

Technological Challenges in Organic Electronics, Photonics and Magnetics

Program Solicitation

NSF 04-554



National Science Foundation

Directorate for Engineering

Division of Electrical and Communications Systems
Division of Bioengineering and Environmental Systems
Division of Chemical and Transport Systems
Division of Civil and Mechanical Systems
Division of Design, Manufacture and Industrial Innovation

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

May 11, 2004

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Technological Challenges in Organic Electronics, Photonics and Magnetics

Synopsis of Program:

The National Science Foundation (NSF) announces a solicitation on Technological Challenges in Organic Electronics, Photonics and Magnetics. This interdisciplinary research will foster interactions among various disciplines that will impact the field of organic/polymeric electronics, photonics and magnetics, thereby resulting in heretofore-unanticipated breakthroughs and enabling technologies. Organic electronics, photonics and magnetic devices integrated to intrinsic and hybridized systems, represent a highly promising interdisciplinary area of technology, that will provide greatly increased functionality and the potential to meet future challenges of scalability, flexibility, low power consumption, light weight, and reduced cost. This focused initiative seeks high-risk/high-return research proposals on novel concepts in organic electronics, photonics and magnetics. Emphasis will be placed on enabling technologies critical to the continued growth of organic electronics, photonics and magnetics in the next decade to address the scientific issues and technological challenges associated with the underpinnings of the technology.

Cognizant Program Officer(s):

- Usha Varshney, **Solicitation Coordinator**, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: uvarshne@nsf.gov

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- Vasundara V. Varadan, Division Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9146, email: vvaradan@nsf.gov
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- Maria Burka, Program Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-7030, fax: (703) 292-9054, email: mburka@nsf.gov
- Robert M. Wellek, Deputy Division Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-8370, fax: (703) 292-9054, email: rwellek@nsf.gov
- Julie Chen, Program Director, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 510 N, telephone: (703) 292-5365, fax: (703) 292-9056, email: jchen@nsf.gov
- Donald Senich, Senior Advisor, Small Business Procurement Policy, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 550 S, telephone: (703) 292-7082, fax: (703) 292-9056, email: dsenich@nsf.gov
- Glenn H. Larsen, ENG/OAD Clearance Officer, Directorate for Engineering, 505 N, telephone: (703) 292-4607, fax: (703) 292-9013, email: glarsen@nsf.gov
- Dr. Doug Kirkpatrick, Program Manager, DARPA/ATO, Arlington, VA, telephone: 703-526-4762, fax: 703-516-8788,

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

- 47.041 --- Engineering

Eligibility Information

- **Organization Limit:**

Proposals may only be submitted by U.S academic institutions and nonprofit research organizations in support of single investigators or small interdisciplinary groups of three or more investigators.

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- **PI Eligibility Limit:** An individual may participate in only **one** proposal, whether as a PI, co-PI or non-senior personnel. Individuals considering the submission of a small group proposal should contact a cognizant program officer listed in this solicitation prior to proposal submission to clarify the appropriateness of the contemplated group proposal. An individual who participates in a small group proposal as a PI, co-PI or non-senior personnel may not participate in any other proposal.
- **Limit on Number of Proposals:** There is no limit on the number of proposals an eligible institution may submit.

Award Information

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 12 to 15
- **Anticipated Funding Amount:** \$4,250,000 Awards up to \$300,000 for a single investigator and up to \$600,000 for a small interdisciplinary group for a duration of three years are anticipated, pending the availability of funds.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Full Proposal Preparation Instructions:** Standard GPG Guidelines apply.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required.
- **Indirect Cost (F&A) Limitations:** Not Applicable.
- **Other Budgetary Limitations:** Not Applicable.

C. Due Dates

- **Full Proposal Deadline Date(s)** (due by 5 p.m. proposer's local time):
May 11, 2004

Proposal Review Information

- **Merit Review Criteria:** National Science Board approved criteria apply.

Award Administration Information

- **Award Conditions:** Standard NSF award conditions apply.
- **Reporting Requirements:** Standard NSF reporting requirements apply.

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I. INTRODUCTION

Organic/Polymeric electronics, photonics and magnetic devices integrated to intrinsic and hybridized systems, represent a highly promising interdisciplinary area of technology, that will provide greatly increased functionality and the potential to meet future challenges of scalability, flexibility, low power consumption, light weight, and reduced cost. Continued advances in electronics, photonics and magnetic systems are critically important in sustaining the nation's economic growth, particularly in the areas of telecommunications, information technology, wearable microprocessors, organic memories, efficient solid-state lighting, alternate power generation sources, and healthcare engineering, such as the use of conductive polymers as artificial muscles and in nerve tissue replacement. Further applications include electrochromic camouflage coatings, foldable electronic newspapers, flexible large-area imaging and display systems, low-cost thin-film transistors and integrated circuits, photovoltaic devices, organic batteries and fuel cells, injection lasers, organic MEMS, and sensors. The creation of a strong scientific and technological base ranging from synthetic chemistry to device engineering, and from circuit design and systems to manufacturing will become increasingly important to advance the frontiers of this technology. This interdisciplinary research will foster interactions among various disciplines that will impact the field of organic/polymeric electronics, photonics and magnetics, thereby resulting in heretofore-unanticipated breakthroughs and enabling technologies. The anticipated market is very large, expected to exceed \$2.0 billion by 2007, and research advances promise breakthroughs that can have a pervasive impact on technological developments. Consequently, there is a need to address scientific issues and challenges associated with the underpinnings of organic electronics, photonics and magnetics. This initiative will solidify the infrastructure that will enhance scientific understanding of key phenomena in organic/polymeric electronics, photonics and magnetics, and will accelerate applications in industry and society in order to promote economic growth. The goal will be to advance and establish the basic science and technology needed to explore and utilize new concepts in organic/polymeric electronics, photonics and magnetics.

II. PROGRAM DESCRIPTION

This focused initiative seeks high-risk/high-pay-off studies of novel engineering concepts in organic/polymeric electronics,

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photonics and magnetics, and its applications. Proposals are sought under this solicitation that address major advances in the state-of-the-art in organic/polymeric electronics, photonics and magnetics with the goal of producing significant benefits to society. This research will be carried out by single investigators or a small inter-disciplinary group, with the objective of generating new concepts and approaches stimulated by the interaction of diverse disciplines. Novel stand-alone concepts and breakthrough ideas are encouraged. Proposals offering incremental advances in existing technologies are discouraged. Research should focus on critical, enabling engineering technologies for long-term growth. Such research might include concepts for theoretical and experimental aspects of charge transport properties and device physics, processing techniques and manufacturing technologies, interface engineering, device design, circuits and packaging, metrology and diagnostic tools, architectures and systems engineering. The initiative bridges science and technology by introducing new concepts, and has as its intent the promotion of evolution of thought and techniques that address issues ranging from fundamentals to applications. Proposals should discuss effective ways in which education and outreach are integrated within the research program to achieve the broader impacts of the proposed activity. Cooperative activities among academia, industry, and national laboratories as well as the use of shared facilities and international collaborations are encouraged. International collaborations should identify the names and institutions of the collaborators, the nature and goals of their research, and the international synergies and benefits to be gained from the collaboration. Foreign institutions may not directly apply for funding. International activities normally sponsored by the Division of International Programs (<http://www.nsf.gov/sbe/int/>) will be considered. Proposals involving industrial partnerships following the Grant Opportunities for Academic Liaison with Industry (GOALI, <http://www.nsf.gov/home/crssprgm/goali/>) guidelines are strongly encouraged.

TOPICAL AREAS:

This initiative will provide research support under six broadly defined topical areas. Specific areas include, but are not limited to, the following topics:

1. Transport Properties and Device Physics

Research proposals advancing the understanding of fundamental properties that elucidate device characteristics and performance are invited under this topic. Specific issues relating to charge injection and transport, grain boundary effects, defects, crystallinity, maximal room temperature carrier mobility similar to that of inorganic semiconductors, cycling stress-effects, long time-scale relaxation effects, and operating lifetimes in organic field effect transistors (OFETs) and electrochemical (EC) transistors. New modeling and simulation approaches for bandwidth theories, band calculations, coupling constant determination, nanoscale effects, and polaron phenomena are of interest.

Issues relating to carrier diffusivity, recombination, quenching, trapping and annihilation rates of excitons, transport models for disordered systems, improved light extraction in LEDs, quantum efficiency, quantum optics with organic materials, and experimental approaches for singlet exciton (SE)-to-triplet exciton (TE) ratio in long conjugation-length polymers are of concern in organic and polymeric light emitting diodes (OLEDs). Other issues include charge generation; field effects on carrier transport, charge collection, solar spectrum match for organic photovoltaic cells (OPVs) and macromolecules, photoconducting detectors; charge injection and transport through single molecules, photodegradation and device lifetimes, device and systems-level reliability and feasibility of electrically pumped and microring organic lasers, and conversion efficiencies and lifetimes for low-cost, energy-efficient lighting.

Of particular interest are organic-based magnetism, magnetic field control of organic electronic and optoelectronic devices, longer spin flip lifetimes, maximum spin polarization and interface control, photo-induced magnetism, spin dynamics, 3D magnetism in organic molecules, and spin-polarized magnetic organic semiconductors for use in spintronics devices.

2. Processing Techniques and Manufacturing Technologies

Advances in processing techniques that lead to improvement in material properties, and manufacturing methodologies scalable to both micro- and macro- levels at high throughput are sought under this topic. Proposals may relate to a broad range of subtopics, such as new processing techniques to achieve molecular ordering, high electron and hole mobilities, transparent electrodes, efficient optical extraction, spin casting, photolithography, soft lithography, micromolding on flexible substrates, low-cost and high-volume manufacturing processes compatible with organic semiconductors and devices,

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patterning techniques such as two-photon 3D lithography, large area electronics and photonics, encapsulation, 3D micro and nanofabrication, roll-to-roll processing, and moisture-resistant encapsulation, innovative printing techniques including self-assembled monolayer-based printing for amorphous and polycrystalline semiconductor-based circuits on plastics.

Under this topical area only proposals involving quantum leaps in material property development are acceptable, while proposals involving general materials development will not be considered. Novel materials ranging from small aromatic molecules to conjugated polymers, including organic semiconductors, semiconducting block copolymers, materials extending the range of absorption to longer wavelength with improved stability, materials with high nonlinear optical (NLO) coefficients, magnetic polymers, biopolymers, smart wires, self-healing wires, self-selecting wires, high temperature materials for photoinduced magnetism for signal processing and data storage, large bandwidth electro-optic materials, electroactive organic materials for large-area and low-cost applications, conjugated polymers for emerging communications and information technologies based on the use of optical signals and data transfer, and biocompatible and biodegradable conductive polymers to influence tissue replacement and growth, smart bandages and dressings, drug delivery units, and biodegradable stents are appropriate. Transparent electrodes, and low-cost high-temperature organic packaging materials are of further interest to this topic area.

3. Interface Engineering

Under this topic, issues relating to molecular engineering of hybrid organic and inorganic materials, surfaces, interfaces (organic/organic, organic/metal, organic/dielectric), structures, nanocomposites, control of structural, magnetic and optical properties of hybrids, novel functionality such as light emission, thermal, chemical and mechanical or biological sensitivity not found in conventional or amorphous silicon, doping and charge accumulation at hybrid interfaces, stability and operating lifetimes, new approaches to reduce quenching mechanisms of electroluminescence, are of interest. Similarly, novel polymerization and processing techniques to prepare hybrid structures along with molecular and supramolecular templating to create complex yet functional hierarchical structures are of interest.

4. Device Design, Circuits and Packaging

Of particular interest are integrated organic device technologies, both monolithic and hybridized to silicon, and holistic electronic/optical packaging techniques. Faster charge transit that promises faster switching speeds, stability and reliability of devices, circuits and systems and reliability of prototype network systems, organic semiconductor-based circuitry, including $N \times N$ array of switches, sources and detectors (wavelength selectivity and complementarity), amplifiers, pn junctions, Schottky barriers, electrochemical emitting junctions, LEDs to drive lasing cavities, photoexcited organic lasers, nonlinear optical devices, molecular electronic devices and three-dimensional electro-optic circuitry, are also of interest.

Research ideas for flexible electronics using polymer substrates and paper thin ICs, including organic thin film transistors, nanotransistors, electroactive organic devices, organic light emitting diodes, photodetectors, lasers, photovoltaics, solid-state lighting, electro-optical modulators, polymer waveguide devices, polymer optical fibers, organics in integrated circuits, organic magnets, all-organic non-volatile memory, organic spintronic devices, organic MEMS, nanoscale LEDs, photonic circuits including lasers, integration of optical components, negative differential resistance devices, and coupling and packaging of organic-based devices and components are encouraged. Light sources in biomedical applications for phototherapy and noninvasive examination, and chemically and/or biologically sensitive OFETs for medical applications are further encouraged.

5. Metrology and Diagnostic Tools

Proposals are invited on new and improved tools and diagnostic techniques to image and characterize morphology and chemical, structural, electronic, optical and magnetic properties of materials, interfaces, buried layers and structures with nanometer-scale resolution; measurements and new nondestructive methods for probing organic and inorganic interfaces requiring atomic-level resolution; and innovative techniques to evaluate device encapsulation and performance including techniques that will exploit strong interactions between microwave-induced resonance and emission currents in organic photonics devices and systems.

6. Architectures and Systems Engineering

Proposals involving technologies such as silicon-on-plastic, device architectures where a single chip controls electronics over larger areas, and active systems based on nanotubes and nanowires, competing with inorganic semiconductors at the systems level are encouraged under this topic. In addition, sensor systems, RFID tags, smart cards, memory elements, displays, photovoltaic arrays, large area smart lighting, photodetector arrays as LED diagnostics, X-ray detectors, organic electronic patches to test silicon circuitry, pixilated antennas and other wireless electronic systems, and systems on light-weight flexible plastic substrates that could revolutionize organic electronics, photonics, and magnetic systems, are of interest. Integrated intrinsic and hybridized organic electronics, photonics and magnetic systems for futuristic applications, 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 focal to this initiative.

III. ELIGIBILITY INFORMATION

An individual may participate in only **one** proposal, whether as a PI, co-PI or non-senior personnel. Individuals considering the submission of a small group proposal should contact a cognizant program officer listed in this solicitation prior to proposal submission to clarify the appropriateness of the contemplated group proposal. An individual who participates in a small group proposal as a PI, co-PI or non-senior personnel may not participate in any other proposal.

Proposals may only be submitted by U.S academic institutions and nonprofit research organizations in support of single investigators or small interdisciplinary groups of three or more investigators. There is no limit on the number of proposals an eligible institution may submit.

IV. AWARD INFORMATION

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. DARPA may co-fund awards of interest to them.

Anticipated Type of Award: Standard or Continuing Grant.

Estimated Number of Awards 12 to 15.

Anticipated Funding Amount: 4,250,000. Awards up to \$300,000 for a single investigator and up to \$600,000 for a small interdisciplinary group for a duration of three years are anticipated, pending the availability of funds.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Instructions:

Proposals submitted in response to this program announcement/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/cgi-bin/getpub?gpg>. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

Proposers are reminded to identify the program announcement/solicitation number (04-554) in the program announcement/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.

B. Budgetary Information

Cost Sharing:

Cost sharing is not required in proposals submitted under this Program Solicitation.

C. Due Dates

Proposals must be submitted by the following date(s):

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

May 11, 2004

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this announcement/solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: <http://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. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program announcement/solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this announcement/solicitation.

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. Proposers are no longer required to provide a paper copy of the signed Proposal Cover Sheet to NSF. Further instructions regarding this process are available on the FastLane Website at: <http://www.fastlane.nsf.gov>

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

The National Science Board approved revised criteria for evaluating proposals at its meeting on March 28, 1997 ([NSB 97-](#)

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

On July 8, 2002, the NSF Director issued [Important Notice 127](#), Implementation of new Grant Proposal Guide Requirements Related to the Broader Impacts Criterion. This Important Notice reinforces the importance of addressing both criteria in the preparation and review of all proposals submitted to NSF. NSF continues to strengthen its internal processes to ensure that both of the merit review criteria are addressed when making funding decisions.

In an effort to increase compliance with these requirements, the January 2002 issuance of the GPG incorporated revised proposal preparation guidelines relating to the development of the Project Summary and Project Description. Chapter II of the GPG specifies that Principal Investigators (PIs) must address both merit review criteria in separate statements within the one-page Project Summary. This chapter also reiterates that broader impacts resulting from the proposed project must be addressed in the Project Description and described as an integral part of the narrative.

Effective October 1, 2002, NSF will return without review proposals that do not separately address both merit review criteria within the Project Summary. It is believed that these changes to NSF proposal preparation and processing guidelines will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two National Science Board approved merit review criteria are listed below (see the [Grant Proposal Guide](#) Chapter III.A for further information). 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 he/she 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 and original 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?

NSF staff 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 Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. Proposals submitted in response to this announcement/solicitation will be reviewed by Ad Hoc 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.

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 Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

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.

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

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program Division 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.A. for additional information on the review process.)

B. Award Conditions

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 (NSF-GC-1); * or Federal Demonstration Partnership (FDP) Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from

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More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Website at <http://www.nsf.gov/cgi-bin/getpub?gpm>. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Website at <http://www.gpo.gov>.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for the PI and all Co-PIs. 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. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, 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.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding this program should be made to:

- Usha Varshney, **Solicitation Coordinator**, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: uvarshne@nsf.gov
- Filbert J. Bartoli, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: fbartoli@nsf.gov
- Rajinder Khosla, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: rkhosla@nsf.gov
- Paul J. Werbos, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: pwerbos@nsf.gov
- Vasundara V. Varadan, Division Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9146, email: vvaradan@nsf.gov
- Bruce K. Hamilton, Division Director, Directorate for Engineering, 505 N, telephone: (703) 292-8301, fax: (703) 292-9013, email: bhamilto@nsf.gov
- Shih Chi Liu, Program Director, Directorate for Engineering, Division of Civil & Mechanical Systems, 545 S, telephone: (703) 292-8360, fax: (703) 292-9053, email: sliu@nsf.gov

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- Maria Burka, Program Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-7030, fax: (703) 292-9054, email: mburka@nsf.gov
- Robert M. Wellek, Deputy Division Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-8370, fax: (703) 292-9054, email: rwellek@nsf.gov
- Julie Chen, Program Director, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 510 N, telephone: (703) 292-5365, fax: (703) 292-9056, email: jchen@nsf.gov
- Donald Senich, Senior Advisor, Small Business Procurement Policy, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 550 S, telephone: (703) 292-7082, fax: (703) 292-9056, email: dsenich@nsf.gov
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- Dr. Doug Kirkpatrick, Program Manager, DARPA/ATO, Arlington, VA, telephone: 703-526-4762, fax: 703-516-8788,

For questions related to the use of FastLane, contact:

- Gwendolyn Owens, Administrative Manager, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: gowens@nsf.gov

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at <http://www.nsf.gov/cgi-bin/getpub?gp>. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

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