chemical properties, in addition to structures; exploring opportunities for hierarchical materials by combining self-assembly (bottom-up) with top-down additive manufacturing and 4D printing; blending manufacturing approaches for heterogeneous (soft and hard) materials; precision synthesis and characterization of macromolecular/bespoke polymer materials.

In addition, further potential research topics to broaden the current MRSEC portfolio include, but are not limited to:

- ***Structural Materials under Extreme Conditions***: this effort addresses fundamental challenges in ceramic, metallic, and polymeric structural materials, and their composites for applications under extreme conditions.
- ***Materials for Clean, Sustainable Energy***: this effort addresses development of earth-abundant / non-toxic element-based materials and sustainable practices that support: materials for clean, sustainable energy harvesting, conversion and storage; and materials for energy-efficient processing, storage, and communication of

information. Proposals in this area must address topics that are distinct from ongoing research efforts supported by other federal agencies.

In summary, research topics for proposed IRGs are generally expected to be aligned with research typically supported by DMR; deviations from such research efforts, however, may be considered upon prior consultation with the cognizant NSF Program Officers listed in this solicitation.

Finally, adhering to NSF's mission which calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, MRSECs are required to engage in and lead education and outreach activities to this end. Proposals should address a limited number of well-chosen education and outreach activities, and delineate a targeted roadmap to address a single, clear and measurable goal, with long-term verifiable impact that extends beyond the Center itself. Potential goals may include but are not limited to catalyzing the transfer of students from community colleges to 4-year academic STEM programs, increasing persistence in STEM among pre-college and undergraduate students from underrepresented groups, and improving K-12 student performance in STEM fields on the local and/or regional level. Planned activities should be evidence-based and should rely on documented best practices whenever possible. Centers may partner with other institutions, including but not limited to minority-serving institutions, women's colleges, institutions that primarily serve persons with disabilities, community colleges, military colleges, and K-12 schools, as appropriate. The proposed roadmap should encompass the lifetime of the award (6 years), as well as a discussion of longer-term efforts.

II. Program Description

Materials Research Science and Engineering Centers are supported by the National Science Foundation to undertake materials research of a scope and complexity that would not be feasible under traditional funding of individual research projects. The MRSEC program demonstrates NSF's commitment to excellence in research and education; it is national in scope, encouraging coordination of the overall effort among Centers; and it complements, but does not substitute for, NSF support for individual investigators, small groups, national user facilities, and instrumentation in materials research. More information about MRSECs may be found at https://www.mrsec.org.

A MRSEC may encompass two to three interdisciplinary research groups (IRGs). Each IRG involves several faculty members (typically from a minimum of 6 to a maximum of 12) addressing a major topic or area, in which sustained support for interactive effort by the several participants of complementary backgrounds, skills, and knowledge is critical to progress. The IRGs in a Center may be thematically related, or they may address different aspects of materials research. The MRSEC in its entirety is holistic, its rationale conditioned on the connection of all its parts, with synergy arising from common infrastructure, shared facilities, education and outreach activities, and other Center-spanning initiatives.

MRSECs incorporate the following activities to an extent commensurate with the size and vision of the Center:

- Academic-institution-based materials research of the highest quality: each IRG must have a well-integrated research program distinguished by intellectual excellence and driven by a clear vision that could lead to fundamental advances, new discoveries, and/or technological developments of national and international significance. Each IRG must show clear benefits of a multi-investigator, interdisciplinary and collaborative approach to address a major materials topic or area and must delineate the linkages between researchers within the IRG.
- Seed funding: NSF intends to provide flexibility for the Center to respond quickly and effectively to new opportunities and pursue high-risk/high-impact and transformative research. These may include (but are not limited to): seed support for faculty to further add or broaden existing efforts; emerging areas of interdisciplinary research; programs to link the university effort in materials with industry, national laboratories, and other sectors; the development of tools and cyber infrastructure for remote access to instrumentation; and innovative interdisciplinary educational and broadening participation ventures. Seed funding through the Center is not intended to provide a substitute for NSF individual investigator funding. Seed funding mechanisms and impact to the MRSEC is evaluated at post-award Site Visits of the MRSECs.

- Promotion of the integration of research and education, and development of effective education/outreach activities that are consistent with the Center size, leverage participant expertise and interest, and address local and national needs. Research Experiences for Undergraduates (REU) are required; see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517 for specifics.
- A MRSEC should pursue activities with proven impacts in improving scientific education. It may also experiment with novel approaches as appropriate.
- Fostering increased participation in materials research and education of members of underrepresented groups in science and engineering (e.g., women, Blacks or African Americans, Hispanics or Latinos, Native Americans, Alaska Natives, Native Hawaiians, and Other Pacific Islanders, and persons with disabilities) at all academic levels. A Center is strongly encouraged to develop cooperative programs with organization(s) serving predominantly underrepresented groups in science and engineering and/or predominantly undergraduate institutions.
- Development of shared experimental and computational facilities, properly staffed, equipped and maintained, and accessible to users from the Center, the broader university community, and other organizations. A goal is to maintain the long-term health of the materials research infrastructure in the United States and contribute to a national network of materials research facilities.
- Promotion of partnerships by supporting a Center's active cooperation with industry and international organizations, and other sectors, such as national laboratories, non-profit organizations, and state and local governments, in order to stimulate and facilitate knowledge transfer among the participants and strengthen the links between university-based research and its application.

Each MRSEC has the responsibility to manage and evaluate its own operation with respect to program administration, planning, content and direction. NSF support is intended to promote optimal use of university resources and capabilities, and to provide maximum flexibility in setting research directions, developing cooperative activities with other organizations, and responding quickly and effectively to new opportunities in materials research and education that are important to the nation's needs and technology base.

A MRSEC may address any area of research supported by the NSF Division of Materials Research which include 8 programs (known as Topical Materials Research Programs, TMRP): Biomaterials (BMAT), Ceramics (CER), Condensed Matter Physics (CMP), Condensed Matter and Materials Theory (CMMT), Electronic and Photonic Materials (EPM), Metals and Metallic Nanostructures (MMN), Polymers (POL), and Solid State and Materials Chemistry (SSMC). For a detailed description of the research supported by the 8 TMRP visit https://www.nsf.gov/materials. IRGs not well aligned with DMR supported research will not be reviewed. Proposers are strongly encouraged to contact the Program Director listed in this solicitation to ascertain that the planned research fits the scope of the DMR role in the suggested topical areas. Inclusion of IRGs not appropriate for consideration by DMR may be returned without review.

In addition to research excellence, these centers provide the infrastructure of equipment, education and outreach needed to ensure that the program as a whole meets its objectives and provides for effective coordination within and beyond the Center community. Centers are required to contribute to the network addressing common problems and applications. Center shared experimental and computational facilities constitute the Materials Research Facility Network, a network of facilities that help to maintain and advance materials research infrastructure in the United States. More information about the network may be found at www.mrfn.org.

III. Award Information

Individual MRSEC awards are expected to range in size from approximately $3 million/year for a 2-IRG MRSEC to a maximum of $4.5 million/year for a 3-IRG MRSEC. Awards will be made for an initial duration of up to six years, but the level of funding is contingent on successful progress and upon the outcome of external review. The number of awards will depend on the availability of funds and the quality of proposals received. Any funding provided to existing Centers after the initial duration will be based on the submission of a re-competing proposal as described below.

Awards are based on comprehensive, competitive merit review. Proposals from existing (re-competing) MRSECs will be evaluated in open competition with new proposals; the re-competing MRSEC's prior accomplishments must be described

in the Results from Prior NSF Support section of the preliminary and full proposals and will be an important consideration. The commitment of each Center to introduce substantially new research topics and undertake innovative research will also be important in considering re-competing proposals. If a proposal from an existing center is successful, a new cooperative agreement will be awarded for the center.

The anticipated effective date of new MRSEC awards is September 1, 2023.

IV. Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 1

Only one MRSEC preliminary proposal may be submitted by any one organization as the lead institution in this competition. An institution proposing research in several groups should submit a single MRSEC proposal with multiple Interdisciplinary Research Groups (IRGs). A MRSEC proposal must contain a minimum of 2 IRGs and a maximum of 3 IRGs. The IRGs in a Center may be thematically related, or they may address different aspects of materials science typically supported by DMR. A single Center at an organization allows efficient usage of resources, including common infrastructure, and better coordination of education and other activities of the Center.

Institutions that were awarded a MRSEC in the FY 2020 competition as the lead institution are **not** eligible to submit a MRSEC proposal as a lead institution in this competition.

MRSEC full proposals may be submitted by invitation only.

Limit on Number of Proposals per PI or co-PI: 1

An individual may be the Principal Investigator (PI) or co-PI for only one preliminary proposal, i.e., no investigator, PI or co-PI, can be listed on the NSF proposal Cover Sheet on more than one proposal.

Additional Eligibility Info:

US IHEs with broad research and education programs in the area of condensed matter physics, solid state and materials chemistry, materials science and engineering, biomaterials and biophysics, and related areas of science and engineering may submit ***preliminary proposals***.

In order to reduce the burden of proposal writing for the materials research community and the burden of subsequent proposal review and evaluation for reviewers and NSF staff, NSF will accept ***full proposals*** for MRSECs ***by invitation only***, based on the results of the preliminary proposal evaluation.

While more than one organization may participate in a single proposal or preliminary proposal, one organization must accept overall management responsibility for the proposal. A single organization may

not be the lead organization in more than one preliminary proposal. An individual may be the Principal Investigator (PI) or co-PI for only one preliminary proposal. No investigator, PI or co-PI, can be listed on the NSF proposal Cover Sheet on more than one proposal.

Separately submitted collaborative proposals are not allowed.

V. Proposal Preparation And Submission Instructions

A. Proposal Preparation Instructions

Preliminary Proposals *(required)*: Preliminary proposals are required and must be submitted via the NSF FastLane system, even if full proposals will be submitted via Grants.gov.

It is important that preliminary proposals conform to the instructions provided in this solicitation and the *Proposal and Award Policies and Procedures Guide, PAPPG*. Conformance with all preparation and submission instructions is required. NSF may return without review proposals that are not consistent with these instructions.

I. **MRSEC Preliminary Proposals *(required):***

1. **NSF Cover Sheet.** Proposers are reminded to identify this program solicitation number in the program announcement/solicitation block of the NSF Cover Sheet, and to select "Materials Rsch Sci and Eng Cent" from the FastLane organization unit pull-down list. Make sure to select the "Preliminary Proposal" checkbox. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Enter $2 in the requested amount box. Failure to submit this information may delay processing.
2. **Project Summary.** The Project Summary of a MRSEC proposal needs to contain the following three components: (a) in the Overview - the rationale for establishing the Center and the anticipated associated synergies; (b) in the statement on Intellectual Merit – a brief description of the proposed interdisciplinary research groups, including their intellectual merit; and (c) a statement on the broader impacts of the proposed activities such as research, education/outreach, broadening participation, shared facilities, and collaborations. **Limit: 1 page.**
3. **Table of Contents**. Will be generated automatically by FastLane.
4. **Project Description.** Include ONLY the following:
    a. *A list of MRSEC investigators: these are faculty* (faculty rank and/or equivalent) listed by full name, organizational and departmental affiliation, and major role in the proposed center (e.g., IRG 1, IRG 2, education). This list should include: (i) Primary Participants: receiving NSF-MRSEC support; (ii) Primary Collaborators: affiliates from National Laboratories or International affiliates. Primary Participants and Primary Collaborators are individuals that will play a continuous crucial role in the Center; and (iii) Secondary Participants: not receiving NSF-MRSEC support and not playing a central role. **Limit: 1 page.**
    b. *Achievements under recent NSF support.* Collaborative research and education activities funded by NSF should be an emphasis in this section. Re-competing MRSECs must describe research and other achievements from the previous MRSEC support. If desired, collaborative research activities funded by other agencies may be included. In addition, if any PI or co-PI listed on page 1 of the **NSF Cover Sheet** has received NSF funding with an end date in the past five years, information on the award is required. Each PI and co-PI who has received more than one award must report on the award most closely related to the proposal. Do not describe awards of Primary Participants not appearing on page 1 of the NSF proposal Cover Sheet. **Limit: 2 pages.**
    c. *Introduction.* State rationale and the vision of the MRSEC. In separate paragraphs identify the research, education, and diversity goals of the MRSEC. **Limit: 1 page.**
    d. *A description of each proposed area of multi-investigator, interdisciplinary research group (a minimum of 2 IRGs and a maximum of 3 IRGs)*. List names of faculty-level participants, as well as numbers of undergraduate students, graduate students and postdoctoral researchers in each group. Provide a concise description of the long-term research goals and intellectual focus and outline the planned

research activities. The need for an interactive, interdisciplinary approach involving several investigators, and the means of achieving this, should be clearly established. IRGs are sought that solve fundamental, timely and complex materials problems that are intellectually challenging and important to society. **Limit for each IRG: 3 pages**.

e. *Other significant activities* include: **Page limit for Section 4e: 4 pages**

i. *Education, human resource development, and diversity strategic plan.* Proposals should address a limited number of well-chosen education and outreach activities, and delineate a targeted roadmap to address a single, clear and measurable goal, with long-term verifiable impact that extends beyond the Center itself. The proposed roadmap should encompass the lifetime of the award (6 years), as well as a discussion of longer-term efforts. This section should describe the Center's strategic plan to broaden participation at all levels, the metrics that will be established to measure progress made, and the desired outcomes for the 6-year award period and beyond. To allow students from outside the MRSEC to benefit from the breadth of the MRSEC opportunities, a Research Experiences for Undergraduates (REU) program with at least 50% off campus participation is required. The MRSEC REU program will be funded through the MRSEC award; no separate REU proposal is required. In addition, MRSECs are expected to demonstrate a significant inclusion of underrepresented groups (e.g., women, African Americans, Hispanics, Native Americans, Pacific Islanders, and persons with disabilities) as Center participants.

ii. *Collaborations with industry, national laboratories, and other sectors.* Describe plans for significant intellectual and resource exchange, cooperation, and partnership with other organizations including but not limited to academic organizations, industry, international institutions and organizations, national laboratories, non-profit organizations, federal, state, and local governments and others.

iii. *Leadership, administration and management* of the Center. Describe the Center management team and provide an outline of the proposed arrangements for the integrated Center management structure. In addition, briefly describe the criteria and mechanisms for selecting and evaluating seed projects.

5. **References Cited.** List only references cited in the Project Description. See the PAPPG for format instructions. **Noncompliance with NSF PAPPG guidelines may result in the preliminary proposal being returned without review.**
6. **Biographical Sketches.** For the preliminary proposal, a biographical sketch is required for the PIs/co-PIs listed on the NSF Cover Sheet only (a maximum of 5 biographical sketches); biographical sketches for other senior personnel are NOT required or allowed. **Noncompliance with NSF PAPPG format guidelines may result in the preliminary proposal being returned without review. Limit: 3 pages for each biographical sketch.**

Single Copy Documents:

Collaborators & Other Affiliations Information:

Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG.

Requested Additional Information:

Suggested Reviewers. Submit a list of individuals who may be suitable to act as impartial reviewers as a Single Copy Document. Include their names, affiliations, phone numbers, e-mail addresses, and areas of expertise (or IRG#); make sure they don't also appear in the collaborators list.

Also, immediately after submission of the preliminary proposal, please send via e-mail to mrsec@nsf.gov the following:

- A pdf file with the filename: preproposal #_institution_COI (replacing institution with university name). A combined list of full names of: collaborators/co-authors within the past 4 years; co-editors within the past 2 years; graduate

advisor(s); postdoctoral advisor(s); postdoctoral scholars within the past 4 years; and all prior graduate students. This list is for all Primary Participants as defined in Sections 4.a.i and 4.a.ii.

- Proposers who provided a list of suggested reviewers are also requested to submit a pdf file with the filename: preproposal #_institution_ reviewers. This list should include suggested reviewers for each individual IRG with the following 9 columns: last name, first name, middle initial, institution, department, phone number, e-mail address, expertise, IRG(s). Proposers may also include a short list of reviewers not to use if they so wish.

Please make sure that these pdf files are searchable.

No additional material is required or accepted with the preliminary proposal submission. *Budget, Current and Pending Support, Facilities, Equipment and Other Resources, Post-Doctoral Mentoring Plan, and Data Management Plan* sections are not required or accepted.

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF *Grants.gov Application Guide*: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/bfa/dias/policy/docs/grantsgovguide.pdf). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

See Chapter II.C.2 of the PAPPG for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

II. MRSEC Full Proposal Preparation Instructions: A full proposal may be submitted only by invitation. Invitations will be communicated by no later than mid-October based on individual IRG recommendations. A minimum of 2 recommended IRGs is required for a Full proposal invitation.

The standard PAPPG or NSF Grants.gov Application Guide instructions for proposal preparation apply, with the following modifications.

1. **NSF Cover Sheet.** Proposers are reminded to identify this program solicitation number in the program announcement/solicitation block of the NSF Cover Sheet, and to select "Materials Rsch Sci and Eng Cent" from the FastLane organization unit pull-down list. Grants.gov Users: The program solicitation number will be pre-populated by Grants.gov on the NSF Grant Application Cover Page. Grants.gov users should refer to Section VI.1.2. of the NSF PAPPG for specific instructions on how to designate the NSF Unit of Consideration. Make sure that the button asking "If This Is A Preliminary Proposal ..." is UNCHECKED; also make sure to enter your preliminary proposal number in the box asking "Show Related Preliminary Proposal Number If Applicable."

2. **Project Summary.** The Project Summary of a MRSEC proposal needs to contain the following three components: (a) in the Overview - the rationale for establishing the Center and the anticipated associated synergies; (b) in the statement on Intellectual Merit – a brief description of the proposed interdisciplinary research groups, including their intellectual merit; and (c) a statement on the broader impacts of the proposed activities such as research, education/outreach, broadening participation, shared facilities, and collaborations. **Limit: 1 page.**
3. **Table of Contents.** Generated automatically by the system.
4. **Project Description.** Include the following:
    a. A list of MRSEC investigators; these are faculty (faculty rank and/or equivalent) listed by full name, organizational and departmental affiliation, and major role in the proposed center (e.g., IRG 1, IRG 2, education). This list should include: (i) Primary Participants: receiving NSF-MRSEC support; (ii) Primary Collaborators: affiliates from National Laboratories or International affiliates. Primary Participants and Primary Collaborators are individuals that will play a continuous crucial role in the Center; and (iii) Secondary Participants: not receiving NSF-MRSEC support and not playing a central role. **Limit: 1 page.**
    b. *Achievements under recent NSF support*. Collaborative research and education activities funded by NSF should be an emphasis in this section. Re-competing MRSECs must describe research and other achievements from the previous MRSEC support. If desired, collaborative research activities funded by other agencies may be included. In addition, if any PI or co-PI listed on page 1 of the **NSF Cover Sheet** has received NSF funding with an end date in the past five years, information on the award is required. Each PI and co-PI who has received more than one award must report on the award most closely related to the proposal. Do not describe awards of Primary Participants not appearing on page 1 of the NSF proposal Cover Sheet. **Limit: 5 pages**.
    c. *Introduction and strategic plan*. Provide a clear vision for and description of the proposed MRSEC and its potential scientific, technological, and societal impacts. Briefly describe the organizational setting of the Center, its proposed scope and organization, activities in research and education and their integration, development of human resources, shared research facilities, collaborative activities with industry, national laboratories, and others. Outline how the MRSEC plans to achieve the goals, the process and metrics used to monitor progress, and the mechanisms of assessment. **Limit: 4 pages.**
    d. *Interdisciplinary research groups* (a minimum of 2 IRGs and a maximum of 3 IRGs). For each IRG proposed, provide a concise description of the long-term research goals and intellectual focus, and describe the planned research activities in sufficient detail to enable the assessment of their scientific merit and significance. Describe the role and intellectual contribution of each primary participant in the IRG, and briefly outline the resources available or planned to accomplish the research goals (it will be helpful to boldface the name of each primary participant wherever it occurs). The need for an interactive, interdisciplinary approach involving several investigators, and the means of achieving this, should be clearly established. Place the IRG in the context of the Center as a whole and describe interactions with other groups and organizations. At the beginning of each IRG section in the proposal, name the MRSEC investigators that will contribute to this IRG; also, estimate the total number of undergraduate students, that of graduate students and of postdoctoral researchers that will participate in the IRG. **Limit for each IRG: 10 pages.**
    e. *Other significant activities include*: **Page Limit for Section 4e: 10 pages**
        i. *Seed funding.* Describe the criteria and mechanisms for selecting and evaluating seed projects. Do not identify specific projects, only the request for projects, and the review and evaluation processes.
        ii. *Education and human resources development.* Proposals should address a limited number of well-chosen education and outreach activities, and delineate a targeted roadmap to address a single, clear and measurable goal, with long-term verifiable impact that extends beyond the Center itself. The proposed roadmap should encompass the lifetime of the award (6 years), as well as a discussion of longer-term efforts. This section should describe the Center's strategic plan to broaden participation at all levels, the metrics that will be established to measure progress made,

and the desired outcomes for the 6-year award period and beyond. To allow students from outside the MRSEC to benefit from the breadth of the MRSEC opportunities, a Research Experiences for Undergraduates (REU) program with at least 50% off campus participation is required. The MRSEC REU program will be funded through the MRSEC award; no separate REU proposal is required. When preparing the budget for the MRSEC REU program, proposers must follow NSF REU budget guidelines; see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517&org=NSF for specifics.

iii. *Diversity strategic plan.* MRSECs are expected to demonstrate a significant commitment to the involvement of underrepresented groups (e.g., women, underrepresented minorities, persons with disabilities) as Center participants (MRSEC leaders, faculty participants, undergraduate and graduate students, and postdoctoral researchers). Describe the Center's strategic plan to broaden participation at all levels, the metrics that will be used to measure progress, and the desired outcome for the 6 year award period.

iv. *Shared facilities.* Describe the existing shared experimental and computational facilities and those to be established, including specific major instrumentation, and plans for the development of instrumentation. Describe plans for maintaining and operating the facilities, including staffing, provision for user fees, and plans for ensuring access to outside users. Distinguish clearly between existing facilities and those still to be developed. Describe proposed contribution to a network of materials research facilities in the United States.

v. *Collaboration with industry, national laboratories, and others.* Describe plans for significant intellectual and resource exchange, cooperation, and partnership with other organizations that may involve academic organizations, industry, national laboratories, non-profit organizations, federal, state, and local governments, international organizations, and others. Define the goals of the collaboration; describe the planned activities and expected outcomes. Describe the roles of the primary participants, the mechanisms planned to stimulate and facilitate knowledge transfer, and the potential long-term impact of the collaborations.

vi. *Management.* Describe the plans for administration of the Center, including the functions of key personnel and the role of any advisory committee, executive committee, and/or program committee or their equivalent. Describe the procedures and criteria used to select, administer, and evaluate the Interdisciplinary Research Groups and other research programs of the Center, including collaborative programs with other groups and organizations. Plans for administering the seed funding, educational activities, and shared experimental facilities should be described under items (4e.i), (4e.ii), and (4e.iv), respectively.

vii. *Organizational and other sector support.* Provide a description of the resources that the organization will provide to the project, should it be funded. Resources such as space, faculty release time, faculty and staff positions, capital equipment, access to existing facilities, collaborations, and support of outreach programs should be discussed, but not given as dollar equivalents.

f. *Summary Table of Requested NSF Support.* In tabular form as follows, summarize the overall support levels planned for each of the major activities of the MRSEC. For each entry in the table include direct and indirect costs. Column totals must equal the total budget requested from NSF for the period shown. Include major capital equipment under shared facilities. **Support for graduate students should normally be included under research, not under education and human resources**

SUMMARY TABLE OF REQUESTED NSF SUPPORT ($k)

ACTIVITY	YEAR 1	%	6-YEAR TOTAL	%
IRG 1 (Title)				
IRG 2 (Title)				
IRG 3 (Title)				
Seed Funding and Emerging Areas				
Total Research (IRGs + Seeds)				
Shared Facilities				
Education and Human Resources				
Collaboration with Industry and Other Sectors				
Administration				
Total		100		100

Participant number table:

PROPOSED NUMBER OF PARTICIPANTS (First 3 Years)

Number	YEAR 1	YEAR 2	YEAR 3
Primary Participants			
National Labs and International Participants			
Secondary Participants			
Primary Participants Requesting Salary Support			
Postdoctoral Researchers			
Graduate Students			
REU Students			

Technical Support Staff			
Administrative Support Staff			

Complete the following subaward table only if any subaward is proposed:

SUBAWARD ($k)

Number	YEAR 1	6-YEAR TOTAL
Subawardee Institution 1		
Subawardee Institution 2 (repeat as needed)		
TOTAL		

5. **References Cited.** List only references cited in the Project Description. See the PAPPG for format instructions. **Noncompliance with NSF guidelines may result in the full proposal being returned without review.**
6. **Biographical Sketches.** A biographical sketch (**limited to three pages**) is required for each individual designated as Senior Personnel, including each investigator listed in Sections 4.a.(i) and 4.a.(ii). No additional biographical sketches may be included. See the PAPPG for format instructions. **Noncompliance with NSF PAPPG guidelines may result in the full proposal being returned without review.**
7. **Budget pages and budget justification.** Complete budget pages for each year of support (1-6). A six-year cumulative budget will be automatically generated by NSF's electronic systems. Provide a six-year summary budget justification that may not exceed a total of 5 pages. The budget must include travel costs associated with attendance by the PI/co-PIs to the Annual MRSEC Directors Meeting usually held at NSF. Provide separate budget pages for the lead institution and for each organization receiving a subaward. Provide a separate budget justification, up to five pages, for each subaward. Do not list personnel with zero support on the budget page; FastLane will not allow proposal submission with personnel listed with zero support. See PAPPG for further instructions.
8. **Current and Pending Support.** List current and pending support only for each individual designated as Senior Personnel, including the Primary Participants listed in Section 4.a.(i).
9. **Facilities, Equipment and Other Resources.** Upload a document or insert text that states "See Project Description."

   In accordance with the guidance provided in the PAPPG, please submit the following required:

10. **Supplementary Documentation**
    - **Postdoctoral Researcher Mentoring Plan,** if applicable.
    - **Data Management Plan**. This solicitation supports the emerging area of data-intensive computational and theoretical materials research. Investigators are strongly encouraged to think through the process of digital data creation and develop practices and a plan for sharing digital data. The Data Management Plan should discuss how digital data created through the project will be made findable, accessible, interoperable, and reusable, as appropriate for the project and the created data. The Data Management Plan should be responsive to the guidance presented at the **Division of Materials Research** link under

Requirements by Directorate, Office, Division, Program, or other NSF Unit, at https://www.nsf.gov/bfa/dias/policy/dmp.jsp. *It is a reasonable expectation that digital data supporting published work will be freely available without request within a reasonable time from publication.* Proposers are reminded that reviewers will also be asked to review the Data Management Plan, as appropriate

- **Letters of Collaboration:** Include only official letters of collaboration (see below). Scan your signed letters and upload them to the proposal, but do not send originals.

Letters of support should not be submitted, as they are not a standard component of an NSF proposal. Letters of collaboration, limited to stating the intent to collaborate and not containing endorsements or evaluation of the proposed project, are allowed. Letters of collaboration should follow the single-sentence format:

"If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by the NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description."

Departure from this format may result in the proposal being returned without review. The Project Description should document the need for and nature of collaborations, such as intellectual contributions to the project, permission to access a site, an instrument, or a facility, offer of samples and materials for research, logistical support to the research and education program, or mentoring of U.S. students at a foreign site. *Up to five letters of collaboration are allowed. Only one letter per page*. **Limit: 5 pages.**

11. **Single Copy Documents: Collaborators & Other Affiliations Information.** Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG. Submitters using Grants.gov may upload this document as a PDF.

    Requested Additional Information:

    *Suggested Reviewers***.** Submit a list of individuals who may be suitable to act as impartial reviewers as a Single Copy Document. Include their names, affiliations, phone numbers, e-mail addresses, and areas of expertise (or IRG#); make sure they don't also appear in the collaborators list. Also, immediately after submission of the preliminary proposal, please send via e-mail to mrsec@nsf.gov the following:

    - A pdf file with the filename: preproposal #_institution_COI (replacing institution with university name). A combined list of full names of: collaborators/co-authors within the past 4 years; co-editors within the past 2 years; graduate advisor(s); postdoctoral advisor(s); postdoctoral scholars within the past 4 years; and all prior graduate students. This list is for all Primary Participants as defined in Sections 4.a.i and 4.a.ii.
    - Proposers who provided a list of suggested reviewers are also requested to submit a pdf file with the filename: preproposal #_institution_ reviewers. This list should include suggested reviewers for each individual IRG with the following 9 columns: last name, first name, middle initial, institution, department, phone number, e-mail address, expertise, IRG(s). Proposers may also include a short list of reviewers not to use if they so wish.

Please make sure that these pdf files are searchable.

No additional material is required or accepted with the full proposal submission.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Awards are expected to range in amount from approximately $3 million/year for a 2-IRG MRSEC to a maximum of $4.5 million/year for a 3-IRG MRSEC.

C. Due Dates

- **Preliminary Proposal Due Date(s)** ***(required)*** (due by 5 p.m. submitter's local time):

  June 21, 2022

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  November 22, 2022

  By invitation only

D. FastLane/Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the NSF Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The NSF Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: https://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF Proposal Processing And Review Procedures

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior

NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and other underrepresented groups in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

In addition to the National Science Board merit review criteria, MRSEC proposals have additional review criteria. Given competing proposals of essentially equal merit, NSF staff will be responsible for ensuring that the overall program reflects an appropriate balance among research topics and among centers of differing size and complexity. Preliminary proposals will be evaluated in terms of their potential to meet the criteria for full proposals.

MRSEC proposals will be evaluated in terms of the IRGs and of the Center as a whole, using the following additional criteria:

A. Interdisciplinary Research Groups: (Used in evaluating preliminary and full proposals)

i. Does the IRG describe a well-integrated research program distinguished by intellectual excellence and driven by a clear vision leading to fundamental advances, new discoveries, and/or technological developments that could have national and international significance?

ii. Are the capabilities of the investigators, technical soundness of the proposed approach, and adequacy of the resources (available or proposed), including instrumentation and facilities appropriate for a Center?

iii. Are the benefits of a multi-investigator, interdisciplinary approach to address a major topic or area normally supported by the Division of Materials Research for each IRG clearly laid out? Does cooperation and interdependence of the investigators within the IRG come across?

iv. Is the work of a scope and complexity that requires Center support?

v. Is the IRG addressing cutting-edge science?

B. The Center as a Whole: (Used in evaluating full proposals)

i. Is the organizational setting and rationale for the Center justified?

ii. Is there potential for stimulating multidisciplinary interactions and collaborations on campus? Is there potential for organizational, national, and international impacts?

iii. Are education/outreach activities consistent with the Center's size? Does the proposed MRSEC research appear well-integrated with the education activities?

iv. Does the MRSEC foster increased participation in materials research and education of members of underrepresented groups in science and engineering at all academic levels (faculty, postdoctoral researchers, and students)?

v. Is the Data Management Plan appropriate, both for the type of data anticipated and for the kind of project proposed? In some cases, a detailed data management plan may not be required; however, in this case, the Data Management Plan must ***include a compelling and proposal-specific justification.***

vi. The Data Management Plan should be responsive to the guidance presented at the **Division of Materials Research** link under **Requirements by Directorate, Office, Division, Program, or other NSF Unit**, at https://www.nsf.gov/bfa/dias/policy/dmp.jsp. Does the Data Management Plan effectively convey that digital data supporting published work will be freely available within a reasonable time from publication, without the need for request to the investigator, and in a way that the data is findable, accessible, interoperable, and reusable?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Reverse Site Review.

Preliminary proposals will be reviewed by topical panels; ad-hoc mail review will be utilized for the review of the invited Full proposals. A panel of experts will be in attendance at the Reverse Site Visit Panels that will be held starting in late February or early March 2023 at NSF.

Based on the Full proposal review, Reverse Site Visit Panel invitations will be communicated in late January 2023.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. Award Administration Information

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF

Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, Ensuring the Future is Made in All of America by All of America's Workers (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's Build America, Buy America webpage.

Special Award Conditions:

Special award conditions for MRSECs will be within the cooperative agreement.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Center-specific annual progress reports and continuation requests are required with special formatting for use in MRSEC reports and for longitudinal comparisons. Those additional reporting requirements will be referenced in the cooperative agreement.

VIII. Agency Contacts

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Serdar Ogut, MPS/DMR, telephone: (703) 292-4429, email: sogut@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- NSF Help Desk: 1-800-381-1532 Research.gov Help
- Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a con. rmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. Other Information

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at https://www.grants.gov.

About The National Science Foundation

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.
To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-8143
- **To Locate NSF Employees:** (703) 292-5111

Privacy Act And Public Burden Statements

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

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Policy Office, Division of Institution and Award Support

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