DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR program rests with the Program Management Office. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/PM/SBIR
Attn: Dr. Bud Durand
1400 Wilson Boulevard
Arlington, VA 22209

The proposals will be processed in the Program Management Office and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 61 technical topics to which small business may respond. A list of the topics is included below, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. DARPAR therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior. Each proposal submitted to DARPA must have a topic number and can only respond to one topic.

DARPA has prepared a checklist to assist small business activities in responding to DARPA topics. Please use this checklist prior to mail in or hand carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
FY1990 Topic Descriptions

SB90-001 TITLE: Electrochemical Power Supplies for Low Power Electronic Systems

CATEGORY: Exploratory Development

OBJECTIVE: A "wind-up" battery.

DESCRIPTION:

General – DARPA is interested in innovative concepts to eliminate chemical batteries for low power man-pack electronics equipment. Current and foreseeable systems need many pounds of batteries for extended field operations without re-supply. The DARPA sponsored mini Global Positioning System receiver uses approximately 25 watt-minutes per navigation fix. This level of stored energy could be accumulated over a period of time by extracting power from normal activities, or the energy could be stored by a manually wound spring device to be released on demand over a relatively short period of time. Systems that are compact, rugged, convenient, and reliable are preferred. Scalability to large sizes or the ability to connect multiple devices together to provide higher power levels are also desirable characteristics.

Phase I – Prototype devices demonstrating 4 watts of output at 12 volts for 5 minutes.

Phase II – Rugged field test units with demonstrated reliability.

SB90-002 TITLE: Re-Examination of Analog Computing Techniques and Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop an analog or hybrid computer that solves a useful military problem and offers significant advantages in speed, size or power over an all-digital implementation.

DESCRIPTION:

General – In the face of demands for digital processing speeds in the gigaflop range (and higher) analog computer has generally been ignored as an alternative for rapid solution of interesting and useful problems. In keeping with the philosophy that new technology may allow implementation of old concepts that meet modern needs, DARPA encourages a re-look at analog computation as an alternative to digital processing for selected problems.

Phase I – Innovative applications of analog computation are sought along with new approaches which cast classes of difficult modern computational problems in an analog form. Include a feasibility demonstration of solving an interesting problem by analog methods.

Phase II – Prototype hardware for a specific application.

SB90-003 TITLE: Low Volume, High Efficiency Power Sources for Small Satellites

CATEGORY: Exploratory Development

OBJECTIVE: The analysis and design of candidate space-qualified electrical power sources for small spacecraft that have a low volume and high efficiency compared to current space electrical power sources.

DESCRIPTION:

General – All spacecraft require some type of electrical power source to operate the spacecraft systems. Spacecraft electrical power needs range from continuous/steady low power levels up to burst/high power levels. Small spacecraft may require tens of watts up to a few kilowatts of power depending on the application. Current spacecraft electrical sources are solar panels and batteries. These systems are presently small-scale versions of electrical power sources designs created for much larger spacecraft. Designs optimized for small satellites are needed.

Phase I – Identify candidate electrical power sources that promise significant improvements in system volume and efficiency when compared to current designs. Identify and categorize applicable components and architecture, define areas for subsequent trade-off studies, and produce development schedules and risk assessments of various systems.

Phase II – Perform trade-off studies and system architecture analysis of candidate systems that can be space qualified and optimized for small satellite operations. Areas of concern here are: survivability in the space environment, mission requirements and duty cycles, fabrication and testing issues, and development risk. The outcome of Phase II will be the selection of a design deserving of future development and prototype manufacture.

SB90-004 TITLE: Novel Propulsion Systems for Small Satellites

CATEGORY: Basic Research

OBJECTIVE: To identify and assess the feasibility of novel propulsion systems for small satellites. The results will indicate the level of effort needed for future development of candidate systems.

DESCRIPTION:

General – Most spacecraft, large or small, require some type of propulsion system. Propulsion systems are used for orbit change maneuvers, large orbit transfer maneuvers, and altitude control. Because of the inherent volume and mass constraints of small satellites, existing conventional propulsion systems are of modest performance. New propulsion systems need to be identified that will increase the capabilities of small satellites.

Phase I – Identify candidate concepts for use as propulsion systems on small satellites. The alternative concepts will be characterized and trade-off analysis areas for Phase II will be identified.

Phase II – Perform trade-off and performance analysis of the candidate propulsion concepts. This may include mechanical performance, mission profile compatibility, development needs and risks, and definition of technology advances to be realized. This effort will produce concept assessments and plans for possible future development.

SB90-005 TITLE: Innovative Thermal Control Concepts for Small Satellites

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate the performance of candidate innovative thermal control systems for small satellite.

DESCRIPTION:

General – An inherent problem with small satellites is the lack of surface area that can serve as thermal radiators for heat generated by on-board systems. The present situation restricts the power levels of small satellites to the order of hundreds of watts. This prevents small space platforms from being used for such missions as high capacity

communications. Thermal control concepts that will allow small satellites to deal with higher power load heating will permit the use of this class of satellite in new areas.

Phase I – Identify alternative approaches to controlling thermal loads on spacecraft and those systems generating the most heat. Plans for developing the alternatives will be generated during this time.

Phase II – Develop at least some of the Phase I approaches identified. This development work could include computer simulations, bench tests, control system demonstrations, and environmental testing. The result of this phase will be a realistic knowledge of the effectiveness of the alternatives.

SB90-006 TITLE: Miniaturized DC-to-DC Converters for Small Satellites

CATEGORY: Engineering Development

OBJECTIVE: To develop and construct a prototype DC-to-DC converter that incorporates features to reduce size and weight and to improve conversion efficiency.

DESCRIPTION:

General – Most spacecraft employ DC-to-DC convert electrical power obtained by solar panels to the proper characteristics for use by other spacecraft systems including charging storage batteries. DC-to-DC converters are also used to dispense storage battery electrical power to other systems when needed. Present space qualified DC to DC converter designs are a mass and volume burden to small spacecraft, an effect not of concern to large satellites. Therefore, small satellite systems can derive significant benefit from any advances that can reduce the mass and volume of DC-to-DC converters.

Phase I – Identify electrical components that can contribute to the reduction of size and volume of some qualified DC to DC converters; operate in a microgravity, vacuum environment; demonstrate conversion stability over a wide range of temperatures; resist radiation; and have conversion efficiency and demonstrate low volume and mass compared to existing systems. Phase I efforts will also identify design trade-off areas, operational environment constraints and a Phase II development and production schedule and risk assessment.

Phase II – Perform component and design architecture trade-off studies and production and testing of prototype DC-to-DC converter. Testing of the prototype will include environmental testing in a ground based space chamber.

SB90-007 TITLE: Novel, Low Energy Orbital Transfer Concepts for Small Satellites

CATEGORY: Basic Research

OBJECTIVE: To identify and understand new novel concepts for low energy orbital transfer of small satellites.

DESCRIPTION:

General – There is a need to learn about and understand new methods of performing low energy orbit transfers of small satellites. Such concepts could extend on orbit life of small satellites and enhance overall mission utility.

Phase I – Identify alternative concepts for performing low energy orbit transfer maneuvers and analysis and performance criteria for subsequent efforts.

Phase II – Evaluate the performance, advantages and disadvantages of the candidate alternative concepts. The result of this effort will be an understanding of the development's efforts and value of these concepts.

SB90-008 TITLE: Novel Blue-Green Laser and Filter Technologies for Tactical Airborne Laser Communications

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel blue/green (B/G) lasers and filters for tactical airborne laser communication.

DESCRIPTION:

General – Tactical airborne laser communications (TALC) involves two-way communications between an autonomous high altitude, long endurance (HALE) aircraft and a submerged submarine. To perform robust downlink communications, the HALE aircraft must utilize a small, lightweight, prime-power efficient transmitting laser matched in peak wavelength to wide field-of-view, highly transmissive, narrow optical-bandwidth receiving filter carried onboard the submarine. Similar technology needs holds for submarine-to-aircraft uplink path. Conventional approaches to TALC either meet the required laser or filter characteristics, but have not been optimized for both ends of the link. This effort will define and develop candidate B/G transmitting lasers and receiving filters for TALC.

Phase I – Novel B/G laser and matching filter technologies for TALC will be investigated and assessed. Conventional Submarine Laser Communications technologies such as transmitting lasers and Cesium atomic line receiving filters will be excluded from consideration. However, innovative lasers matching lines of the Cesium atomic line filter, or novel green atomic line filters will be considered under this announcement. In addition, new frequency conversion techniques employing conventional laser concepts will also be considered. All laser proposals must show supporting material or provide convincing arguments that the candidate B/G transmitter has a high performance matching optical receiving filter.

All receiving filter proposals must show supporting material or provide convincing arguments that the candidate filter has a matching high-performance B/G transmitter and can eventually meet the following minimum performance requirements:

Phase II – Laboratory investigation of candidate technology. Phase II laboratory work should validate claims of selected technology eventually meeting Phase I minimum performance characteristics.

SB90-009 TITLE: Interferometic Fiber Optic Gyro Manufacturability

CATEGORY: Engineering Development

OBJECTIVE: To develop innovative interferometic fiber optic gyro (IFOG) component manufacturing equipment and techniques.

DESCRIPTION:

General – Solid-state inertial navigation systems offer the potential of superior guidance capabilities at extremely low cost. Such navigation systems are needed in advanced tactical weapon concepts such as standoff missile defense, as well as in tactical and strategic surveillance applications. Among all the leading candidate technologies for expendable guidance units, IFOGs appear to have the greatest potential for reducing unit procurement costs to less than 1000 per axis. (The ultimate goal is to reduce IFOG unit fabrication costs to significantly less than 1000 per axis).

This effort addresses the development of innovative manufacturing techniques and equipment for producing IFOG components at extremely low cost.

Phase I – Various manufacturing techniques and equipment improvements will be identified and assessed in terms of their ability to reduce IFOG unit production costs to less than 1000 per axis. Example areas of interest are:

(a) Rapid, gradient-free, optical fiber coil winding machinery. Technical emphasis should be for large production throughput of rotation sensing, polarization-maintaining fiber coils.

(b) Robotic optical fiber/integrated optical circuit attachment machines. These machines should create device connections or splices possessing low-loss backscatter and precise polarization alignment.

(c) Robotic assembly machinery to fabricate g- and thermal load resistant packaging of IFOG inertial measurement units.

(d) High-throughput production of wide-band um optical sources, and

(e) High-throughput production of IFOG integrated optical circuitry.

Phase II – Demonstrate feasibility of the proposed IFOG manufacturability improvement concept.

SB90-010 TITLE: Low Observable Technology for Infrared, Acoustic, and Visible Signature Suppression on Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: To explore techniques, materials, and concepts to reduce the observability of airborne vehicles to surveillance and target acquisition sensors.

DESCRIPTION:

General – Modern sensing technology reduces the survivability of aircraft through enhanced target acquisition. New techniques that can reduce the acoustic, visible, radar, and infrared signatures of air vehicles are needed to maintain the battlefield effectiveness of air vehicles (which include manned aircraft, unmanned air vehicles, cruise missiles, and air launched weapons). Promising efforts will be carried to the demonstration phase if the potential of the effort represents a significant advancement.

Phase I – Explore conceptually promising techniques, materials, and concepts that reduce air vehicle signatures in the different sensor spectrums. Analytical reports will be generated.

Phase II – A limited number of Phase I efforts showing extremely high potential will progress to Phase II. Depending on the work involved, this Phase II effort will continue the conceptual analysis to establish confidence in the initiative, or in some cases, will progress to a laboratory demonstration or measurements program.

SB90-011 TITLE: Passive (Non-Radio Frequency/Non-Electro Optic) Sensors for Application to Low Observable Aircraft

CATEGORY: Exploratory Development/Advanced Development

OBJECTIVE: To develop brass board sensors systems for proof-of-concept and demonstration of concept performance and effectiveness.

DESCRIPTION:

General – Current sensor systems on conventional and low observable aircraft exploit infrared and/or radiometric information to provide passive detection of targets of interest. Technologies exist to defeat these sensors. Other types of passive systems (e.g., gravity gradiometers, electro-static detectors, magnetic sensors, etc.) need to be explored/developed as alternatives.

Phase I – Development of system concepts, analysis of performance and effectiveness, estimates of developmental costs/schedule, possible limited sub-component test.

Phase II – Design, lab and test of system or a representative critical sub-component of the system as a proof of concept demonstration.

SB90-012 TITLE: Relocateable Target Sensor Technology

CATEGORY: Exploratory Development

OBJECTIVE: DARPA is investigating the technology for detecting and targeting strategic targets which are capable of relocating on a frequent basis. Examples of this category of target are rail-mobile and road-mobile intercontinental ballistic missiles. Because of the location uncertainty, targeting acquisition systems are required which are often based on imaging sensors that rely on distinguishing the target from the background using visible, infrared or radar portions of the spectrum. However, detection capability is degraded if the target is located in a heavily cluttered environment and employs active deception and denial techniques (e.g. camouflage). If the target location is uncertain or has changed before commit of a weapon, automatic target cueing/recognition techniques may be required to handle the large number of images generated during the search to reacquire the target.

DESCRIPTION:

General – DARPA is interested in innovative sensor technology to detect these relocatable targets. Possible approaches may take advantage of other regions of the electromagnetic spectrum, of unique signature phenomenology of man made versus natural objects, of innovative sensor combinations, or of innovative sensor processing technology. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally useful. It is anticipated that the investigation of these technologies would be divided into two phases:

Phase I – Concept definition and analysis. The concept definition will include the operational architecture and emphasize how the innovative approach will contribute to improved effectiveness. The analysis will include theoretical development based on physical principals as well as analytical assessment of available experimental data.

Phase II – Based upon successful conceptual analysis, a laboratory demonstration will be developed to verify the technical approach.

SB90-013 TITLE: Innovative Sensor for Target Acquisition and Tracking, for Use on Hypersonic Weapons

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate innovative sensor concepts for use in acquiring and tracking airborne targets. These sensor concepts should be compatible with autonomous hypersonic vehicles and the necessary guidance requirements.

DESCRIPTION:

General – DARPA is currently embarking on a program to develop and demonstrate key technologies required for the introduction of an operationally hypersonic weapon system concept. One of the key requirements of the hypersonic interceptor is the ability to autonomously acquire and track targets with a minimum of targeting and guidance updates from external sensors. As target signatures become smaller, through the introduction of advanced technologies, it becomes more difficult for the acquisition and tracking sensors onboard the hypersonic vehicle. The purpose of this effort is to investigate new and innovative technologies that can help to improve the capabilities of the onboard sensors for an autonomous hypersonic interceptor.

Phase I – Conceptually develop new sensors or sensor technology with analysis indicating the projected levels of performance. Provide a development and demonstration plan for the proposed sensor or sensor technology.

Phase II – Demonstration and validation of key technological issues upon which the innovative sensor(s) or sensor technology is based. Base this demonstration on the plan prepared in Phase I.

SB90-014 TITLE: Remotely Piloted Vehicle Technology

CATEGORY: Basic Research

OBJECTIVE: To identify and exploit high pay off advanced technology that enhances the capability and cost effectiveness of unmanned aerial vehicle (UAV) systems.

DESCRIPTION:

General – Future UAV systems will need enhanced vehicle endurance, speed and payload capability. These systems will need to be more survivable, and associated sensors, data links, and control stations must provide much greater flexibility for the user.

Phase I – The development and demonstration of UAV subsystems and components that include air vehicle, avionics, sensors, data link, mission planning and control stations, launch and recovery concepts.

Phase II – Alternatives launch and recovery techniques must be developed to reduce overall support requirements.

SB90-015 TITLE: New Optical Materials on Which to Base Development of Solid Sate Lasers in the Mid-Infrared

CATEGORY: Basic Research

OBJECTIVE: New approaches to develop efficient solid state laser materials in the 2 to 5 micron spectral region. This program shall emphasize the feasibility of efficient laser operation, laser material growth and characterization techniques.

DESCRIPTION:

General – There is a strong requirement for efficient solid-state laser materials in the 2 to 5 micron spectral region for both DoD and non-DoD applications. The database on these materials is very limited. New approaches are required to develop crystal classes which show promise of yielding new laser materials. Demonstration of laser operation with tenability in the mid infrared, innovative material growth, evaluation, and characterization techniques will be emphasized in this program.

Phase I – Exhaustive search of crystal classes that show promise of yielding new laser materials in the mid infrared, and demonstration of laser operation.

Phase II – Optimization of laser design, demonstration of tenability, and evaluation of laser material growth techniques.

SB90-016 TITLE: Innovative Methods for Protecting Mid-Infrared Sensors from Attack by Lasers

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative concepts and techniques for protection of mid-infrared sensors against in-band cw and pulsed lasers without degrading the performance of the sensor.

DESCRIPTION:

General – Mid-infrared (IR) sensors are used in missile seekers and thermal imagers. These sensors must be protected against in band laser attack. Innovative concepts and techniques are needed to protect the sensor without degrading the performance characteristics (e.g., the development of survivable high performance sensors (SHPS). Protection techniques must be effective simultaneously against both cw and pulsed lasers in the MIR spectral region.

Phase I – A conceptual design, laboratory demonstration of MIR sensor protection concept against in-band cw and pulsed lasers.

Phase II – A proof of principle demonstration of protection concept without degrading the Performance characteristics of sensors against in band laser cw and pulsed lasers.

SB90-017 TITLE: Innovative Methods for Protecting Electro-Optic and Infrared Sensors from Attack by High Power Microwave Energy

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop, demonstrate, and test innovative protection techniques to attenuate the effects of high power microwave (HPM) energy on electro-optic (EO) and infrared (IR) sensors and related signal processing electronics.

DESCRIPTION:

General – HPM energy can damage EO and IR sensors and related signal processing of electronics of smart weapons, precision guided munitions/missiles and communications. The damage mechanisms can be burn out of components of latch up/upset of electronics. Innovative techniques are needed for production of sensor systems against HPM attack without affecting the performance. This program emphasizes the development and demonstration of concepts for protection against “front door” HPM attack which do not affect the performance of EO and IR sensors and related signal processing electronics.

Phase I – Identify and demonstrate innovative approaches for protection without affecting the performance of EO and IR sensors and related electronics against HPM attack. Determine the design and performance requirements for use of this technology in current and future EO and IR sensor systems and related electronics.

Phase II – Design, develop, demonstrate and test the technology concepts identified in Phase I.

SB90-018 TITLE: Simple and Inexpensive Means of Detecting Laser Illumination of Tactical Platforms

CATEGORY: Exploratory Development

OBJECTIVE: Develop simple, compact, lightweight, laser warming/sensing devices to detect unambiguous verification of laser illumination of tactical platforms.

DESCRIPTION:

General – Simple, compact, and light weight laser warning/sensing devices are needed for unambiguous detection of laser illumination of tactical platforms such as ground vehicles, low altitude fixed wing/rotary wing aircraft and submarines. These devices shall have a high sensitivity and shall be immune to false alarms due to fast rise-time pulsed non-laser radiation, sun glints, and radio frequency electromagnetic interference (RF/EMI). Measurement of laser characteristics and direction of arrival of laser radiation are also desired. These devices must be of low cost so that they can be proliferated on numerous tactical platforms.

Phase I – Develop a conceptual design of a high sensitivity, compact, lightweight, low cost continuous wave and pulsed laser warning devices. Designs must adapt to numerous tactical platforms and be immune to false alarms due to fast rise time non-laser radiation, sun glints, and RF/EMI.

Phase II – A proof-of-principle demonstration of the laser warning device against continuous wave and pulsed lasers in the visible and near infrared in the laboratory and field conditions.

SB90-019 TITLE: Innovative Concepts to Test the Efficacy of Directed Energy Weapons (Lasers, Microwaves, Particle Beams) by Simulation/War gaming

CATEGORY: Exploratory Development

OBJECTIVE: To develop concepts, algorithms and software for computer simulation/war gaming to test the utility and effectiveness of directed energy weapons (e.g., lasers, microwaves, and particle beams) in combined arms setting in the modern tactical battlefield.

DESCRIPTION:

General – Unlike conventional weapons systems, directed energy weapons (DEW) system have line of sight, speed of light engagement and both soft and hard kill mechanisms for smart weapons sensors and guidance/control electronics and communications systems. To realize the full potential and understand the limitations and develop tactics, doctrine and training for the emerging DEW technology, utility and effectiveness must be established for combined arms setting in simulation/war gaming in a distributed simulation network such as developed by DARPA.

Phase I – Examine the data base for susceptibility and vulnerability of targets against DEW, define and formulate modeling requirements for the utility and effectiveness concepts for DEW technology in combined arms setting simulation/war fighting networks such as SIMNET-D.

Phase II – Develop computer simulation and modeling based on findings of Phase I for DEW beam propagation through atmosphere, accessibility and target interaction, and kill mechanism of selected targets to assess the utility and effectiveness in simulation/war fighting networks such as SIMNET-D.

SB90-020 TITLE: Novel Ways to Monitor/Verify Use of Directed Energy Weapons Which May Be Restricted by Future Treaties.

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel concepts to unambiguously monitor/verify use of directed energy weapons (DEW) such as lasers for strategic applications, which may be restricted by future treaties. Remote/emplaced sensors will be developed to monitor/verify testing these weapons systems.

DESCRIPTION:

General – Directed energy weapons such as ground-based lasers with sufficient brightness/energy can be used for strategic application-ballistic missile defense (BMD) and anti-satellite (ASAT) uses. Treaties might be negotiated to restrict development of such weapons. However tests conducted at low brightness with cooperative targets might be concealed. Novel concepts are needed for remote/emplaced sensors and associated data processing requirements.

Phase I – Examine the database on primary and secondary observables of DEW such as ground-based lasers for strategic applications. Define design concepts for remote/emplaced sensors for unambiguous monitoring/verification of DEW use for strategic applications.

Phase II – Demonstrate proof-of-principle experiments at domestic facilities based on findings of Phase I.

SB90-021 TITLE: New Approaches in the Design of Very Compact, Wideband, High Power, Microwave Antennas

CATEGORY: Exploratory Development

OBJECTIVE: The development of a portable, wideband, collapsible antenna which when deployed, will irradiate roughly ten square meters from a height of about twenty meters.

DESCRIPTION:

General – A super compact high power microwave device is currently being developed to fit inside a capsule of the size of a cannon shell. An antenna is also required to fit inside this capsule such that when deployed, will radiate an area roughly ten square meters from a height of about twenty meters. The frequency of the radiation centers around a few GHz with a power level of hundreds of MW.

Phase I – The conceptual design of this antenna showing the shape, the size, and its parametric dependence on the power, the height, and the area of coverage. A scheme must be identified that shows how this antenna is to be packaged and deployed.

Phase II – A proof-of-principle experiment is to be performed which can demonstrate the features of Phase I.

SB90-022 TITLE: Innovative Technologies for the Production of High Current, High Repetition Rate Cathodes

CATEGORY: Exploratory Development

OBJECTIVE: To construct a lightweight, compact cathode that can generate at least with a repetition rate of 10 kHz.

DESCRIPTION:

General – High current electron beam propagation study requires a cathode which can generate tens of kA at an energy of a few MeV, a pulse length about tens of ns, and a repetition rate of at least 10 kHz. This cathode will be used as the injector to a compact accelerator currently being developed. This injector must be compact, rugged, lightweight and able to operate over long intervals without interruptions.

Phase I – A conceptual design of this cathode showing the operating principle, the estimated size and weight.

Phase II – A proof-of-principle experiment showing the current scaling and the repetition rate capability.

SB90-023 TITLE: New Ideas for High Power, High Repetition Rate Switches

CATEGORY: Exploratory Development

OBJECTIVE: New concepts for relatively lightweight, inexpensive and compact power conditioning systems to drive ferromagnetic induction cells for compact recirculating induction accelerators.

DESCRIPTION:

General – The power supply must provide an accelerating voltage to a group of induction cells with total load currents in the range over a duration of 30 ns. A voltage rise-time of a few nanoseconds

Phase I – A conceptual design of this pulsed power-switching system showing the estimated size and weight.

Phase II – A proof-of-principle experiment will be performed that will demonstrate the operating principle, the power scaling and switching capability of the pulsed power system.

SB90-024 TITLE: Diamond Films for Wear/Erosion Resistance

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to completely characterize the deposition of polycrystalline diamond on infrared (IR) transmitting substrates, such that wear resistance, transmission and thermal conductivity are optimized.

DESCRIPTION:

General – Polycrystalline diamond films are being considered for a number of DoD applications requiring resistance to wear, as well as high transmissivity within the near infrared spectral region and high thermal conductivity. Generally, these films would be deposited onto IR dome materials, to provide enhanced dome properties for high-speed missiles.

Phase I – The desired result of this effort is to demonstrate deposition of polycrystalline diamond films on generic IR dome materials, typically ZnS and ZnSe. Adhesion and wear resistance are to be evaluated, and optimized as a function of the deposition parameters.

Phase II – The result of this effort will be to extend the Phase I effort to include the evaluation of spectral transmissivity and thermal conductivity on deposited diamond films. A complete characterization of the deposition process with respect to adhesion, wear, transmission and thermal conductivity will be required.

SB90-025 TITLE: Supercritical Fluid Processing Technology

CATEGORY: Basic Research

OBJECTIVE: To investigate and demonstrate the utilization of supercritical fluid technology as a novel processing capability for defense related systems that will lead to a prototype demonstration that has viability for scale-up for practical application during Phase III. Possible areas for application of supercritical fluid processing technology include demilitarization of chemical and explosive munitions, the processing of high performance polymer systems, and the processing of energetic materials.

DESCRIPTION:

General – Supercritical fluid technology (SCF) through the use of the extraordinary solvating character of fluids at supercritical conditions offers unique opportunities for the development of novel processing techniques for material systems both generated and required by the Department of Defense. SCF offers the opportunity for demilitarization of chemical and explosive munitions including rockets under highly controlled conditions. Investigation of chemical reactions and solubilities of the various components of interest in SCF will be required to determine their dependence upon temperature, pressure and upon the supercritical fluid itself or perhaps a mixture of supercritical fluids. It also offers the opportunity to process high performance polymers and energetic materials as well as offering the possibility for extraction of desirable components from a complex mixture.

Phase I – Investigation of the reactions of organo-heteroatomic compounds such as chlorinated organics, pesticides and herbicides in supercritical fluid media. Identify reactions occurring and their dependence on temperature and pressure. Study the reactions of propellant and explosive compounds in supercritical fluid media. Investigate the extraction of nitramines from energetic binders without decomposition of individual components to permit recovery for subsequent use. Gain a greater understanding of supercritical fluid properties, development of experimental

measurement techniques and better methods to predict a fluids solvating capabilities. Establish the efficacy of the SCF processing technology under investigation.

Phase II – Having established the efficacy of the SCF processing technology under investigation, Phase II will emphasize the optimization of the processing technology and the development of a prototype demonstration to verify the validity of the technique. The demonstration must also show the viability for scale up for practical application should the project transition to Phase III.

SB90-026 TITLE: Mathematical Modeling of Fluid Flow in Chemical Vapor Deposition and Plasma Reactors.

CATEGORY: Basic Research

OBJECTIVE: Development and experimental verification of a computational description of the fluid dynamics, homogenous/heterogeneous reactions and heat transfer phenomena in a plasma enhanced chemical vapor deposition (CVD) reactor.

DESCRIPTION:

General – Plasma enhanced CVD processes are an approach to densification of composites and deposition of protective coatings with considerable potential for expanded application in t he future. However, process development is currently hindered by a lack of understanding and mathematical models of interactions between the plasma enhanced chemical reactions, fluid flow dynamics and heat transfer within the reactor. Recent progress has been achieved in the computational description of CVD silicon in a rotating plate reactor. Additional efforts to incorporate plasma enhancements and alternate reactor geometry are required.

Phase I – Develop reaction models and computational algorithms to incorporate plasma enhanced reaction chemistry into a mathematical description of CVD processing.

Phase II – Experimental testing and verification of the computational algorithms developed in Phase I.

SB90-027 TITLE: Applications of Wavelet Theory in Modeling Functions of Defense Systems.

CATEGORY: Basic Research

OBJECTIVE: To demonstrate properties of a signal that are best studied by affine wavelet or Weyl-Heisenberg wavelets, or Gabor bases.

DESCRIPTION:

General – In recent years the field of wavelet analysis has become recognized as an important signal-processing tool. The object is to characterize the properties of a signal that are best distinguished by affine wavelet, Weyl-Heisenberg wavelets, or Gabor bases.

Phase I – The task will be to characterize both by theory and detailed numerical simulation, several properties that wavelets distinguish better than a Fourier transform sliding window.

Phase II – The task will be to extend this analysis to the Weyl-Heisenberg wavelets and the Gabor bases.

SB90-028 TITLE: In-Situ Process Sensors for Real-Time Microcircuit Manufacturing Control

CATEGORY: Basic Research

OBJECTIVE: To develop sensors for real-time process control during wafer at a time semiconductor device processing.

DESCRIPTION:

General – Sensors are required for real-time process control during wafer at a time semiconductor device processing. They should be non-intrusive, monitor what is occurring at the wafer surface, and probe the processing environment. Examples include measurement of metal, silicon, and dielectric film thickness, refractive index, resistivity, and other properties at a number of locations a silicon wafer during film growth or deposition. Sensors for monitoring the plasma environment during reactive ion etching and remote microwave etching of dielectric, silicon, metal, and silicide films are also sought. Dynamic and steady state wafer temperature measurements are critical. Sensors for in-situ particle detection in pumping lines, load locks, and process chambers are required. Sensors are also sought to do real-time sensing of process equipment to ensure equipment reliability and enhance mean time between failure. These could include voltages, pressures, etc., for radio frequency plasma, microwave plasma, lamp heaters, gas flow controllers, pumps, power supplies, and other components. All sensors must be compact, robust, and highly cost effective.

Phase I – Initiate effort as described above by beginning exploration of advanced sensors. By the completion of Phase I, potential viability of the selected approach(es) should be clearly demonstrated.

Phase II – Take the initial concept to concrete demonstration of applicability. This should include cooperative evaluation with a semiconductor manufacturing activity.

SB90-029 TITLE: Traveling Heater Method Growth of Bulk Compound Semiconductor Alloy Crystals

CATEGORY: Basic Research/Exploratory Development

OBJECTIVE: Explore the Growth of Bulk Compound Semiconductor Crystals, especially II-VI, using the Traveling Heater Method.

DESCRIPTION:

General – A method of bulk compound semiconductor crystal growth is needed which will yield material suitable for high performance electronic and optoelectronic devices. The traveling heater method (THM) has been successfully applied to the growth of a number of compound semiconductors, including mercury cadmium telluride. This announcement solicits proposals to apply THM to the growth of materials such as zing telluride, which are important for devices. In addition, further development of this technique is required in order to make it more suitable for use in a production facility.

Phase I – Apply THM to the growth of compound semiconductor material. Perform electrical, optical, and structural characterization of the growth material. Deliver several samples of material for independent characterization.

Phase II – Optimize THM. Develop a large database of material samples upon which refinements of the growth process can be based. Explore variations in growth parameters such as spatial and temporal temperature profiles. Extend the technique to larger diameter crystal boules. Develop and/or exercise computer models of the growth process. Develop concepts for real time monitoring and controlling of the growth process. Perform characterization of material samples. Deliver samples for independent characterization.

SB90-030 TITLE: Self-Assembling Microstructures

CATEGORY: Basic Research

OBJECTIVE: To explore the use of polymerizable self-assembling materials (SAM's) either directly – because of their intrinsic physical or chemical properties – or indirectly – as templates of unique size and morphology – for the "bottoms-up" fabrication of advanced optical and electronical materials/components leading to prototype device demonstration which form the basis for Phase III.

DESCRIPTION:

General – Recent work has demonstrated the ability to form hollow, polymerizable soda-straw like structures whose nominal diameter is 0.5 microns and whose length can be made to vary from 10 microns to greater than 2 mm. Intrinsic particle properties include: anisotropy, helicity and chirality on the micron scale – which provide a basis for control of particle orientation and optical/electronic interactions; quasicylindrical symmetry with a hollow core – which offers rigidity, porosity, low mass and non-linear optical interactions; controlled aspect ratio – which provides for tailored, broadband electromagnetic interactions/resonances, diffusion-limited separations, flow modification and fiber-like behavior; internal/external surfaces and chemistry; microvial capability – for encapsulation and ceramic micro engineering; micro honeycomb structure – for the fabrication of high strength to mass materials; confined axial growth – which might be exploited in the formation of controlled asymmetric interconnects and "bottoms-up" fabrication – which allows rational control f bulk, film and surface material properties. The particles may be exploited either directly, because of their intrinsic properties, or as substrates or templates of unique size and morphology for subsequent fabrication/processing steps (e.g. the formation of particle-based whisker reinforced composites). The particles have been successfully coated with then metallic films of copper, nickel and perm alloy to a length of 100 microns, aligned in both aqueous and non-aqueous media by flow, electric and magnetic fields, and embedded with controlled alignment in both epoxies and optical cements.

Current work explores their use in the fabrication of advanced electron source components, as optical limiters for laser eye protection, as bi-refrigerant suspensions for advanced optical devices, and as low loss, high dielectric composites for electronic warfare use. Proposals seeking to investigate the use of SAM's in device design and fabrication are welcome.

Areas of interest include, but are not limited to, the use of SAM's in high dielectric composites for energy storage, conducting composites for radio frequency shielding, non-linear thin film optical devices, advanced acoustic sensors and field-emitter arrays.

Phase I – Material characterization and component/device design.

Phase II – Device proof of concept demonstration.

SB90-031 TITLE: Artificial Neural Network Technology

CATEGORY: Basic Research

OBJECTIVE: To advance the state of the art in artificial neural network (ANN) theory and model development, develop and demonstrate hardware implementation technologies for future construction of full-scale ANN computers, and identify and investigate promising applications for ANNs.

DESCRIPTION:

General – Proposals must clearly describe the novel features proposed, their motivation, and their expected computational advantages.

In the theory and modeling category, DARPA is interested in new artificial neural network architectures that will provide enhanced information processing capabilities; faster, more efficient training procedures; requirements for scale-up to large-sized networks; characterization of properties, limitations, and data requirements of ANNs; and relationships between ANNs and conventional information processing approaches.

Special applications proposals must describe the motivation for choosing the specific application and the expected advantages of the proposed ANN system over competing approaches.

Hardware base development implementation technologies proposed may be specific for a particular ANN model architecture or general to accommodate a variety of different ANN model architectures. If the proposal addresses hardware specific for a particular ANN model architecture, the technology proposed must allow near-term implementation that will demonstrate the expected power of ANNs.

Phase I – Address the following tasks: theory and model development – develop and implement new conceptual systems; hardware-design and fabricate prototype hardware implementations; and applications – develop and implement tailored ANN systems.

Phase II – Focus on testing the newly developed ANN systems on specific applications and measuring their performance relative to competing technologies.

SB90-032 TITLE: Electronic Ceramics for Novel Devices and High-Speed Packages

CATEGORY: Basic Research

OBJECTIVE: To develop and exploit ceramics for novel electronic devices and high-speed packages.

DESCRIPTION:

General – Innovative ideas in the utilization of familiar ceramics for military electronic applications or the development of new ceramics for such applications are solicited. Recent utilization of ceramics for nonvolatile memories, room-temperature thermal imagers, and high-speed packaging are examples of the type of applications that are of interest. These ceramics may result in either active or passive devices, or they may improve the signal transmission properties of packages. Work on ceramic single-crystal thin films or multi-grained thin films should result in films that are compatible with either silicon or gallium arsenide integrated circuit technologies.

Phase I – Initiate effort as described above by beginning exploration of novel materials, devices, or packaging structures. By the completion of Phase I, clearly demonstrate potential viability of the selected approach(es).

Phase II – Take the initial concept to concrete demonstration of applicability. For example, this could include demonstration of advanced electronic devices or packages.

SB90-033 TITLE: Large-Diameter III-V Crystal Growth

CATEGORY: Basic Research

OBJECTIVE: To develop technology for large-diameter III-V crystal growth for optoelectronics applications.

DESCRIPTION:

General – DARPA is seeking the development of single-crystal growth methods that will result in at least three-inch diameter boules of either gallium arsenide or indium phosphide with improved reproducibility, uniformity, and crystalline perfection for optoelectronics and integrated optoelectronics applications. The method proposed should be capable of growing semi=insulating and low resistivity crystals. Target material parameters should be selected on the basis of opto-electonic device requirements.

Phase I – Answer key questions regarding crystal quality and potential for scale-up. While initial experiments may be conducted with small melt volumes, fundamental factors should not limit the crystal diameter to three inches or the boule to an insufficient length.

Phase II – Expand upon the initial results by scaling up to larger diameter and longer boule length and by beginning a correlation between materials, parameters and device performance.

SB90-034 TITLE: Lightweight Payloads for High-Altitude Balloons

CATEGORY: Exploratory Development

OBJECTIVE: To provide demonstrated alternatives for payloads that have commercial and military applications.

DESCRIPTION:

General – DARPA is interested in exploring possible options for balloon borne payloads within the field of communications and surveillance. Balloon technology provides a unique platform for positioning small payloads at high altitude for significant periods of time. New technologies in packaging, electronics, spectral analysis, and power generation should make a wide array of payload options available. Two basic kinds of balloons are being considered as lifting candidates. One is a 24-hour life, zero pressure balloon intended for 70,000 feet and a nominal 5-pound payload. The other is a super pressure balloon intended for one-year endurance at 120,000 feet with a 50-pound payload. Any novel payload concept for military application will be considered but some techniques are considered critical:

1. A launch of the smaller balloon will be made by a ship at sea with minimum shipboard equipment and personnel. A separate ground launch version will be considered.
2. The payload must be expendable.

Phase I – Provide analysis and/or experimental data on a proposed design to show technical feasibility of the payload and potential applications of the concept.

Phase II – Complete a working model of the proposed payload and conduct sufficient flight tests to demonstrate the concept.

SB90-035 TITLE: Integration of Low-Cost with Fiber Optic Links

CATEGORY: Exploratory Development

OBJECTIVE: To provide the basis for significantly lower cost and more efficient sensor arrays for military and commercial applications.

DESCRIPTION:

General – Innovative ideas are needed for new methods to reduce construction, installation, and maintenance costs, while increasing the efficiency of low-cost sensor arrays through the use of fiber-optic links. Large arrays of low-cost sensors are a critical component of numerous surveillance and data gathering techniques. Currently the number of sensors associated with any portion of an array is limited by the signal loss of the network between sensors. In addition, the existing methods of integrating those sensors is costly. New approaches and technologies utilizing fiber optics have potential to solve these problems. Any novel technique will be considered; however, capability in the following areas is of high interest in this program.

1. Efficient construction and implementation techniques to reduce costs and achieve high performance.
2. The capability to function in one or all of the following extreme environments: submergence in saltwater to several thousand fathoms; buried in the ground to a depth of more than a mile; and maintenance flexibility in temperatures near zero degrees Fahrenheit.

Phase I – Provide analysis on the feasibility of applying fiber-optic technology to sensor systems and integration, and identify the most promising path for development.

Phase II – Verify the feasibility of the technique through experimentation as identified in Phase I.

SB90-036 TITLE: Development of Computer Aided Design Models for Microwave and Millimeter Wave Devices and Circuits

CATEGORY: Exploratory Development

OBJECTIVE: To provide models for microwave and millimeter wave frequency solid-state devices and monolithic format circuits that accurately predict actual device and circuit performance over the widest possible frequency range; and to interface these models with commercially available computer aided design software packages and workstations.

DESCRIPTION:

General – At the present time, reasonably accurate models are available for microwave solid-state devices and circuits that operate in a linear mode within the frequency range from 1 to 20 GHz. Additional work is needed to improve the accuracy of models for operation of devices and circuits in the 20 to 100 GHz range and for operation of active devices in a non-linear (high power) mode. Devices of particular interest are metal-semiconductor field effect transistors (MESFETs), high electron mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs) fabricated from III-V compound semiconductor materials. Circuits of particular interest are in a monolithic format fabricated from gallium arsenide. The most desirable models are those which can be used to tie processing parameters to circuit design parameters.

Phase I – Select one or more devices and/or circuit configurations and develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements. Consideration should be given to how models proposed will extend computer aided design capabilities beyond those afforded by use of currently existing models and to compatibility of models with existing commercially supported software packages and workstations.

Phase II – Complete model development and write an appropriate software description that can be used in conjunction with commercially supported software and workstations.

SB90-037 TITLE: Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To provide computer aided design methods to accurately analyze the predicted performance of new analog and/or circuit structures intended for operation in the 1 to 100 GHz frequency range.

DESCRIPTION:

General – A number of recent device structures have been proposed which may result in a superior transmitter and/or receiver performance at microwave and millimeter wave frequencies. In some cases, the basic device structure is not new but the material structure proposed for device fabrication is. In other cases, completely new device structures are under consideration. Similarly, new circuit designs are under consideration that result in performance advantages such as broader band operation, high efficiency operation or higher power outputs. This project will result in the development of computer aided design techniques and models that can be used to analyze the performance and advantages to be gained from incorporation of new devices and circuits in microwave and millimeter wave systems.

Phase I – Select one or more promising microwave and/or millimeter wave device and/or circuit structures for model development from technical discussions and literature searches. Provide a proposed model with a clear indication of accuracy and needed improvements.

Phase II – Complete modeling and computer aided design software. Emphasize accuracy and compatibility with existing commercially available computer aided design software and workstations.

SB90-038 TITLE: Implementation of New Gallium Arsenide Growth Techniques (Vertical Float Zone) Developed at Naval Research

CATEGORY: Exploratory Development

OBJECTIVE: To develop a prototype vertical float zone gallium arsenide growth system suitable for producing substrates with characteristics desirable for fabrication of microwave and millimeter wave solid state devices and circuits.

DESCRIPTION:

General – The Electronics Technology Division of the Naval Research Laboratory (NRL) has produced high purity gallium arsenide crystals using the liquid encapsulated vertical zone melting technique. This growth method offers promise as a means of producing superior material because of low thermal stress. The samples produced at NRL exhibited lower etch pit densities and less crystalline defects than those produced by other means (e.g. liquid encapsulated growth). Unfortunately, NRL only has the capability to produce crystals that are one inch in diameter. This project will result in the ability to fabricate gallium arsenide crystals by the liquid encapsulated vertical zone melting technique that are at least three inches in diameter and single crystalline in structure. Material parameters that affect semiconductor device performance will be measured (e.g. mobility, dislocation densities, etch pit densities, etc.) and material will be supplied for fabrication of microwave and millimeter wave devices.

Phase I – Provide a design and plan for constructing the necessary fabrication system and fabricating the desired material.

Phase II – Construct the crystal puller designed in Phase I and grow at least three boules of three inch diameter gallium arsenide. Provide material parameter data on representative slices of gallium arsenide from the seed, middle and tail end of each boule. Deliver boules for use in device fabrication and further evaluation.

SB90-039 TITLE: Developing Mach Operating System Family Modules

CATEGORY: Exploratory Development

OBJECTIVE: To develop a number of innovative servers, device drivers, and or user interface modules for Mach. Specific areas include (but are not limited to) device drivers, user interface tools, servers to provide special functionality to the Mach operating system for particular applications.

DESCRIPTION:

General – Mach, the Carnegie-Mellon University developed operating system supporting Unix compatibility, multiprocessors and extendable environments is becoming the base for a large number of systems. Acceptance of this operating system will be further enhanced by the availability of “public domain” implementations of device drivers and servers.

Individual proposals should describe specific modules that will be produced. Modules shall be developed in such a way as to make them free of subsidiary licenses and available, royalty free, to the entire Mach community. Potential bidders need to establish their technical credibility in the Mach operating system as well as the specific technical area in which their module covers. Selection will be based on the need for the proposed module, cost, and proposers’ technical competence.

Phase I – Develop the specification of the module or modules proposed. In addition, a prototype implementation of the module will be completed.

Phase II – Complete implementation of the module with full functionality will be developed and full user documentation as well as design documentation will be produced.

SB90-040 TITLE: Advanced Manufacturing Techniques for Flat Panel Displays

CATEGORY: Exploratory Development

OBJECTIVE: To identify and develop manufacturing techniques that can be applied to the low-cost, high volume manufacture of direct-view, flat-panel displays.

DESCRIPTION:

General – Flat panel displays have many applications in military systems and potentially have significant applications in consumer and industrial products. Presently available flat panel displays are limited in size, resolution, ability to present color, grey scale and motion. They are expensive due to low manufacturing yields and complex processes.

Phase I – Select one or more direct view flat panel technologies (e.g. active matrix liquid crystal display or electroluminescent). Analyze the manufacturing process to identify opportunities for cost reduction through process simplification, yield enhancement, throughput improvement, replacement of specialized high cost manufacturing equipment with low cost equipment, materials substitution, changes in panel design (e.g. reduction in interconnects of driver requirements), etc. Provide a clear indication of how such changes would affect panel cost and manufacturability. Most desirable are approaches that combine the realities of the manufacturing environment with innovative technical solutions.

Phase II – Implement/demonstrate proposed changes on a production line. For the phase the production line can be the contractor's own, a team proposed by the contractor, or a contractor performing under another DARPA or U.S. Government contract.

SB90-041 TITLE: Advanced Optical Techniques Extending Use of Optical Tools Below 0.5 Micrometer Geometry Constraints

CATEGORY: Exploratory Development

OBJECTIVE: To develop techniques for optical lithography used in the fabrication of integrated circuits with lateral features sizes below 0.5 micrometers.

DESCRIPTION:

General – The ever-evolving trend toward smaller features in integrated circuit technology continues to demand smaller tolerances in processing. Unless alternative approaches are developed, the resulting decreases in yield and reliability is catastrophic. Similarly, the trend toward larger chips requires improved uniformities in the optics over larger lens diameters. The lithography system is a complex combination of interactions among materials, processing, optics, and mechanical manipulations. Potential improvements may include work in such areas as: light sources of wavelength <3,000 angstroms, improved control for focal depth, larger lens diameters and higher numerical apertures, optical materials for appropriate wavelengths, better mechanical controls for mask-wafer alignment, improved resists, additives to resists, new combinations of multilayer films, in situ diagnostics, test and evaluation approaches, and process parameter control.

Phase I – Select one or more approaches and demonstrate at the simplest level which will prove feasibility. Characterize and evaluate parameters against requirements projected for the final system configuration.

Phase II – Demonstrate the complete photolithography cycle of wafer exposure and pattern definition. Characterize and evaluate a complete set of pertinent parameters, including resolution, dimension control, and processing latitude.

SB90-042 TITLE: Low Cost, High Throughput Test Methods for Analog Semiconductors

CATEGORY: Exploratory Development

OBJECTIVE: To develop the test equipment and methodology to non-destructively evaluate the electronic and optical (as applicable) performance of specialized analog circuits for full frame memory, infrared focal plane arrays and charge coupled device signal processing applications.

DESCRIPTION:

General – Analog processing electronics are essential in applications where digital conversion electronics are either impractical or the a-d converters with the necessary speed and accuracy are not available. Processing electro-optical sensor applications in the analog domain affords the potential of signal processing at the sensor. This provides an opportunity for smart sensor modules for autonomous sub munitions. However, while technology for evaluation of analog processing electronics for DoD applications, does not benefit from this commercial leverage. As a result, the evaluation of analog circuits, especially circuits for specialized applications, is costly and the throughput is limited. Innovative test methods are required to completely evaluate analog circuit performance, including noise measurements prior to integration of the circuit into the processing module. This is especially important for circuits with specialized operating conditions such as cryogenic temperature requirements, stability for precision guidance and operation in a countermeasure environment. A test methodology and the equipment to reduce test time and qualify the part for system integration will reduce the cost of specialized analog circuits to DoD systems. This, in turn, will broaden the application base of analog processing electronics.

Phase I – Develop the concept for a test methodology to evaluate analog circuits. Circuits with broad DoD application will be selected and techniques for measurement of essential circuit parameters; signal-to-noise ratio, noise spectrum (if applicable), and frequency response will be determined. Establish a preliminary design for test equipment that will demonstrate a dramatic reduction in testing cost.

Phase II – Develop equipment to evaluate circuit performance under realistic system operating conditions and demonstrate the cost savings over previous test methods.

SB90-043 TITLE: Dry Etching for III-V and II-VI Semiconductors

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate dry etching techniques with potential for revolutionizing the manufacturing process for mercury cadmium telluride (MCT) infrared focal plane arrays (IRFPA).

DESCRIPTION:

General – MCT IRFPAs are produced with a wet chemical process for delineation of junctions, for definition of diffusion barriers between active regions and for cleaning surface areas prior to thin film deposition. The wet chemical process is difficult to control and is not amenable to the automation necessary for high throughput, high yield semiconductor manufacturing. Dry etching of compound semiconductors, either by laser ablation or in a plasma reactor is feasible, but has not been demonstrated as a production technique for MCT detectors. Diode performance has been shown with the dry etching process, but the characteristics are not equivalent to state of the art diodes produced with the wet chemical process. Development of a production compatible dry etch process for MCT photo detectors requires design and demonstration of a reactor with geometry suitable for uniform, high throughput etching, optimization of the etch parameters, development of photo masking approaches and automation technology. Realization of this technique will substantially increase the control essential for process repeatability, and

demonstrate a crucial sub module for a mercury cadmium telluride detector micro factory, where processing is accomplished in a completely controlled environment. In addition, the dry etching technique is potentially applicable to gallium arsenide, which has application as an IRFPA signal processing circuit.

Phase I – Establish the concept for dry etching MCT will by producing individual photodiodes with various geometries using wet processing and dry etching. Diode characteristics will be evaluated and the dry etching process parameters optimized to achieve performance equivalent to the best diodes produced with the wet chemical process.

Phase II – Produce IRFPAs with the dry chemical process and evaluate in a laboratory test bed. Establish a database with a limited production run of IRFPAs designed to assess the dry etching performance.

SB90-044 TITLE: Non-Invasive Characteristics Techniques for In-Process Control of II-VI Compound Material Growth Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate in-process sensors for production control of mercury cadmium telluride material growth for infrared focal plane arrays.

DESCRIPTION:

General – Mercury cadmium telluride growth by either bulk techniques, liquid phase epitaxy or vapor phase epitaxy is accomplished by control of the growth system parameters: temperature, pressure and reactor geometry. The characteristics of the material as it is grown are not monitored, and the material characterization is usually accomplished subsequent to growth by a series of evaluations which sample small sections of the wafer. Since several growth runs are completed before a thorough characterization is available, growth parameters cannot be adjusted in real time to optimize the growth. An in-situ sensor to control material properties is needed to optimize the growth process for a production environment. This is also necessary to eliminate the successive growth of low quality material before a complete evaluation is obtained. This control philosophy not only achieves real time adjustment of growth parameters, but also eliminates the need for costly post-growth material evaluations. Several optical techniques are available to nondestructively map wafer properties, but these have not been integrated into the growth apparatus and investigated as growth control mechanisms. Significant cost reduction benefits can be realized from a reproducible, high quality material input to the infrared focal plane array manufacturing line before substantial value is added to the product.

Phase I – Investigate potential non-invasive sensors for in-situ monitoring of material parameters, and perform the material characterizations necessary to verify the feasibility of the selected approach. Complete the design of a production growth system with integral in-situ sensors for monitoring material characteristics.

Phase II – Build a prototype reactor with in-situ sensors and perform a series of controlled growth runs, validating material quality with optical and electrical measurements, and with diode array test structures. Provide improved materials for fabrication of infrared focal plane arrays.

SB90-045 TITLE: Anti-Reproduction Document Coating

CATEGORY: Basic Research

OBJECTIVE: To develop a coating or film that when applied to a document would prevent its reproduction.

DESCRIPTION:

General – Development of an "easy to apply" coating or film that when adhered to a document would prevent its reproduction by conventional xerographic techniques. Application of the coating or film must not impeded the legibility of the document and must not be removable to allow reproduction.

Phase I – Initiate effort as described above by identifying candidate films and/or coatings and begin exploration of same.

Phase II – Take the initial concept to concrete demonstration of applicability.

SB90-046 TITLE: Experimental Determination of Differences in Seismic Coupling of Explosions Detonated in Different, Hard, Brittle Rocks

CATEGORY: Basic Research

OBJECTIVE: To predict the yields of Soviet underground nuclear tests detonated in different, hard, brittle rocks.

DESCRIPTION:

General – Seismologists have generally assumed that explosions detonated in different, hard, brittle rocks such as granite or slate or sandstone will couple equally. However, this assumption is critical in view of recent possibilities to obtain information on the detailed geology of the emplacement sites of Soviet nuclear explosions which often are detonated in such rocks.

The theoretical analysis of coupling in these rocks is difficult and there is a substantial lack of experimental data. It is through that laboratory and field experiments with conventional explosives can provide a great deal of insight into this problem.

Problems of importance to consider in experimental design include the roles of saturation, hydrostatic pressure, distance to the free surface, scaling of cracks with respect to explosion yield, yield scaling in general, and the effect of gravity on the development of spall.

An important objective is that a body of reliable, reproducible data be developed which future workers in the field can use.

Phase I – Outline the experimental plan for Phase II and illustrate the experimental techniques by the acquisition of good data for a few samples.

Phase II – Obtain results for several types of rocks with different degrees of saturation and hydrostatic pressure. Form a discussion of the applicability of these results to full scale underground nuclear testing, design a test and predict a result.

SB90-047 TITLE: Experimental Determination of the Excitation of Seismic Regional Phases as a Function of Explosion Source Depth

CATEGORY: Basic Research

OBJECTIVE: To predict the relative and absolute excitation and regional phases of Soviet underground nuclear tests as a function of depth.

DESCRIPTION:

General – Several studies have recently shown that the Lg phase from explosions is of lower frequency than the Lg phase from nearby earthquakes. One explanation for this phenomenon is that the explosions, being near surface, are detonated in a medium with a lower Q. A second explanation is that the Lg phase from explosions is generated from

P to S conversions at the free surface. Theory suggests that this conversion is more efficient the shorter the distance in terms of wavelengths form the source to the surface.

However, some theoretical analyses do not confirm the effect, and some theoreticians believe that the effect of spall is much larger than that of linear conversion at the free surface. Experimental laboratory and field data would help to resolve the problem.

In particular a complete accounting of the energy from the source is needed. For example, if tin the linear case there is a reduction in amplitude of the fundamental and higher mode surface waves as the shot increases in depth, where does the energy go?

Experimental results are desired for both the linear and non-linear case. However, it is clear that the linear problem must be experimentally solved first, and that the non-linear problem may involve experimentally difficult problems related to medium destruction, yield scaling, and effects of gravity.

Phase I – Outline the experimental plan for Phase II and the experimental techniques illustrated by the acquisition of good data for a few depths. Compare the data with theoretical linear predictions.

Phase II – Obtain results for different depths, horizontally layered structures, and recording distances. Illustrate the effects of non-linearity for a few cases. Outline a series of large scale conventional or nuclear tests to conclusively illustrate the differential effects of different source depths on the relative amplitudes of regional phases.

SB90-048 TITLE: Applications of Acoustic Charge Transport Technology

CATEGORY: Exploratory Development

OBJECTIVE: To obtain applications of acoustic charge transport devices.

DESCRIPTION:

General – Acoustic charge transport (ACT) technology has evolved in recent years from a basic research activity to the demonstration of ACT devices which are suitable for application in 6.2 and 6.3 developmental systems. ACT devices are sampled analog signal processing elements similar in some respects to both charge-coupled devices and surface acoustic wave devices, but without the more serious limitations of either of those older technologies. The devices demonstrated to date or under development include digitally programmable transversal filters, fixed and programmable vector processors, correlators, analog memories, convolvers, and various hybrid structures. These devices all offer extremely wide bandwidths and dynamic range, low noise operation, and the advantages of implementation as monolithic gallium arsenide integrated circuits. Ultimately, the integration of ACT devices with digital processing elements on the same chip will provide extremely powerful and compact processor structures. The application areas for ACT devices include radar and radar electronic countermeasures, electronic support measures, and communications systems. The devices allow for enhanced performance of conventional concepts as well as making possible new, innovative approaches. Proposals which address the exploitation of ACT technology and devices for military systems are of current interest to DARPA. Any novel application concept will be considered, ranging from insertion into existing systems to entirely new system or subsystem concepts made potentially feasibly because of ACT. Novel ACT device/processor architectures and their applications are also of interest, including research in fabrication, production and testing of such devices.

Phase I – A complete description of the proposed application, including identification and justification of required performance characteristics; a complete description of the proposed ACT based system, including detailed system design and description of operation, predicted performance, including experimental data or analysis as appropriate estimated size and cost, identification of risk areas, specifications for the ACT device, and the underlying tradeoffs, analysis, and options in the design. Results will be documented in a Phase I final report.

Phase II – Demonstrate the proposed system in hardware. Level of demonstration will depend upon the specific program as described in the Phase II proposal.

SB90-049 TITLE: New Ideas for Unconventional Sensors for Ground Targets and Helicopters

CATEGORY: Exploratory Development

OBJECTIVE: To obtain new ideas for unconventional sensors for ground targets and helicopters

DESCRIPTION:

General – Modern military craft generally emphasize a reduction of observable signature (e.g. radar, infrared, visible, etc.) to enhance their battlefield survivability. In addition, modern forces can be expected to take full advantage of cover, concealment, and deception techniques. These factors will combine to reduce the effectiveness of conventional military sensor systems in the detection and classification of targets. In light of such efforts to reduce the effectiveness of conventional systems, DARPA is interested in examining unconventional sensing concepts which, though perhaps less capable in a general sense, possess special characteristics which make them desirable or even required for target detection, tracking, or classification/identification. Such sensors may seek to exploit unusual target signatures which are perhaps unsupressed, or use a form of energy which is less affected by current conventional techniques. The interest includes specialized sensor concepts that may have been previously discarded but merit reexamination in light of technological advances in signal processing, components, or other underlying technologies. All military target classes are of interest, but with special emphasis on ground based moving and stationary and airborne rotary. Similarly, a wide variety of sensor platforms/configuration are of interest, including ground based, airborne manned and unmanned, unattended, and active or passive, distributed, netted or point.

Phase I – Complete description of the sensing technology, including underlying theory and experimental data as appropriate; complete discussion of the application of this technology to the detection, tracking, or classification of targets, including system concepts, hardware configurations, predicted performance, critical supporting technologies, sample designs, estimated sizes and costs, and in particular a detailed description of the various signal processing.

Phase II – Demonstrate a system concept in hardware or the execution of some critical Feasibility experiments. Level of demonstration or experiment (e.g. field, laboratory, simulation, etc.) and status of hardware will depend upon the specific program as described in the Phase II proposal.

SB90-050 TITLE: Thin Films with Electrical Controllable Reflectivity/Transmissivity to Visual or Infrared

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate cost effective, low current, durable panels of one square foot or larger with variabilities of at least 0.2.

DESCRIPTION:

General – Electrical control of the visual and infrared signatures of aircraft, ships, land vehicles and other systems is sought through the application of lightweight surface modification technologies.

Phase I – Define quantification of physical parameters, producibility/cost analysis, potential applications and fabrication techniques. Small-scale experimental results are desired.

Phase II – Fabricate and thoroughly test panels for technical performance and for robustness/potential degradations. Further producibility work is desired.

SB90-051 TITLE: New Wide-Area Mine Concepts/Munitions

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate key components or technologies and the system cost effectiveness quantified for new wide-area mine concepts or munitions.

DESCRIPTION:

General – Anti-armor and anti-helicopter wide-area mines are currently under development. New concepts capable of attacking aircraft, railroads, missile, or other targets are sought. This includes improved munitions (e.g. warheads) for any of the above applications.

Phase I – Define concept technical parameters and operational concept. Assess the required key technology developments and quantify the cost effectiveness.

Phase II – Fabricate and test the system or key components. Deliver a producibility analysis and fabrication plan.

SB90-052 TITLE: The Use of Active Materials to Enhance Fragment-Impact Initiation of Explosives.

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate greatly improved energy efficiencies for the initiation of explosives by fragment-impact relative to those required for shock initiation.

DESCRIPTION:

General – A fragment of a given size can initiate an explosion if it impacts at a high enough speed. Reductions in both the mass and speed required are desired for fragments between 1 and 20 grams through the use of detonation boosting materials or techniques.

Phase I – Perform parameter analysis and verification of the technique, preferably through experiment. Provide warhead concepts and cost estimates and identify potential applications.

Phase II – Perform rigorous testing and quantification of the concept. Producibility planning and cost reduction analysis is desired.

SB90-053 TITLE: Innovative Application of Binary Phase grating Optics

CATEGORY: Advanced Development

OBJECTIVE: To test binary optic elements with appropriate hardware to demonstrate innovative military or space applications. Applications should demonstrate an optics cost or weight savings, a simpler system design (optics, housing, processing, etc.) or an application that could not otherwise be addressed with reasonable conventional optics.

DESCRIPTION:

General – Binary optics technology ahs the potential to be used in unique applications that could not otherwise be provided with conventional (grind and polish) optics. This effort should concentrate on demonstrating a unique application(s) that uses binary optics.

Phase I – Develop a military or space application that would uniquely benefit from binary optic elements and complete the optical design.

Phase II – Fabricate the binary optical element(s) and measure the capability of the elements separately, and with the application hardware.

SB90-054 TITLE: Innovative Uncooled, Infrared Imaging Techniques That Minimize the Thermal Isolation Effect of the Focal Plane Array

CATEGORY: Exploratory Research

OBJECTIVE: To develop and demonstrate in the laboratory an innovative technique to thermally isolate an uncooled focal plane array from its surrounding environment. Techniques should use a non-contact read-out of the array, with detectors less than three mils on a side.

DESCRIPTION:

General – The present uncooled, infrared imaging arrays are read-out through interconnects that thermally connect the array to its surrounding environment. This limits the ultimate sensitivity of the array. Ultimately, the limit can be improved by eliminating all thermal contact with its surroundings with innovative read-out techniques, such as optical, magnetic, or electro-magnetic.

Phase I – Perform experiments to demonstrate the thermal isolation capability and technique for a non-contact read out. Demonstration can be on large area detectors (less than 25 mils per side).

Phase II – Demonstrate the concept using detectors less than 5 mils per side.

SB90-055 TITLE: Integrated Earphone, Night Vision Goggles and Burst Communications in Helmet for Low Probability of Detection and Intercept for Small Units.

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase III several copies of demonstration operational users under simulated field conditions must evaluate system and system components must be integrated in a helmet in the demonstration.

DESCRIPTION:

General – Small units people may require a system that allows local communications with low probability of interception, enhanced vision in low or night-light and long range low probability or intercept communications. To allow hands free operation, the system must be integrated in a helmet. It must be low cost and easy to maintain and use.

Phase I – Design a detailed system, demonstrate components and provide a helmet mockup.

Phase II – Conduct test in laboratory and field, by potential operational users, of general junction, integrated units under various conditions of weather, terrain, distance and numbers.

SB90-056 TITLE: Novel Configurations of Electromagnetic Launchers and Their Associated Power Supplies

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for electromagnetic launcher and power supply components.

DESCRIPTION:

General – Concepts are sought for novel configurations of electromagnetic launchers and their associated power supplies. The emphasis should be on high electrical efficiency and the absence of high current arcs, current collection brushes and mechanical commutation.

DARPA and the services have been engaged in programs to develop electromagnetic guns and launcher. The SBIR solicitations are regarded as a source of new ideas for future component alternatives.

Phase I – In detail, refine the proposed concepts, execute an optimized design and conduct a performance analysis of proof-of-principle hardware. Subcomponent development may be appropriate.

Phase II – Construct and test demonstration hardware.

SB90-057 TITLE: Innovative and Novel Means of Attacking Tactical Armored Vehicles by Reducing Their Firepower, Mobility, Armor, Crew Capability, etc.

CATEGORY: Exploratory Development

OBJECTIVE: To explore new and innovative means of defeating armored vehicles other than massive disruption of armor.

DESCRIPTION:

General – Concepts are sought for innovative and novel means of attacking tactical armored vehicles by reducing or eliminating effectiveness of firepower, mobility, armor, crew capability and/or rendering them vulnerable to further attack. Concepts for penetration of heavy armor are not of interest in this solicitation. This work will be part of a more general Mission Kill program.

Phase I – Provide a detailed refinement of the proposed concepts and execute an optimized design and perform an analysis of proof-of-principle hardware. Subcomponent development may be appropriate.

Phase II – Construct and test demonstration hardware.

SB90-058 TITLE: Speech Recognition Modules

CATEGORY: Exploratory Development

OBJECTIVE: To establish a library of reusable modules written in a standard, portable language (preferably Common Lisp or Ada) and embodying state-of-the-art techniques for speech recognition.

DESCRIPTION:

General – This library will serve as a base for composing future applications requiring these components. Individual modules would use standard interfaces, structures, and descriptions. Complicated functions would be composed from other less complex modules.

Considerable progress has been made in the development of speech recognition techniques, but each research group typically writes its own, machine and site dependent software. This has the unintended effect of inhibiting technology transfer. A tool kit of component modules with well specified interfaces and structures written in a standard language will significantly alleviate this problem.

Phase I – Develop the framework for constructing a library of speech recognition modules. Carry this framework through the coding and documentation of a few modules.

Phase II – Significantly expand the initial library. Use it to construct a real application. Successfully export the library to at least one other site.

SB90-059 TITLE: Generic Reasoning Modules

CATEGORY: Exploratory Development

OBJECTIVE: To establish a prototype library of reusable, generic reasoning modules bases on well researched cognitive (information processing) models written in standard languages (Common lisp or Ada).

DESCRIPTION:

General – This library will serve as a base for rapid prototyping future applications requiring advanced reasoning components. Individual modules should use standard interfaces, structure and descriptions. Complicated functionality would be composed from primitive library modules.

Use of artificial intelligence (AI) techniques within the broader strategic computer community has been spotty because the majority of AI tools and components are vertically integrated. A tool kit of AI components with well specified interfaces and module structures written in standard languages will significantly alleviate this problem.

Phase I – Develop the framework for construction of a library of AI modules and components. Carry this framework through the documentation of one or two simple AI modules (such as an interference engine, or unification modules).

Phase II – Extend the initial concept of the AI component library and add several more modules to the library. Exercise the library in the construction of a simple test "application" development.

SB90-060 TITLE: Knowledge-Based Re-planning in Resource Constrained Domains

CATEGORY: Exploratory Development

OBJECTIVE: To investigate and develop new or extended knowledge-based techniques to facilitate re-planning in application domains subject to resource scarcity and uncertainty.

DESCRIPTION:

General – Traditional artificial intelligence planners develop plans assuming complete world knowledge and unlimited resources. Plan generation is distinct from plan execution and re-planning implies the generation of a new plan. This effort addresses the development of new techniques that enable a planner to modify its plan during execution due to changing environmental conditions, resource constraints, or uncertainty about the effect of plan actions.

Phase I – Characterize and assess state-of-the-art knowledge-based approaches to re-planning. Describe an approach that exploits the strengths of these approaches or incorporates a new approach. Illustrate the technique on a simplified, but scalable problem agreeable to both DARPA and the contractor.

Phase II – Extend the approach in a more complex problem that exhibits characteristics of resource scarcity, uncertainty, and changing environmental conditions. Perform an evaluation that illustrates the value added of the new approach over those assessed in Phase I.

SB90-061 TITLE: Distributed Artificial Intelligence/Database for Command and Control

CATEGORY: Basic Research

OBJECTIVE: To explore a layered approach to intelligent command and control system implementation.

DESCRIPTION:

General – Significant advances have been made in the past several years in the area of distributed systems design. However, most work has assumed the availability of communication services on demand. Command and control systems that must operate in areas with limited and unreliable communication may be faced with decision making in absence of adequate communications. In such a system, it will be impossible to maintain database consistency. In addition, very limited communications will make state update and database reconciliation difficult or impossible.

By partitioning the problem into three layers: decision making, distributed state, and communication infrastructure, each layer may be implemented and evaluated in isolation and then merged to provide a distributed robust system.

This SBIR requests development of layer interface specifications between the upper two layers of this system. It specifically will include services provided and characteristics of those interfaces in periods of stress such as network partition.

Phase I – Develop the specification of inter-layer interfaces. Some exploratory implementation of components within the two layers in question is desirable.

Phase II – Prototype implementation of layers for a trial system, with analysis of performance under a variety of traffic and partition scenarios.