

# EMERGING FRONTIERS IN RESEARCH AND INNOVATION 2013 (EFRI-2013)

1. Flexible Bioelectronics Systems (BioFlex)
  2. Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)
  3. Photosynthetic Biorefineries (PSBR)
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## PROGRAM SOLICITATION NSF 12-583

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### REPLACES DOCUMENT(S): NSF 11-571

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#### National Science Foundation

Directorate for Engineering  
Emerging Frontiers in Research and Innovation

Directorate for Mathematical & Physical Sciences  
Division of Mathematical Sciences  
Division of Materials Research

Directorate for Biological Sciences  
Division of Molecular and Cellular Biosciences



#### Air Force Office of Scientific Research

**Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):

September 06, 2012

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

October 10, 2012

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

February 08, 2013

## IMPORTANT INFORMATION AND REVISION NOTES

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### Important Reminders

A revised version of the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), [NSF 11-1](#), was issued on October 1, 2010 and is effective for proposals submitted, or due, on or after January 18, 2011. Please be advised that the guidelines contained in [NSF 11-1](#) apply to proposals submitted in response to this funding opportunity.

**Cost Sharing:** The PAPPG has been revised to implement the National Science Board's recommendations regarding cost sharing. Inclusion of voluntary committed cost sharing is prohibited. In order to assess the scope of the project, all organizational resources necessary for the project must be described in the Facilities, Equipment and Other Resources section of the proposal. The description should be narrative in nature and must not include any quantifiable financial information. Mandatory cost sharing will only be required when explicitly authorized by the NSF Director. See the PAPP Guide Part I: *Grant Proposal Guide (GPG) Chapter II.C.2.g(xi)* for further information about the implementation of these recommendations.

**Data Management Plan:** The PAPPG contains a clarification of NSF's long standing data policy. All proposals must describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans. FastLane will not permit submission of a proposal that is missing a Data Management Plan. The Data Management Plan will be reviewed as part of the intellectual merit or broader impacts of the proposal, or both, as appropriate. Links to data management requirements and plans relevant to specific Directorates, Offices, Divisions, Programs, or other NSF units are available on the NSF website at: <http://www.nsf.gov/bfa/dias/policy/dmp.jsp>. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

**Postdoctoral Researcher Mentoring Plan:** As a reminder, each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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#### Program Title:

Emerging Frontiers in Research and Innovation (EFRI)

1. Flexible Bioelectronics Systems (BioFlex)
2. Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)
3. Photosynthetic Biorefineries (PSBR)

#### Synopsis of Program:

The Directorate for Engineering at the National Science Foundation has established the Office of Emerging Frontiers in Research and Innovation (EFRI) to serve a critical role in focusing on important emerging areas in a timely manner. This solicitation is a funding opportunity for interdisciplinary teams of researchers to embark on rapidly advancing frontiers of fundamental engineering research. For this solicitation, we will consider proposals that aim to investigate emerging frontiers in the following three specific research areas:

1. Flexible Bioelectronics Systems (BioFlex),
2. Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI), and
3. Photosynthetic Biorefineries (PSBR).

This solicitation will be coordinated with the Directorate for Mathematical & Physical Sciences and the Directorate for Biological Sciences within NSF. Additionally, interest within other Federal agencies, specifically Air Force Office of Scientific Research (AFOSR), may lead to an interagency effort in support of certain PSBR and ODISSEI projects. Proposals submitted under the PSBR and ODISSEI topics may be shared with interested representatives from AFOSR.

EFRI seeks proposals with transformative ideas that represent an opportunity for a significant shift in fundamental engineering knowledge with a strong potential for long term impact on national needs or a grand challenge. The proposals must also meet the detailed requirements delineated in this solicitation.

**INFORMATION WEBCAST: The EFRI Office held an information workshop on September 22, 2011 to discuss EFRI programs and answer questions about the solicitation. Since the topics are repeated for FY 2013, the information on the Webcast remains current.**

Details are posted on the EFRI website ([www.nsf.gov/eng/efri](http://www.nsf.gov/eng/efri)).  
The Webcast can also be viewed directly by visiting: [tvworldwide.com](http://tvworldwide.com)

#### 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.*

- Sohi Rastegar, Director, Office of Emerging Frontiers in Research and Innovation (EFRI), 505, telephone: (703) 292-8305, email: [srastega@nsf.gov](mailto:srastega@nsf.gov)
- Garie Fordyce, Program Manager, Office of Emerging Frontiers in Research and Engineering, telephone: (703) 292-4603, email: [gfordyce@nsf.gov](mailto:gfordyce@nsf.gov)
- TOPIC 1: Flexible Bioelectronics Systems, (BioFlex), telephone: 703-292-8339, email: [uvarshne@nsf.gov](mailto:uvarshne@nsf.gov)
- Usha Varshney, BioFlex Coordinator / Program Director, NSF/ENG/ECCS, telephone: (703) 292-8339, email: [uvarshne@nsf.gov](mailto:uvarshne@nsf.gov)
- Leon Esterowitz, Program Director, NSF/ENG/CBET, telephone: (703) 292-7942, email: [lesterow@nsf.gov](mailto:lesterow@nsf.gov)
- TOPIC 2: Origami Design for Integration of Self- assembling Systems for Engineering Innovation (ODISSEI), telephone: see below, email: [ccooper@nsf.gov](mailto:ccooper@nsf.gov)
- Clark Cooper, ODISSEI Coordinator / Program Director, NSF/ENG/CMMI, telephone: (703) 292-7899, email: [ccooper@nsf.gov](mailto:ccooper@nsf.gov)
- Christina L. Bloebaum, Program Director, NSF/ENG/CMMI, telephone: (703) 292-8611, email: [cbloebau@nsf.gov](mailto:cbloebau@nsf.gov)
- TOPIC 3: Photosynthetic Biorefineries (PSBR), PSBR Coordinator / Program Director, NSF/ENG/CBET, telephone: 703-292-4997, email: [gantos@nsf.gov](mailto:gantos@nsf.gov)
- George Antos, Program Director, NSF/ENG/CBET, telephone: (703) 292-4997, email: [gantos@nsf.gov](mailto:gantos@nsf.gov)
- Bruce K. Hamilton, Program Director, NSF/ENG/CBET, telephone: (703) 292-8320, email: [bhamilto@nsf.gov](mailto:bhamilto@nsf.gov)
- Ram Gupta, Program Director, NSF/ENG/CBET, telephone: (703) 292-2407, email: [ragupta@nsf.gov](mailto:ragupta@nsf.gov)

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

- 12.800 --- Air Force Office of Scientific Research
- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.074 --- Biological Sciences

### Award Information

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**Anticipated Type of Award:** Standard Grant

**Estimated Number of Awards:** 12 to 16 (4-year awards)

**Anticipated Funding Amount:** \$32,000,000 in FY 2013, pending the availability of funds.

## Eligibility Information

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### Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

### PI Limit:

Principal Investigators (PI) must be at the faculty level as determined by the submitting organization. A minimum of one PI and two co-PIs must participate.

### Limit on Number of Proposals per Organization:

None Specified

### Limit on Number of Proposals per PI: 1

The principal investigator and co-principal investigators may participate in only one proposal submitted to this solicitation. It is the responsibility of the submitting institution to ensure that the PI and all co-PIs are participating in only one proposal submitted to this solicitation.

## Proposal Preparation and Submission Instructions

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### A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **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, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=gpg](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg).
  - 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: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](http://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:** Not Applicable

### C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
September 06, 2012
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
October 10, 2012
- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):  
February 08, 2013

## Proposal Review Information Criteria

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**Merit Review Criteria:** National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

## Award Administration Information

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**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.

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## I. INTRODUCTION

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The Office of Emerging Frontiers in Research and Innovation (EFRI) provides funding opportunities for interdisciplinary teams of researchers to embark on rapidly advancing frontiers of fundamental engineering research. EFRI seeks proposals with potentially transformative ideas that represent an opportunity for a significant shift in fundamental engineering knowledge with a strong potential for long term impact on national needs or a grand challenge. For this solicitation, EFRI will consider proposals that aim to investigate emerging frontiers in the following three specific research areas: (1) Flexible Bioelectronics Systems (BioFlex), (2) Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI), and (3) Photosynthetic Biorefineries (PSBR). The proposals must meet the detailed requirements delineated in this solicitation.

AFOSR is pleased to collaborate with NSF in the pursuance of revolutionary scientific breakthroughs related to Origami Design for the Integration of Self-assembling Systems for Engineering Innovation (ODISSEI) and Photosynthetic Biorefineries (PSBR). AFOSR program managers will collaborate with NSF in the review, selection and potential funding of proposals submitted under this solicitation. The Air Force Office of Scientific Research (AFOSR) manages the basic research investment for the U.S. Air Force (USAF). As a part of the Air Force Research Laboratory (AFRL), AFOSR's technical experts foster and fund research within the Air Force Research Laboratory, universities, and industry laboratories to ensure the transition of research results to support USAF needs. Using a carefully balanced research portfolio, research managers seek to create revolutionary scientific breakthroughs, enabling the Air Force and U.S. industry to produce world-class, militarily significant, and commercially valuable products. Proposers interested in learning more about AFOSR's mission and research interests should consult the AFOSR website, <http://www.wpafb.af.mil/afri/afosr/>.

Interest within the Air Force Office of Scientific Research (AFOSR) may lead to proposals submitted under the PSBR and ODISSEI topics being shared with interested representatives from AFOSR for co-funding consideration.

The Department of Energy (DOE) has interest in this solicitation but has made no financial commitments at this point due to budgetary constraints. DOE has interest in the PSBR area and will participate in the review. DOE may contribute funds if funds are available.

1. **Flexible Bioelectronics Systems (BioFlex)** - BioFlex represents a highly promising interdisciplinary research area that will provide unique opportunities for early detection, diagnosis, and delivery for healthcare applications. Hybrid BioFlex systems integrated with novel materials, sensors and devices resulting in new functionalities will have a profound influence on the future of personalized medicine, telemedicine, and healthcare delivery. BioFlex technologies with electronic circuits and devices on flexible substrates have the potential to meet future challenges by developing novel hybrid flexible *in vivo* and *ex vivo* biosystems that will further have the advantage of being biocompatible, resorbable, highly conformable, bendable, portable, light weight and low power consumption. Furthermore, such systems can potentially be scaled-up and manufactured at reduced costs using roll-to-roll and other manufacturing techniques. In addition, technologies that can provide remote monitoring of vital signs, such as blood pressure, heart rate, and blood-oxygen content, among others, can enhance the quality of life for the patient. The significance of such low-cost systems further lies in being potentially disposable and sterile leading to reduced hospital-acquired infections, thereby lowering healthcare costs. It is expected that transformative BioFlex research would have the long-term potential to enhance the quality of patient care, while reducing the total cost of healthcare delivery.
2. **Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)** - The central theme of the ODISSEI initiative is to explore the folding and unfolding of materials and structures at all scales and across scales in order to overcome obstacles associated with the rigorous design of engineered systems. Just as Homer's epic poem, *Odyssey*, relates Odysseus' long journey home following the fall of Troy, ODISSEI represents a journey into an emerging field of science and engineering that encourages the exploration of origami engineering for the design of self-assembling, multifunctional, compliant structures facilitated through the integration of active materials, design theory,

mathematics (geometric origami), and artistic expression. A fundamental understanding of how materials at different scales can be designed to be folded and unfolded, and the relation of such folding to self-assembly, will have tremendous impact in numerous areas of national priority. Such engineered systems would have application in the design of materials, compliant mechanisms, and structures, impacting critical industries including manufacturing, energy, and biomedicine.

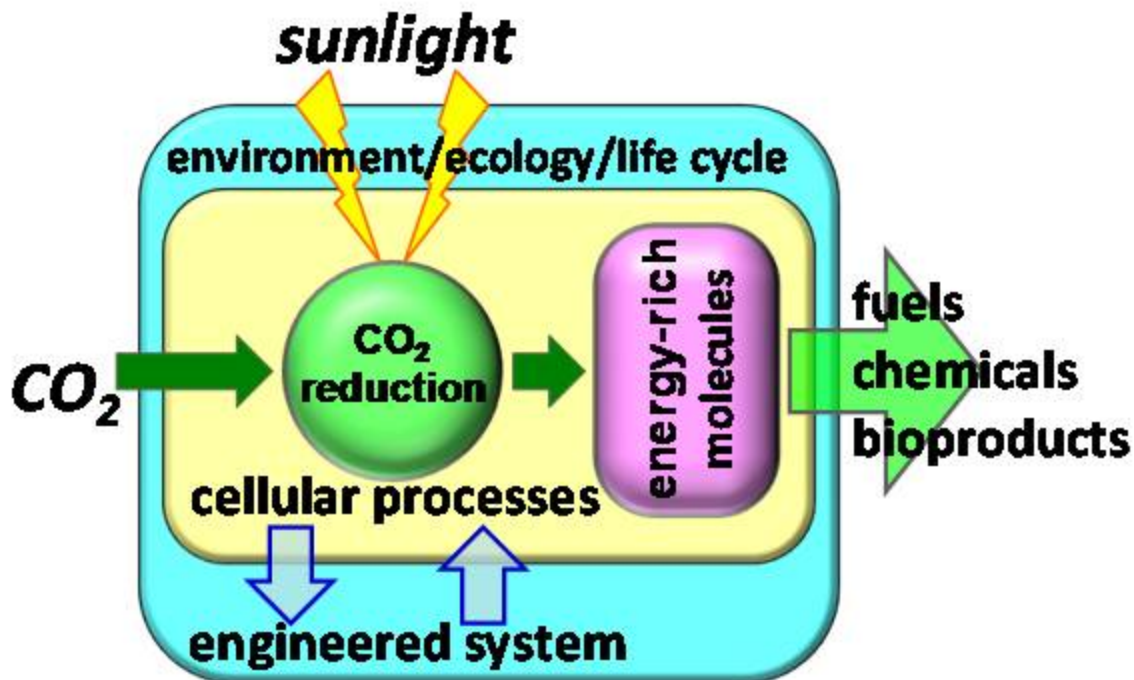
Traditionally, origami has been recognized as the art of paper folding. In recent decades, however, engineers, scientists, and mathematicians have used principles of folding in materials design to achieve substantially more complex shapes and products for applications spanning scales and disciplines, including automotive safety (e.g. airbags), biomedical device design (e.g. deployable heart stents), and DNA Origami for patterning. Origami structures can also be found in nature, such as in the growth process of plant leaves, providing possibilities for biomimicry. Present barriers to folding and unfolding mechanisms pertain to lack of understanding in scaling laws, the inability to easily reorient matter to achieve the desired folding and unfolding, the lack of understanding pertaining to smaller scale influence on larger scale compliance, and the lack of appropriate mathematics and tools to enable rigorous design of foldable engineered systems. Fundamental theories associated with folding and unfolding (in the sciences as well as mathematics) would enhance the ability to achieve rigorous designs for engineered systems and would have the potential to significantly advance numerous areas of national priority.

3. **Photosynthetic Biorefineries (PSBR)** -Achieving the sustainable production of transportation fuels and industrial chemicals will be one of the grand challenges of the 21st century. One direct route to achieve this end is to harness solar energy to drive the conversion of atmospheric carbon dioxide( CO<sub>2</sub>) and water into carbon-based fuels and chemicals. For example, photosynthetic processes in single-celled algae use sunlight as the energy source to reduce atmospheric CO<sub>2</sub> to energy-rich metabolites such as lipids or hydrocarbons, which can be reprocessed into diesel or gasoline or substitutes.

Within the vast diversity of phototrophic microorganisms in marine and terrestrial environments, there are a myriad of unique biocatalytic capacities to convert atmospheric CO<sub>2</sub> and water into a variety of complex and/or energy-dense compounds, including biofuels, commodity or specialty chemicals, or bio-products. This suggests that phototrophic microorganisms may serve as a platform for the sustainable "photosynthetic biorefinery" of the future. However, there are significant barriers and challenges to the realization of photosynthetic biorefineries, including:

- low volumetric productivity of phototrophic organisms in engineered systems,
- feasibility of large-scale bio-manufacturing platforms, particularly for biofuels,
- the sustainability of processes and systems, particularly with respect to water use, and their associated ecological, environmental, and societal implications.

This Frontier Topic, Photosynthetic Biorefineries, seeks to support interdisciplinary research that will explore new paradigms to break through the fundamental barriers currently facing the scale-up of sustainable photobiological processes for the production of fuels, chemicals, and bio-products from sunlight and atmospheric CO<sub>2</sub>. The key idea is to establish the scaling and control principles which unify molecular, cellular, and bio-manufacturing processes to efficiently deliver light and CO<sub>2</sub> to phototrophic microorganisms in scalable cultivation platforms, coupled to the engineering of primary and secondary metabolic pathways that harness photosynthetic processes to flexibly generate complex and/or energy-dense molecules (biofuels, commodity and specialty chemicals, and bio-products), taking into consideration the environmental and life cycle impacts of these processes, as envisioned in the Figure below.



The dual national needs of energy security and reduction of greenhouse gases implicated with climate change, as described in recent reports by the NSF National Science Board, the U.S. Department of Energy as well as the Obama Administration clean energy policy priorities, also drive the need for this EFRI Topic on Photosynthetic Bio-refineries.

#### ENHANCING DIVERSITY IN ENGINEERING - THE BROADENING PARTICIPATION PLAN

The Directorate for Engineering (ENG) promotes diversity in all aspects of its programs. In keeping with ENG's priority to broaden the participation of underrepresented groups(see detailed definition below) in Engineering, the Office of Emerging Frontiers in Research and Innovation is addressing the need to enhance diversity in all fields of Engineering by **requiring all EFRI projects to include a "Broadening Participation Plan"** as part of the EFRI 2013 Solicitation. One goal is to increase the participation of underrepresented groups in the field of engineering and in engineering research. This requirement will not only promote diversity in the human resources engaged in these EFRI projects but will also expand diversity of thought, ideas, and approaches brought

together by EFRI in defining and solving important research questions.

The term "underrepresented groups" refers to and includes the following: women, persons with disabilities, and ethnic and racial groups which are in the minority in engineering including African Americans, Hispanics, Native Americans, Alaska Natives, and Pacific Islanders.

**The Broadening Participation Plan** must be described as part of Broader Impacts of the proposal both in the Project Summary and in the Project Description. It may include, but is not limited to, any of the following menu of activities as appropriate for your project and the circumstances of your institution(s):

- PI, Co-PI, or other SENIOR PERSONNEL - Inclusion of persons from underrepresented groups as PI, co-PI, and/or other senior personnel, as appropriate for the project;
- STUDENT AND POST-DOCs - Inclusion of persons from underrepresented groups as graduate student, undergraduate student, and post-doctoral researchers;
- REU AND GRDS - A plan to apply for post-award supplements to engage undergraduate researchers, using REU supplement, and/or graduate researchers, using Graduate Research Diversity Supplement (see this [url](#) for related information from previous year) that are from underrepresented groups;
- MINORITY SERVING INSTITUTIONS - Engaging faculty and/or student researchers at minority serving institutions in the research project;
- COMMUNITY COLLEGES - Engaging faculty and/or student researchers at community colleges in the research project;
- RESEARCH EXPERIENCE FOR TEACHERS - A plan to apply for post-award supplements to engage teachers through the RET program;
- RESEARCH EXPERIENCE FOR HIGH SCHOOL STUDENTS - Provide research opportunities for members of underrepresented groups at the high school level;
- EXISTING INSTITUTIONAL PROGRAMS - Enhance/collaborate with existing diversity programs at your home institution and/or nearby institutions;
- MENTORING - Senior Personnel serve as role models and mentors for an underrepresented student population;
- TUTORING OPPORTUNITY - Provide tutoring opportunities for underrepresented middle school, high school, and undergraduate students;
- K-12 OUTREACH - Outreach activities that will interest and attract underrepresented K-12 students to engineering undergraduate programs.

The EFRI Office encourages the proposers to be creative in the planning of activities to attract and retain members of underrepresented groups to the fields of engineering and engineering research when developing their Broadening Participation Plans.

## II. PROGRAM DESCRIPTION

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The "Required Elements" listed below for each topic are expected to be addressed in both the preliminary proposals as well as in the full proposals.

### 1) Flexible Bioelectronics Systems (BioFlex)

This focused initiative seeks high-risk/high-return, interdisciplinary research proposals on innovative concepts in hybrid flexible bioelectronics systems for healthcare applications. Integrated intrinsic and hybridized flexible bioelectronics systems that can provide greatly increased functionality and the potential to meet future challenges of scalability, flexibility, low power consumption, light weight, and reduced cost are central to this initiative. The proposals should include a systems approach that encompasses several disciplines to address the scientific issues and technological challenges associated with the underpinnings of BioFlex systems based on electronic circuits and devices integrated on flexible substrates. Proposals should be based on transformative ideas that can potentially break new ground in the area of hybrid flexible bioelectronics systems (BioFlex). This BioFlex initiative is expected to bridge the gap between discovery and innovation by promoting transformative concepts to translational systems that include modeling and integration of novel materials, devices, and circuits in systems architectures.

Cooperative activities among academia, industry, and national laboratories as well as international collaborations are encouraged. International activities normally sponsored by the Office of International Science and Engineering (<http://www.nsf.gov/od/oise/about.jsp>) programs will be considered. International collaborations should include a letter of collaboration from international partners describing the nature and goals of their research, and synergies and benefits to be gained from such collaborations. Industrial partnerships including current or past SBIR/STTR grantees, following Grant Opportunities for Academic Liaison with Industry (GOALI) (<http://www.nsf.gov/pubs/2010/nsf10580/nsf10580.htm>) guidelines, are strongly encouraged. Proposals should also discuss effective ways in which education and outreach are integrated within the research program to achieve societal impacts.

BioFlex proposals may address, but are not limited to, the following subtopics:

**Subtopic-1) Science of Devices:** Proposals may include science that can advance the understanding of fundamental properties, functionalities, and performance of devices; theoretical and experimental aspects of charge transport in organic and inorganic thin film and nanowire structures-based devices; charge injection and transport related to defects, grain boundaries, crystallinity, and carrier mobility in flexible structures that serve as building blocks for BioFlex systems; challenges associated with integrating biocompatible and resorbable materials at a macro, micro and nano-scales; and electrodes. Study of materials leading to quantum leaps in device functionalities are of interest.

**Subtopic-2) Interfacial Engineering:** Proposals may contain engineering of surfaces and interfaces between materials (organic/inorganic/biological), devices and systems. Studies related to the understanding of interfaces between devices and tissue, cells, and biological fluids is of interest.

**Subtopic-3) Processing and Scaling-up Techniques:** Processing methodologies leading to advances in scalability, high throughput, and low-cost are also of interest. Novel interconnects concepts and biocompatible device packaging are of interest.

**Subtopic-4) Systems Engineering:** Potential challenges relating to system level integration of materials, devices, interconnects, circuits, power sources, data communication links, and packaging of *in vivo* and/or *ex vivo* BioFlex systems must be discussed.

### Required Flexible Bioelectronics Systems (BioFlex) Elements:

To advance the frontier topic of Flexible Bioelectronics Systems for healthcare applications, the research team expertise should cut across disciplines. The BioFlex proposals are required to address the following five BioFlex elements:

**BioFlex 1)** Either the PI and/or one of the Co-PIs on the proposal must be from the Bioengineering discipline.

**BioFlex 2)** Proposals sought under this solicitation must address a systems-level approach including modeling, simulation and integration of bioengineered system's components such as novel materials, devices, circuit architectures, interconnects, power sources, data communication links, and packaging, that can create major advances in state-of-the-art hybrid flexible electronic systems for healthcare applications. Proposals offering incremental advances in existing technologies are discouraged. Research should focus on critical, enabling engineering and fundamental scientific challenges that can create and sustain long-term growth of BioFlex applications.

**BioFlex 3)** Describe which aspect of the proposed BioFlex system is flexible or conformable.

**BioFlex 4)** Describe the energy/power source required for the proposed BioFlex system. It may include conventional or new energy-harvesting concepts.

**BioFlex 5)** Discuss the social, environmental, and economic implications of the proposed BioFlex system. The discussion may include the ultimate goal of producing significant benefits to society in terms of quality of life, while possibly lowering the total cost of healthcare delivery.

## **2) Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)**

The goal of ODISSEI is to achieve self-assembling, multifunctional, compliant structures that are enabled through the integration of active materials, design theory, compliant mechanisms, mathematics, and artistic expression. Insights from origami mathematics, artistic expression, topology optimization, and complex systems will provide inspiration for these integrated self-assembling systems.

Successful proposals will focus on one or more of the following four key themes listed below. It is recognized that there may be unique collaborations which promote research at the intersection of the ODISSEI themes.

**NOTE:** *The theme or themes being addressed should be clearly identified in the Letter of Intent as well as in the first line of the project summary in both the preliminary and full proposals.*

**Theme-1) Compliant Mechanisms:** Understanding the key factors contributing to structural compliance and its interaction to material properties provides numerous research challenges (e.g. through the use of tensegrity structures or any other basic concepts or constructs). A key idea here is to achieve a reduction in the number of parts necessary in a designed product (at any scale), through exploitation of folding and unfolding mechanisms. In order to rigorously design products with fewer and foldable parts, an understanding of the mathematical challenges and uncertainties associated with creases and folds must be achieved and modeled at different scales and, as appropriate, across scales. There are numerous opportunities for research teams in this area, which would span numerous industries and disciplines. For instance, topology optimization could be used to design a functionally graded multifunctional material system at the microscale and its upscaling could provide the macro compliant mechanism design. Another example of a possible research effort might involve exploring how folding and unfolding at smaller scales could influence compliance at larger scales to achieve a rigorously designed product with fewer and foldable parts. Such a project would have implications far beyond design, including manufacturing.

**Theme-2) Active Materials:** Fundamental understanding of how materials at different scales can be designed to be folded and unfolded through matter reorientation at creases and the relation of such folding to self-assembly can transform present design and manufacturing practice. In this context, there are intriguing opportunities to explore nonlinearities and time or rate-dependency for folding/unfolding mechanisms in smaller scales, which can be integrated with associated scaling laws. Opportunities for research teams that are interested in the application of origami concepts to active materials are myriad and include, for example, the folding and/or unfolding of matter on the molecular scale in such a way that materials are able to perform multiple tasks and those whose functionality and other behavior depend on chemical moieties and nearest neighbor interactions. It is possible that, using 2-D crystalline or amorphous sheets with precise surface patterning, folding can be triggered that transforms the 2-D sheets into simple and more complicated 3-D structures through surface tension effects or thermal treatment, including polyhedra. For instance, novel active materials could be developed so that thermo-chemo-electro-dynamic favorable origami polyhedral patterns could be developed which are essential for 3D pattern formation. In addition, the density of information that may be written to and retrieved from electronic storage devices is limited by the spacing and resolution of the lines and other features that are achievable. The use of origami to fold such patterned structures in preselected locations could enable an important transition to 3-D storage devices to yield significant augmentations to currently achievable information storage densities. These examples are intended to illustrate the breadth of research topics that could be appropriate for submission in response to this solicitation rather than to narrowly define or restrict proposal topics that appropriate for response.

**Theme-3) Bio-origami:** Several processes in biology rely on the relative position/orientation of interacting molecules or cells. Opportunities exist to explore patterning of 3D tissues by assembling different cells in the 3D matrix. Innovative uses of bio-origami may offer avenues to position cells in a 3D structure, which include challenges to make culture materials that can be sterilized, folded-up, maintain vasculature, etc. Other opportunities in the area of bio-origami include the exploration of designing and building 3D custom "DNA origami" objects (e.g. by means of molecular self-assembling) and their applications. For instance, nucleic acids, which are easily functionalized, provide a dramatic example of self-assembling biopolymers that can be harnessed to build circuitry or other devices. Another possible avenue of exploration in bio-origami pertains to the challenges of protein folding into stable configurations - an area that offers rich opportunities in both modeling and computation.

**Theme-4) Foldable Structures and Microstructures:** Possible avenues of exploration include the use of the art of origami and origami design to explore cognitive experiences associated with spatial transformations, computational modeling, and form finding for developing architecture of materials (e.g. negative Poisson's ratio) as well as innovative (large-scale) structural systems for buildings and bridges. At the lower spatial scales, the goal is to design microstructures with prescribed or improved properties not found in common materials. In this setting, a source of inspiration may be found in mathematical patterns and tessellations. At the higher scales, opportunities exist in either static or kinetic origami structures that are "green," in the sense that they are lightweight and compact, and can be easily recycled. These are alternative deployable structures that can be used in situations where man-made or natural disasters occur. In this scenario, the structure should be easily transported and deployed. Attention could be given to static and dynamic stability, cost, strength, weight (i.e. recognizing the need for minimum weight structures in this context), and ease of construction, deconstruction, and manufacturing. Of particular interest is scaling from micro- to macro- length-scales. For instance, could similar concepts be applied at different length scales (e.g. could a microstructure obtained by means of homogenization techniques be applicable at a larger scale). Answers may offer potentials for discovery of new and innovative structural systems.

### **Required Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI) Elements:**

To be considered for the ODISSEI EFRI program, proposals must be primarily centered on identifying and addressing the obstacles in the design of engineered systems that are enabled by folding and/or unfolding of materials (at any scale and across scales), and facilitated by origami engineering, mathematics, and the fine arts. Proposals must include one investigator from an appropriate engineering discipline. For proposals advancing origami design, at least one investigator must have research expertise in the appropriate design area. It is strongly encouraged that proposals include a participant from the fine arts, as we believe that true innovation in the identified areas of exploration and discovery associated with ODISSEI will best be spurred through artistic influence. It is strongly encouraged that proposals focusing on mathematical and computational discovery associated with folding and unfolding

of materials (and or structures) include an investigator with mathematics or computational expertise, as appropriate. The more competitive proposals will address two or more of the following ODISSEI elements:

**ODISSEI 1)** Development of scientific, mathematical, and/or design theories for folding and/or unfolding;

**ODISSEI 2)** Development of theoretical foundations for self-assembly at all scales and across scales; and

**ODISSEI 3)** Computational discovery and tools to facilitate design of engineered systems through folding and unfolding mechanisms.

**ODISSEI 4)** Dissemination of the scientific and engineering principles associated with folding and unfolding through community and educational outreach.

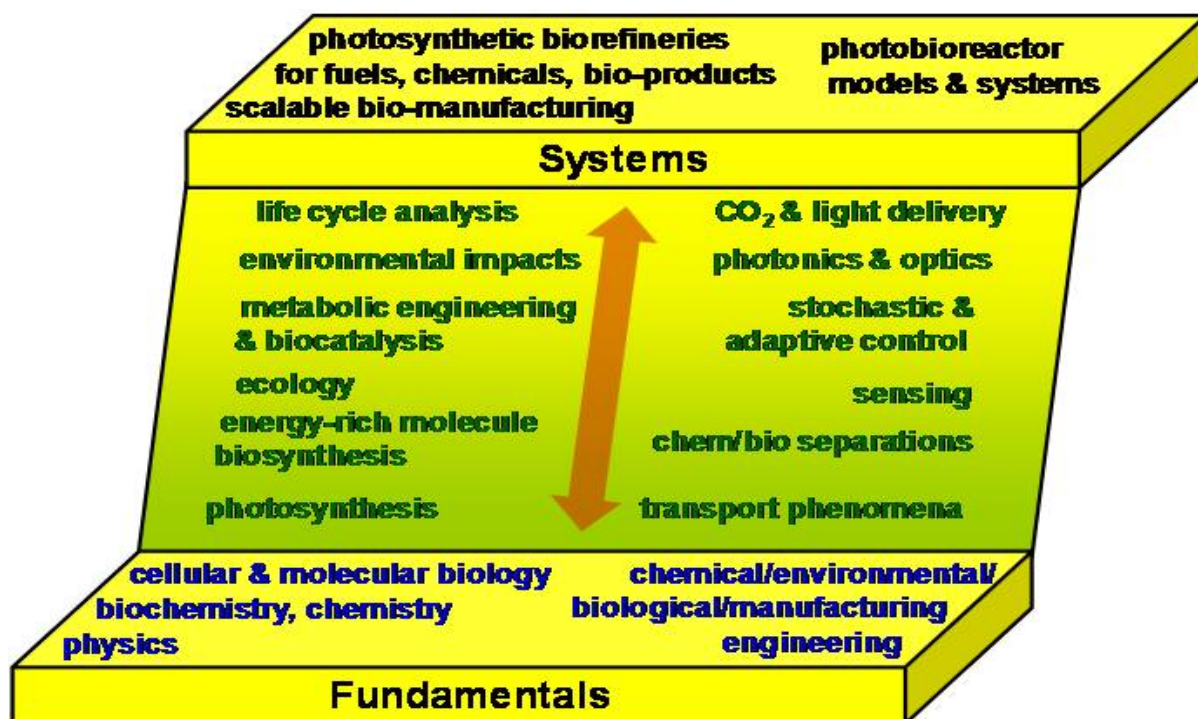
### 3) Photosynthetic Biorefineries (PSBR)

The overarching goal of this EFRI Topic is to establish the fundamental principles which efficiently deliver light and CO<sub>2</sub> to phototrophic microorganisms in scalable platforms for the sustainable and flexible production of fuels, chemicals, and bio-products.

The scale-up of photobiological processes is a multi-scale systems challenge that embraces the fundamentals of the biological and physical sciences as well as the engineering disciplines, and thus requires an interdisciplinary approach. The principles that unify molecular, cellular, and bio-manufacturing processes underlying the efficient delivery of light and CO<sub>2</sub> to phototrophic organisms in scalable cultivation systems are poorly understood. Additionally, there is no theoretical framework to support the rational development of this emerging technology. These engineered systems are inherently complex at large scale because they must capture both sunlight and CO<sub>2</sub> from a diffuse source and then direct and concentrate these inputs to the phototrophic microorganisms in an aqueous medium.

Furthermore, novel metabolic and bioprocess engineering strategies are needed to tailor primary and secondary pathways that harness photosynthesis to flexibly biosynthesize complex and/or energy-dense compounds, and facilitate their separation. These bio-manufacturing platforms must also accommodate the stochastic nature of living organisms that are the biocatalysts for fuels and chemicals production.

Finally, new approaches to the management and control of large-scale bio-manufacturing processes that utilize sunlight as a primary energy source and CO<sub>2</sub> as the primary carbon source, combined with the assessment of the environmental, ecological, and life cycle impacts of these processes, are needed to synergistically advance the science of sustainable bio-manufacturing processes that will enable the photosynthetic bio-refineries of the future bio-economy.



As shown in the Figure above, we envision that the most productive approach will involve two-way feedback, collaborations, and interactions to generate new discoveries and understanding. These interactions will be between researchers with knowledge of the processes, issues and requirements at the systems level and those with knowledge at the fundamental, basic science level. These interactions will embrace a variety of disciplines within the biological and physical sciences as well as engineering.

In summary, it is expected that investments in this EFRI topic will lead to new paradigms for the rational design, process intensification, and upscaling of sustainable biorefineries for the production of fuels, chemicals, and bio-products that use sunlight and atmospheric CO<sub>2</sub> as inputs. These investments will also advance the basic science of flexibly transforming CO<sub>2</sub> to complex and/or energy-rich molecules through metabolic processes in native or engineered phototrophic microorganisms.

#### Required Photosynthetic Biorefineries (PSBR) Elements:

To advance the frontier topic of sustainable Photosynthetic Biorefineries for the production of fuels, chemicals, and bio-products from CO<sub>2</sub> and sunlight, proposals must address the following five elements:

**PSBR 1)** Process concepts must be based on foundational knowledge, particularly in molecular and cellular biology, biochemistry, chemistry, physics, the engineering disciplines, and the environmental sciences. They must also explore new, innovative, and potentially transformative ideas for efficiently and flexibly transforming atmospheric CO<sub>2</sub> to complex and/or energy-rich molecules through metabolic processes in native or engineered microorganisms that harness sunlight as the energy source for CO<sub>2</sub> reduction in



scalable engineered systems.

**PSBR 2)** Process concepts must demonstrate new, innovative, and potentially transformative ideas for efficiently capturing CO<sub>2</sub> and sunlight in engineered systems, and may also consider novel strategies, ranging from the molecular to the bioprocess scale to tailor primary and secondary pathways that make complex and/or energy-dense compounds and facilitate their separation.

**PSBR 3)** Process concepts must demonstrate scalability from the molecular & cellular scale to the bioprocess scale, and should embrace a multi-scale systems approach that proposes new paradigms, as well as potentially transformative modeling & simulation approaches, for the rational upscaling and intelligent/adaptable control of bio-manufacturing platforms for fuels, chemicals, and bio-products that use sunlight and atmospheric CO<sub>2</sub> as inputs; these multi-scale systems approach should also emphasize feedback from the molecular & cellular scale to the bioprocess scale, and vice versa.

**PSBR 4)** Transformative and scalable process concepts must demonstrate the potential for future large scale deployment from economic, ecological, and life cycle perspectives, and pose no adverse environmental or societal impacts.

**PSBR 5)** Process concepts must demonstrate sustainability of natural resource utilization beyond CO<sub>2</sub> and sunlight, including water and raw materials.

### III. AWARD INFORMATION

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The 2013 EFRI awards will be Standard Grant awards. The anticipated number of awards is between 12-16 awards. The anticipated duration of all awards is 4-years. The anticipated funding amount for the EFRI Program is a total of \$32,000,000 in FY 2013, pending the availability of funds. The anticipated funding level for each project team may receive support of up to a total of \$2,000,000 spread over four years, pending the availability of funds. It is not expected that all awards will receive the maximum amount; the size of awards will depend upon the type of research program proposed. It should be noted that interest within other Federal agencies, specifically Air Force Office of Scientific Research (AFOSR), may lead to an interagency effort in support of certain PSBR and ODISSEI projects.

### IV. ELIGIBILITY INFORMATION

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#### Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

#### PI Limit:

Principal Investigators (PI) must be at the faculty level as determined by the submitting organization. A minimum of one PI and two co-PIs must participate.

#### Limit on Number of Proposals per Organization:

None Specified

#### Limit on Number of Proposals per PI: 1

The principal investigator and co-principal investigators may participate in only one proposal submitted to this solicitation. It is the responsibility of the submitting institution to ensure that the PI and all co-PIs are participating in only one proposal submitted to this solicitation.

### V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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#### A. Proposal Preparation Instructions

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##### Letters of Intent (required):

A one-page Letter of Intent is required. The letter should be submitted via FastLane no later than the date specified in this solicitation. The subject heading of the letter should include a brief title of the proposal and the name of the lead institution. Each letter must include the following:

1. THE TITLE- Title of the EFRI proposal, preceded by the words "EFRI-BioFlex:" or "EFRI-ODISSEI:" or "EFRI-PSBR:," as appropriate.
2. THE TEAM- Names, departmental and university affiliation, and expertise of the Principal Investigator and at least two co-Principal Investigators.
3. THE SYNOPSIS (GOALS)- Brief description of the specific goals of the proposal (maximum of 250 words). For the ODISSEI topic, state which theme(s) you will be addressing in the proposal.

These letters of intent are not used as pre-approval mechanisms for the submission of preliminary proposals and no feedback is provided to the submitters. The Letters of Intent are not reviewed but are used to assess the overall response to the solicitation. They help NSF anticipate review requirements for preliminary proposals.

#### Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Sponsored Projects Office (SPO) Submission is not required when submitting Letters of Intent
- A Minimum of 2 and Maximum of 4 Other Senior Project Personnel are allowed
- A Minimum of 0 and Maximum of 3 Other Participating Organizations are allowed
- Submission of multiple Letters of Intent is not allowed

**Preliminary Proposals (required):** Preliminary proposals are required and must be submitted via the NSF FastLane system.

Preliminary proposals will be reviewed by panels of outside experts. Based on the reviews, a limited number of PIs will be invited to submit full proposals. By mid December of 2012, successful PIs should expect to receive an invitation from the EFRI Office to submit a full proposal.

Preliminary proposals should provide a brief overview of the project and should include sufficient information to allow assessment of the main ideas and approaches and how it is appropriate as an EFRI proposal as opposed to existing programs.

#### Preliminary Proposal Preparation Instructions:

Preliminary proposals must be submitted via FastLane in accordance with the instructions below. Preliminary proposals that are not compliant with this solicitation will be returned without review. It is the submitting organization's responsibility to ensure that the proposal is compliant with all applicable requirements. If there are multiple universities involved in a preliminary proposal, it must be submitted as a single proposal and not as multiple collaborative proposals. Preliminary proposals must contain the items listed below and strictly adhere to the specified page limitations. No additional information may be provided as an appendix or by links to web pages. Figures and tables must be included within the applicable page limit. All elements of the proposal, including legends and tables, must meet all formatting requirements for font size and characters per inch as specified in the NSF Grant Proposal Guide (GPG).

Preliminary proposals must include the following items:

**Cover Sheet:** Select the EFRI program solicitation number from the pull down list. Check the box indicated for preliminary proposal. Entries on the cover sheet are limited to the principal investigator and a maximum of four co-principal investigators. A minimum of two co-principal investigators must participate. Additional project leaders or senior personnel should be listed on the project summary page and entered into FastLane as senior investigators.

**Title of Proposed Project:** The title for the proposed EFRI project must begin, as appropriate, with either "EFRI-BioFlex Preliminary Proposal:" or "EFRI-ODISSEI Preliminary Proposal:" or "EFRI-PSBR Preliminary Proposal:". The title must state clearly and succinctly the major emerging frontier in research and innovation that is the focus for the project.

**Project Summary:** The project summary may not be more than one page in length and must consist of three parts:

1. At the top of this page include the title of the project, the name of the PI and the lead institution and a list of co-PIs and senior personnel along with their institutions;
2. Provide a succinct summary of the *intellectual merit* of the proposed project. This should include the transformative nature of the proposed research and the significant leap or paradigm shift in fundamental engineering knowledge it will achieve; and
3. Describe the *broader impacts* of the proposed work, including the potential long-term impact on national needs or a grand challenge.

**Proposals that do not separately address in the project summary both intellectual merit and broader impacts will be returned without review.**

**Project Description.** Project description of the preliminary proposal is limited to five pages and will include the following three sections:

1. **Vision and Goals-** Describe the vision and specific goals of the proposed research in approximately one page;
2. **Approach and Methodology-** Describe the approach and methodology that will be used to achieve the vision and goals in approximately three pages; and
3. **Impact-** Describe how the synergy of experts from different disciplines in the proposed research will achieve a significant advancement in fundamental engineering knowledge and will have a strong potential for long-term impact on national needs or a grand challenge in approximately one page. Include a succinct statement of your preliminary Broadening Participation Plan.
4. Proposals to be considered by AFOSR for co-funding must include in the Project Description a brief explanation of the aspects of the proposal reflecting the Air Force interests and an explicit statement indicating Air Force relevance.

• **References Cited.** Indicate with an asterisk any cited publications that resulted from prior research funded by NSF for the PI, or co-PI (s).

**Biographical sketches.** The standard NSF two-page biographical sketches must be prepared for the PI, co-PIs and other senior personnel listed on the project summary page.

**Current and Pending Support** for the PI, co-PIs, and senior personnel must be included.

**Budget:** The preliminary proposal will include a budget for each of the four years proposed. FastLane will automatically provide a cumulative budget. Preliminary proposals should not include any subcontracts. However, the budget justification should include planned levels for subcontracts to any partner institution. Enter the anticipated total level of subcontract support on line G5, Subawards.

In the **Supplementary Documentation** section, include the following:

1. List of **key personnel involved** (maximum one page), with a succinct description of what each person uniquely brings to the project and how they are integrated to produce positive synergies; and
2. A list, in a single alphabetized table, with the full names and institutional affiliations of all people with **conflicts of interest** for all senior personnel (PI and co-PI's) and any named personnel whose salary is requested in the project budget. Conflicts to be identified are (1) PhD thesis advisors or advisees, (2) collaborators or co-authors, including postdoctoral researchers,

for the past 48 months, and (3) any other individuals with whom or institutions with which the PIs have financial ties (please specify type).

In addition to the FastLane instructions, the proposers must send the following two documents via email immediately after submission of their proposal. After receipt of the proposal number from FastLane, send an email to: [efri2013@nsf.gov](mailto:efri2013@nsf.gov). The subject heading of the email should note the proposal number and the lead institution. Attach the following documents prepared on templates that will be available at <http://www.nsf.gov/eng/efri>:

1. An Excel spreadsheet containing two lists: one lists the last names, first names and institutional affiliations of all senior personnel (PI and co-PI's) and any named personnel whose salary is requested in the project budget; the second one lists the full names and institutional affiliations of all people having **conflicts of interest** with any senior personnel (PI and co-PI's) or named personnel whose salary is requested in the project budget. These lists will be used by NSF to check for conflicts of interest in assembling the review community.
2. A single **PowerPoint slide** summarizing the vision of the EFRI proposal. This will be used during review panel discussions.

Remember to email these two documents to: [efri2013@nsf.gov](mailto:efri2013@nsf.gov); do not use FastLane.

**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 Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=gpg](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg). Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto: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: ([http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)). 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) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

Based on the review of preliminary proposals, a limited number of PIs will be invited to submit a full proposal. If multiple universities are involved in an invited full proposal, it must be submitted as a single full proposal, and not as multiple collaborative proposals.

The review of invited full proposals will include both *ad hoc* and panel reviews. The following exceptions and additions to the GPG apply to full proposals submitted to this Program:

Full proposals will be accepted only from PIs who have submitted preliminary proposals in the current review cycle. Submission of full proposals by PIs whose preliminary proposals received a review recommendation of 'Not Invited' will be returned without review.

**Cover Sheet:** Select the EFRI program solicitation number from the pull down list. Check the box indicated for full proposal. Entries on the cover sheet are limited to the principal investigator and a maximum of four co-principal investigators. Additional project leaders or senior personnel should be listed on the project summary page and entered into FastLane as senior investigators.

**Title of Proposed Project:** The title for the proposed EFRI project must begin with "**EFRI-BioFlex:**" or "**EFRI-ODISSEI:**" or "**EFRI-PSBR:**", as appropriate. The title must state clearly and succinctly the major emerging frontier in research and innovation that is the focus for the project.

**Project Summary** (one-page limit): Provide the following information:

1. The title of the project, the name of the PI and the lead institution or organization, and a list of co-PIs and senior personnel along with their institutions and organization or both;
2. A succinct summary of the **intellectual merit** of the proposed project. This should include the transformative nature of the proposed research, and the significant leap or paradigm shift in fundamental engineering knowledge; and
3. The **broader impacts** of the proposed work, including the potential long-term impact on national needs and a grand challenge or both. Include a summary of your Broadening Participation Plan.

Proposals that do not separately address both intellectual merit and broader impacts in the project summary will be returned without review.

**Project Description** (maximum 15 pages) must include the following subsections:

1. Results from **Prior Research**: Describe prior research of each PI or co-PIs funded by NSF that is directly relevant to the proposed project; and
2. **Proposed Research**: Describe the vision and goals of the proposed research, approaches and methodologies to attain the goals, and the expected outcomes. The project description should address the "Required BioFlex Elements" for EFRI-BioFlex proposals or "Required ODISSEI Elements" for EFRI-ODISSEI proposals or "Required PSBR Elements" for EFRI-PSBR proposals, as applicable, as listed in Section II. Program Description.
3. The project description should end with a subsection labeled "**Impact**" that describes how the proposed project will lead to a significant shift in fundamental engineering knowledge and have strong long-term potential for significant impact on a national need or a grand challenge. The proposal should also discuss effective ways in which education and outreach are integrated within the research program to achieve societal impacts. Concisely articulate unifying and integrative aspects of the proposed research as well as the innovative ideas of the research. The **Impact** subsection must include a **Broadening Participation Plan**. The plan must aim to broaden participation of underrepresented groups in engineering research. For more information see: Enhancing Diversity in Engineering at the end of Introduction, Section I. If needed, you may include additional information, up to five pages, about your Broadening Participation Plan in the Supplementary Documentation section.
4. Proposals to be considered by AFOSR for co-funding must include in the Project Description a brief explanation of the aspects of the proposal reflecting the Air Force interests and an explicit statement indicating Air Force relevance.

**References Cited.** Indicate with an asterisk any cited publications that resulted from prior research funded by NSF for the PI, or co-PI(s).

**Biographical Sketches** for key personnel (PI, co-PIs, and each of the senior personnel listed on the Project Summary page). Use the standard format.

**Current and Pending Support** information must be provided for the PI and each of the co-PIs and Senior Personnel listed in the Project Summary page.

**Budget.** Develop a realistic project budget that is consistent with the proposed activities. Provide detailed budget justifications separately for the lead institution's budget (up to three pages of budget justification), and for each subawardee budget (up to three pages of budget justification for each subaward). Proposed budgets must include funds for travel by at least one PI and at least one graduate student to attend an annual EFRI grantees' meeting.

**Facilities and Equipment:** Provide a description of available facilities and priorities for its use, if applicable. For EFRI projects requiring additional equipment, justify the need for these resources in the context of the innovative work proposed.

In the **Supplementary Documentation** section, include the following:

1. Provide a **list of key personnel** involved (maximum three pages), with a description of what each person uniquely brings to the project and how they are integrated to produce positive synergies;
2. Provide a detailed **management plan** (maximum three pages) including means of communication, data tracking, management of personnel within the project group, management of intellectual property resulting from the project, and timeline of activities;
3. Proposals that would generate significant digital data for preservation must include a **data management plan** (maximum one page). The contents of the data management plan should include: (1) the types of data to be produced, (2) the standards that would be applied for data format and metadata content, and (3) access policies and provision;
4. For proposals that include support for post-doctoral researchers, provide a **post-doc mentoring plan**;
5. **Means of sharing the outcome** of the research with the rest of the scientific community, e.g. publications, web sites, and significant data bases, etc. (maximum two pages). The description should be specific and describe what, how, and when the community would have access to the outcome of the project. This is particularly important for the projects that will produce tangible research tools and resources; and
6. A list, in a single alphabetized table, with the full names and institutional affiliations of all people with **conflicts of interest** for all senior personnel (PI and co-PI's) and any named personnel whose salary is requested in the project budget. Conflicts to be identified are (1) PhD thesis advisors or advisees, (2) collaborators or co-authors, including post-docs, for the past 48 months, and (3) any other individuals or institutions with which the investigator has financial ties (please specify type).

In addition, the proposers **must send the following two documents via email immediately after submission of their proposal**. After receipt of the proposal number from FastLane, send an email to: [efri2013@nsf.gov](mailto:efri2013@nsf.gov). The subject heading of the email should note the proposal number and the lead institution. Attach the following documents prepared on templates that will be available at <http://www.nsf.gov/eng/efri>:

1. An Excel spreadsheet containing two lists: one lists the last names, first names and institutional affiliations of all senior personnel (PI and co-PI's) and any named personnel whose salary is requested in the project budget; the second one lists the full names and institutional affiliations of all people having **conflicts of interest** with any senior personnel (PI and co-PI's) or named personnel whose salary is requested in the project budget. These lists will be used by NSF to check for conflicts of interest in assembling the review community.
2. A single **PowerPoint slide** summarizing the vision of the EFRI proposal. This will be used during review panel discussions.

Remember to email these two documents to: [efri2013@nsf.gov](mailto:efri2013@nsf.gov); do not use FastLane. Please submit these documents even if the information has not changed since submission of the preliminary proposal.

#### Pre-submission Check List

- No principal investigator or co-principal investigator is listed as a principal investigator or co-principal investigator on any other EFRI proposal.
- The Lead PI must be at the faculty level, as determined by the submitting institution.
- If the proposal has multiple organizations, it is not submitted as a collaborative proposal but as a single proposal with subawards.
- Proposal has a minimum number of 3 PI/Co-PIs and a maximum of 5 PI/Co-PIs.
- Total budget does not exceed \$2,000,000 and is spread over 4 years.
- **Broadening Participation Plan:** All proposals must describe a plan (both in Project Summary and Project Description) that promotes the participation of underrepresented groups in engineering.
- **Post-doctoral Researcher Mentoring Plan:** As a reminder, each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals.
- **Data Management Plan:** All proposals must describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans.
- Immediately after submission, an E-mail is sent to: [efri2013@nsf.gov](mailto:efri2013@nsf.gov) with (a) the Excel spreadsheet that includes COI information and (b) a one-page project summary as PowerPoint slide. The subject heading of the email should note the proposal number and the lead institution.

This checklist is provided to aid in the preparation of the proposal, the burden to ensure that the proposal is complete and meets all of the solicitation requirements remains with the Principal Investigator.

## B. Budgetary Information

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**Cost Sharing:** Inclusion of voluntary committed cost sharing is prohibited

## C. Due Dates

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- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
September 06, 2012
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):  
October 10, 2012

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

February 08, 2013

## D. FastLane/Grants.gov Requirements

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- **For Proposals Submitted Via FastLane:**

Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail [fastlane@nsf.gov](mailto:fastlane@nsf.gov). The FastLane Help Desk answers general technical questions related to the use of the FastLane system. 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.

**Submission of Electronically Signed Cover Sheets.** The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: <https://www.fastlane.nsf.gov/fastlane.jsp>.

- **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: [http://www07.grants.gov/applicants/app\\_help\\_reso.jsp](http://www07.grants.gov/applicants/app_help_reso.jsp). In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding 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](mailto: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.

## VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. 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 who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the 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.

### A. NSF Merit Review Criteria

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All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgments.

**What is the intellectual merit of the proposed activity?**

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

**What are the broader impacts of the proposed activity?**

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

#### Additional Solicitation Specific Review Criteria

In addition to the two NSF review criteria (intellectual merit and broader impacts), the following criteria will be used in the review of

all EFRI proposals:

- **TRANSFORMATIVE** - Does the proposed research represent an opportunity for a significant leap or paradigm shift in fundamental engineering knowledge?
- **NATIONAL NEED/GRAND CHALLENGE** - Is there potential for making significant progress on a current national need or grand challenge?
- Responsiveness to "**Required BioFlex Elements**" for EFRI-BioFlex proposals or "**Required ODISSEI Elements**" for EFRI-ODISSEI proposals or "**Required PSBR Elements**" for EFRI-PSB proposals as delineated in Section II. Program Description.
- **Broadening Participation Plan** - Does the plan actively promote, increase, and enhance the participation of underrepresented groups in the field of engineering and in engineering research?
- Effectiveness of the proposed **management plan**.

NSF staff also will give careful consideration to the following in making funding decisions:

#### ***Integration of Research and Education***

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

#### ***Integrating Diversity into NSF Programs, Projects, and Activities***

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- 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.

## **B. Review and Selection Process**

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

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. 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 is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the date of receipt. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, 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.

In developing its recommendations for awards, review panels as well as NSF staff will consider: the relative merit of the EFRI proposals using the criteria listed above, the potential national impact of the proposed activity, the balance of awards among scientific fields, geographical distribution, and the combined ability of the proposals to meet the objectives of the EFRI Office. The EFRI Office will not normally award more than one proposal from any one lead institution in this competition.

In all cases, 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 and 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.

## **VII. AWARD ADMINISTRATION INFORMATION**

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### **A. Notification of the Award**

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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**

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An NSF award consists of: (1) the award letter, 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 letter; (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 letter. 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 [http://www.nsf.gov/awards/managing/award\\_conditions.jsp?org=NSF](http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto: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 *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=aag](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).

**Special Award Conditions:** Awardees must include in the proposal budget funds for travel by PI and one researcher or a student to attend an annual EFRI grantees' meeting.

## C. Reporting Requirements

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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 at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after 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 that PI. 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 FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational), publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report 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.

Awardees will be required to attend and present their research results and plans annually at an annual EFRI grantees' conference for the duration for their award.

## VIII. AGENCY CONTACTS

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*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:

- Sohi Rastegar, Director, Office of Emerging Frontiers in Research and Innovation (EFRI), 505, telephone: (703) 292-8305, email: [srastega@nsf.gov](mailto:srastega@nsf.gov)
- Garie Fordyce, Program Manager, Office of Emerging Frontiers in Research and Engineering, telephone: (703) 292-4603, email: [gfordyce@nsf.gov](mailto:gfordyce@nsf.gov)
- TOPIC 1: Flexible Bioelectronics Systems, (BioFlex), telephone: 703-292-8339, email: [uvarshne@nsf.gov](mailto:uvarshne@nsf.gov)
- Usha Varshney, BioFlex Coordinator / Program Director, NSF/ENG/ECCS, telephone: (703) 292-8339, email: [uvarshne@nsf.gov](mailto:uvarshne@nsf.gov)
- Leon Esterowitz, Program Director, NSF/ENG/CBET, telephone: (703) 292-7942, email: [lesterow@nsf.gov](mailto:lesterow@nsf.gov)
- TOPIC 2: Origami Design for Integration of Self- assembling Systems for Engineering Innovation (ODISSEI), telephone: see below, email: [ccooper@nsf.gov](mailto:ccooper@nsf.gov)
- Clark Cooper, ODISSEI Coordinator / Program Director, NSF/ENG/CMMI, telephone: (703) 292-7899, email: [ccooper@nsf.gov](mailto:ccooper@nsf.gov)
- Christina L. Bloebaum, Program Director, NSF/ENG/CMMI, telephone: (703) 292-8611, email: [cbloebau@nsf.gov](mailto:cbloebau@nsf.gov)
- TOPIC 3: Photosynthetic Biorefineries (PSBR), PSBR Coordinator / Program Director, NSF/ENG/CBET, telephone: 703-292-4997, email: [gantos@nsf.gov](mailto:gantos@nsf.gov)
- George Antos, Program Director, NSF/ENG/CBET, telephone: (703) 292-4997, email: [gantos@nsf.gov](mailto:gantos@nsf.gov)
- Bruce K. Hamilton, Program Director, NSF/ENG/CBET, telephone: (703) 292-8320, email: [bhamilto@nsf.gov](mailto:bhamilto@nsf.gov)
- Ram Gupta, Program Director, NSF/ENG/CBET, telephone: (703) 292-2407, email: [ragupta@nsf.gov](mailto:ragupta@nsf.gov)

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: [fastlane@nsf.gov](mailto:fastlane@nsf.gov).
- Johnetta E. Lee, Program Specialist, NSF/ENG/EFRI, telephone: (703) 292-8305, email: [jlee@nsf.gov](mailto:jlee@nsf.gov)

For questions relating to Grants.gov contact:

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

The following Program Officers may also be contacted for content specific questions on the three EFRI 2012 topics

### **TOPIC 1: Flexible Bioelectronics Systems, (BioFlex)**

Usha Varshney, BioFlex Coordinator / Program Director, NSF/ENG/ECCS, telephone: (703) 292-8339, email: [uvarshne@nsf.gov](mailto:uvarshne@nsf.gov)

Leon Esterowitz, Program Director, NSF/ENG/CBET, telephone: (703) 292-7942, email: [lesterow@nsf.gov](mailto:lesterow@nsf.gov)

Ruth Shuman, Program Director, NSF /ENG/IIP, telephone: (703) 292-2160, email: [rshuman@nsf.gov](mailto:rshuman@nsf.gov)

Bruce Kramer, Senior Advisor, NSF/ENG/CMMI, telephone: (703) 292-5348, email: [bkramer@nsf.gov](mailto:bkramer@nsf.gov)

### **TOPIC 2: Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)**

Clark Cooper, ODISSEI Coordinator / Program Director, NSF/ENG/CMMI, telephone: (703) 292-7899, email: [ccooper@nsf.gov](mailto:ccooper@nsf.gov)

Christina L. Bloebaum, Program Director, NSF/ENG/CMMI, telephone: (703) 292-8611, email: [cbloebau@nsf.gov](mailto:cbloebau@nsf.gov)

Martin Dunn, Program Director, NSF/ENG/CMMI, telephone: (703) 292-7060, email: [mldunn@nsf.gov](mailto:mldunn@nsf.gov)

Joseph A. Akkara, Program Director, NSF/MPS/DMR, telephone: (703) 292-4946, email: [jakkara@nsf.gov](mailto:jakkara@nsf.gov)

David A. Brant, Program Director, NSF/MPS/DMR, telephone: (703) 292-4941, email: [dbrant@nsf.gov](mailto:dbrant@nsf.gov)

Theresa A. Good, Program Director, NSF/ENG/CBET, telephone: (703) 292-7029, email: [tgood@nsf.gov](mailto:tgood@nsf.gov)

Junping Wang, Program Director, NSF/MPS/DMS, telephone: (703) 292-4488, email: [jwang@nsf.gov](mailto:jwang@nsf.gov)

Fariba Fahroo, Program Manager, USAF/AFOSR/RSL, telephone: (703)696-8429, email: [fariba.fahroo@afosr.af.mil](mailto:fariba.fahroo@afosr.af.mil)

Joycelyn Harrison, Program Manager, USAF/AFOSR/RSL, telephone: (703)696-6225, email: [Joycelyn.Harrison@afosr.af.mil](mailto:Joycelyn.Harrison@afosr.af.mil)

Douglas Smith, Program Manager, USAF/AFRL/AFOSR, telephone: (703) 696-6219, email: [douglas.smith@afosr.af.mil](mailto:douglas.smith@afosr.af.mil)

David Stargel, Program Manager, USAF/AFRL/AFOSR, telephone: (703) 696-6961, email: [david.stargel@afosr.af.mil](mailto:david.stargel@afosr.af.mil)

### **TOPIC 3: Photosynthetic Biorefineries (PSBR)**

George Antos, Program Director, NSF/ENG/CBET, telephone: (703) 292-4997, email: [gantos@nsf.gov](mailto:gantos@nsf.gov)

Ram Gupta, Program Director, NSF/ENG/CBET, telephone: (703) 292-2407, email: [ragupta@nsf.gov](mailto:ragupta@nsf.gov)

Bruce K. Hamilton, PSBR Coordinator / Program Director, NSF/ENG/CBET, telephone: (703) 292-8320, email: [bhamilito@nsf.gov](mailto:bhamilito@nsf.gov)

Susanne von Bodman, Program Director, NSF/BIO/MCB, telephone: (703) 292-8440, email: [svonbodm@nsf.gov](mailto:svonbodm@nsf.gov)

Gregory Warr, Program Director, NSF/BIO/MCB, telephone: (703) 292-8440, email: [gwarr@nsf.gov](mailto:gwarr@nsf.gov)

Paul Werbos, Program Director, NSF/ENG/ECCS, telephone: (703) 292-8339, email: [pwerbos@nsf.gov](mailto:pwerbos@nsf.gov)

## **IX. OTHER INFORMATION**

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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, National Science Foundation Update is a free e-mail subscription service 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 Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the [NSF web site](#).

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

## **ABOUT THE NATIONAL SCIENCE FOUNDATION**

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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* provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 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 <http://www.nsf.gov>

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **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](mailto:nsfpubs@nsf.gov)
  - or telephone: (703) 292-7827
- **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 Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). 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:

Suzanne H. Plimpton  
Reports Clearance Officer  
Division of Administrative Services  
National Science Foundation  
Arlington, VA 22230

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