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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)						DATE February 2006	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA2 Applied Research			R-1 ITEM NOMENCLATURE Materials & Biological Technology PE 0602715E				
COST (In Millions)	FY 2005	FY2006	FY2007	FY 2008	FY 2009	FY 2010	FY 2011
Total Program Element (PE) Cost	252.168	288.753	297.277	308.261	315.107	316.107	273.107
Materials Processing Technology MBT-01	140.907	178.355	165.052	177.750	184.772	185.772	167.772
Biologically Based Materials and Devices MBT-02	111.261	110.398	132.225	130.511	130.335	130.335	105.335

(U) Mission Description:

(U) This program element is budgeted in the Applied Research Budget Activity because its objective is to develop technologies related to those materials and biological systems that make possible a wide range of new military capabilities.

(U) The major goal of the Materials Processing Technology project is to develop novel materials, materials processing techniques, mathematical models, and fabrication strategies for advanced structural and functional materials and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of materials including: structural materials and devices, smart materials and actuators, functional materials and devices, and materials that are enabling for improvements in logistics (i.e., novel power sources, water purification, etc.).

(U) The Biologically Based Materials and Devices Project acknowledges the growing and pervasive influence of the biological sciences on the development of new materials and devices as well as the commensurate influence of materials, physics and chemistry on new approaches to biology and biochemistry. Contained in this project are thrusts in the application of biomimetic materials and devices for Defense, the development of biochemical materials to maintain performance, the use of biology's unique fabrication capabilities to produce structures that cannot be made any other way, the application of magnetic materials in biological applications, and the development of manufacturing tools that use biological components and processes for material synthesis.

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(U) <u>Program Change Summary:</u> <i>(In Millions)</i>	<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>
Previous President's Budget	256.480	294.188	299.844
Current Budget	252.168	288.753	297.277
Total Adjustments	-4.312	-5.435	-2.567
 Congressional program reductions	 -0.197	 -10.185	
Congressional increases	0.000	4.750	
Reprogrammings	2.450		
SBIR/STTR transfer	-6.565		

(U) Change Summary Explanation:

FY 2005	The decrease reflects the SBIR/STTR transfer, the DOE transfer directed by P.L. 108-447 offset by an increase to realign the congressional add for Gelled Fuels and Oxidizers from OSD to DARPA for proper execution.
FY 2006	The decrease reflects a congressional cut to Bio-Magnetic Interfacing Concepts, undistributed reductions for Section 8125 and the 1% reduction for Section 3801: Government-wide rescission. These were offset by congressional adds to Nanotechnology Solutions, 3-D Microstructures and Strategic Materials.
FY 2007	Decrease reflects minor shift in program pricing and phasing.

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Materials Processing Technology MBT-01	140.907	178.355	165.052	177.750	184.772	185.772	167.772

(U) Mission Description:

(U) The major goal of this project is to develop novel materials, materials processing techniques, mathematical models and fabrication strategies for advanced structural and functional materials and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of materials including: structural materials and devices, smart materials and actuators, functional materials and devices, and materials that are enabling improvements in logistics.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Structural Materials and Devices	35.319	49.000	51.020

(U) The Structural Materials and Devices program is exploiting emerging material science concepts and processing approaches to tailor the properties and performance of structural materials and devices to DoD requirements. Thrusts in this area include new concepts for ultra lightweight materials, amorphous and multi-functional materials for lowering the weight and increasing the performance of aircraft, ground vehicles, blast/ballistic protection and spacecraft structures. Approaches are also being developed for reducing the risk of introducing new materials in defense acquisitions and maintaining them in the field. Techniques are being established for assessing damage evolution and predicting future performance of the structural materials in Defense platforms/systems through physics-based models and advanced interrogation tools. New, low cost processing and fabrication techniques are also being developed to enable expanded use of new materials and structures in Defense applications as well as to produce novel materials that cannot be made through conventional processing approaches.

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(U) Program Plans:

- Develop multifunctional materials concepts designed to provide significant improvement in the capabilities of Defense systems by providing additional functions (e.g., self-healing, thermal control, blast protection, and power) to load bearing structures, quantify their performance and fabricate specific prototype systems.
- Develop a low cost, protective system based on novel material structures and topology to protect troops and trucks against ballistic threats, shrapnel and blasts from improvised explosive devices.
- Develop and verify models that predict bulk amorphous metal formation and behavior; use these models to produce amorphous materials and coatings with superior properties (including increased fracture toughness and high strain rate behavior and long-term corrosion resistance in saline environment) over crystalline material.
- Demonstrate structural materials fabrication (forming, joining, etc.) technologies that yield bulk amorphous metals suitable for Defense applications, including composites for space applications with 25% reduction in weight and 50% increase in specific properties and aluminum based amorphous alloys for turbine blade applications.
- Demonstrate and validate mathematical models and other critical technical issues for the accelerated insertion of materials that will allow designers to cut the insertion time of new materials by over 50 percent using materials of high value to DoD (turbine metals, aircraft structures).
- Explore techniques for large volume, low cost synthesis and assembly of nanomaterials and nanotubes with controlled attributes that are suitable for high toughness fibers and reinforcements; demonstrate these reinforcement concepts in structural composites in Defense applications such as advanced blast and ballistic damage tolerance.
- Develop models, mathematical techniques and novel sensors that when integrated with sensor data will capture the physics of failure and behavior prediction in materials suitable for assessing in-situ damage accumulation and will also provide current state awareness and structural performance prediction for Defense systems.
- Demonstrate the use of flight information to predict life and failure of critical structural components.
- Establish and demonstrate up to 20% performance improvements and engine durability of high performance gas turbine engines based on vaporization cooling.
- Demonstrate novel, cost effective processing routes for aerospace grade (low oxygen) titanium metal and alloys. Explore processing routes for other structural materials of interest to Defense.
- Demonstrate novel and reproducible process routes for directed, localized and controlled microstructure modification to achieve substantial improvements in structural material properties of interest to Defense, including bronze castings for Navy applications.
- Develop unique, three dimensional approaches for making and replicating materials and structures of interest to DoD.

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- Develop and demonstrate manufacturing technologies that can lead to significant reduction in DoD system cost, especially for low volume.

	FY 2005	FY 2006	FY 2007
Smart Materials and Actuators	28.000	38.000	38.000

(U) In this thrust, smart materials, sensors and actuators for the control of the aerodynamic and hydrodynamic behavior of military systems are being developed and demonstrated to increase performance and lower detectability of aircraft, helicopters, and submarines. “Intrinsically smart” materials that provide self-diagnosis and/or self-repair will be developed as well. Machines are being developed that will increase the individual soldier’s physical capabilities by augmenting speed, strength, and endurance. New combinations of advanced materials, devices, and structural architectures are being developed to allow military platforms to morph or change shape to adapt optimally to changing mission requirements and unpredictable environments. New materials and devices will enable the military to function more effectively in the urban theater of operations.

(U) Program Plans:

- Design, demonstrate and validate an integrated, untethered, and self-powered exoskeleton system for augmenting the locomotion and strength of soldiers. The interface of the machine and human will be dramatically enhanced by the development of novel sensor architectures and control algorithms.
- Demonstrate capabilities of the exoskeleton against specific military metrics and transfer to the Army.
- Develop and demonstrate novel fluidic and mechanical devices, and their associated driving electronics that exploit smart material transducers in order to create new high power actuators for a variety of military applications.
- Develop, design and test the actuators, materials, and control architectures necessary for achieving precise shape change in an airframe to demonstrate the advantages and enable capabilities afforded by the ability to change shape (morphing).
- Demonstrate capabilities of morphing aircraft technology in a wind tunnel.
- Develop and demonstrate key smart materials technologies for plasma fueled and turbulence harvesting aircraft. Develop ultra-light high temperature capability for hypersonic vehicles using novel approaches to enable reduced thermal load, boundary layer control and virtual shape control.
- Develop a rapidly deployable and reversible, portable lightweight barrier to control enemy mobility in urban areas such as intersections, alleyways, doorways, etc.

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- Develop new materials that will intelligently adapt properties (e.g., modulus, strength) in response to the environment.

	FY 2005	FY 2006	FY 2007
Functional Materials and Devices	25.000	38.605	25.000

(U) In this program, new materials and concepts are being applied to the development of functional materials and devices. A fundamental principle of this thrust is to design material microstructures at the scale appropriate to exploit fundamental interactions with the environment in order to create materials with unique properties. Among the materials being developed in this thrust are new permanent magnetic materials with significantly higher magnetic strength and higher operating temperature for motors, generators, flywheels, bearings and actuators. Unique multifunctional fibers that can be woven into fabrics are being developed. Engineered materials (metamaterials) are being developed that provide dramatically new electromagnetic behavior across the complete array of Defense applications. Also, the concept of pushing nanostructured materials into optical regimes to slow light and producing negative index materials promise to yield important new materials and devices for DoD.

(U) Program Plans:

- Develop and demonstrate novel magnetic meta-materials for DoD motor applications including: 1) high temperature, high strength soft magnetic materials for rotor and stator applications in turbine environments; and 2) permanent magnets with superior energy products.
- Develop and demonstrate novel microwave meta-materials that will enable novel antenna and radar designs with reduced size and improved bandwidth and efficiency.
- Develop and demonstrate novel materials that can be remotely switched between two stable electromagnetic and/or structural configurations, including munitions with controllable sensitivity.
- Extend the frequency of operation and/or operational bandwidth of “negative index” or “left handed” materials to demonstrate novel RF and optical applications for Defense. Specific demonstrations include the reduction of UHF antenna size by a factor of 20 with no loss in gain and approaches for sub-wavelength focusing at IR wavelengths.
- Develop new functional material and devices that slow light pulses, resulting in opportunities such as tunable delay lines for optical signal processing, high-speed RF signal processing applications and single-photon quantum devices.

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	FY 2005	FY 2006	FY 2007
Materials for Logistics (Air, Water, Power)	35.138	48.000	51.032

(U) This thrust will apply novel materials and structures to reduce the logistics burden of the warfighter in the field. New materials and concepts for increasing the availability of portable power to the soldier are being investigated, as are approaches for deriving power from the environment for soldiers and sensors. Novel approaches for direct energy conversion from thermal sources such as submarine nuclear reactors are also being examined. New materials and designs will also be applied to the development of novel mesoscale engines (e.g., Stirling, water lubricated steam engines) that will provide needed power on the battlefield. Hybrid superconducting/cryogenic components will provide a new paradigm for power electronics for the “all electric” platforms of the future. Also, new hybrid concepts for long duration, unmanned underwater vehicles will be investigated along with the feasibility of open ocean, littoral and freshwater prototype fuel cell systems, capable of generating continuous, unattended electrical power for greater than 10 years. Other approaches to enzymatic based energy sources will also be examined as will unconventional power sources. Solar cells will be developed that will demonstrate at least 50% efficiency in an affordable, manufacturable photovoltaic (PV) device through the development and fabrication of novel components such as device-grade quality PV materials, electronic doping, nanostructure process control, and the integration of the process capabilities with current micro- and nano-fabrication tools. Finally, materials technologies will also be employed in novel approaches for obtaining and purifying water in the field.

(U) Program Plans:

- Design, develop, and demonstrate robustness of portable power sources in the 20 Watt power range suitable for several mission scenarios including: 1) a three hour micro air vehicle reconnaissance mission; 2) a three day land warrior mission; and 3) a ten day special operation forces mission.
- Develop and demonstrate enabling direct thermal to electric conversion technologies with potential for high (> 20%) conversion efficiencies and high (> 1 W/cm²) power densities for DoD and commercial power generation applications.
- Demonstrate concepts for highly power-dense, man-portable kilowatt generators that will reduce the logistics burden for the soldier in the field.
- Develop and demonstrate in real military environment an efficient, low cost, 400 watt Stirling engine for Defense applications, including powering of small, motorized vehicles.
- Develop and demonstrate unique, energy-saving concepts for obtaining water from non-traditional sources (e.g. water-from-air), for the individual warfighter and small groups of soldiers.

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- Demonstrate materials and components for a hybrid superconducting power system for a terrestrial (>5 MW) application that has high efficiency and reliability and the potential for significantly reduced size (10x) and weight (5x).
- Develop novel rectifying antenna approaches that will allow efficient beaming of power between spacecraft.
- Demonstrate processes that can convert military waste directly into usable power for the military.
- Design bioelectrocatalysts that are compatible to both the environment of the fuel cell, the electrolyte, and electron transport to the electrode.
- Designed, fabricated and tested laboratory models for sediment mounted and water column microbial fuel cells.
- Designed, fabricated and tested preliminary sediment mounted and water column microbial fuel cells.
- Developed preliminary models for estimating power output as a function of microbial speciation and chemical reductant/reactant concentrations.
- Validate power output models in littoral environments.
- Explore unconventional power sources that might yield new, efficient approaches to providing power to the battlefield.
- Develop novel concepts for extremely high efficient solar cells (>50%) and novel solar cell configurations for battlefield deployment.
- Demonstrate efficiency of solar cell optics and converter technologies in high, mid, and low energy photon environments.
- Demonstrate an integrated solar cell of at least 10 cm² area, delivering 500 W/m².
- Establish techniques for suppression of neutron and gamma emission in compact alpha emitter nuclear power generators (a safety issue) and verify methods for suppression of radiation-induced damage in nuclear energy converter mechanisms.
- Exploit advances in nanotechnology to achieve battery systems with a 3X increase in energy density to 400 watt hours/kg, and a 5X increase in power density to 1000 watt/kg with a 30% decrease in weight.
- Develop novel power components (e.g., fuel cells, structural batteries) that have the potential for demonstrating energy densities in the range of 1000-1500 Watt-hours per liter (W-hr/l) for UUV applications.

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	FY 2005	FY 2006	FY 2007
Friction Stir Welding	1.300	0.000	0.000

- (U) Program Plans:
- Continued to investigate the applicability of using Friction Stir Welding to join amorphous alloys without recrystallization.

	FY 2005	FY 2006	FY 2007
Strategic Materials	3.400	2.550	0.000

- (U) Program Plans:
- Development continues on reliable, robust, repeatable, and cost effective Chemical Vapor Composite (CVC) SiC manufacturing process for high tech military, space, and industrial applications.

	FY 2005	FY 2006	FY 2007
Advanced Materials for Electromagnetic Devices	2.000	0.000	0.000

- (U) Program Plans:
- Developed nanoscale mechanical spin switches using a unique nanofabrication capability.

	FY 2005	FY 2006	FY 2007
Cryo-Power Electronics Development for the All-Electric Ship Program	1.300	0.000	0.000

- (U) Program Plans:
- Developed cryogenic electronics for the all electric navy through the establishment of a Cryogenic Electronics Center at Albany.

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	FY 2005	FY 2006	FY 2007
MMI/MBI Nanotechnology Solutions	2.000	0.400	0.000

- (U) Program Plans:
- Investigating new approaches and accelerated the research of leading-edge nano-scale technologies for potential Defense applications.

	FY 2005	FY 2006	FY 2007
SEMATECH	5.000	0.000	0.000

- (U) Program Plans:
- Established an advanced semiconductor prototyping capability for innovative micro-scale and nano-scale technologies.
 - Developed approaches for processing and integration of soft and hard materials based on a silicon-centric platform.

	FY 2005	FY 2006	FY 2007
Gelled Fuels & Oxidizers	2.450	0.000	0.000

- (U) Program Plans:
- Developed new gell-based fuels and oxidizers for advanced DoD propulsion applications.

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	FY 2005	FY 2006	FY 2007
Characterization, Reliability & Applications of 3-D Microstructures	0.000	1.800	0.000

- (U) Program Plans:
- Continue the development of key technologies behind a packaging concept that uses a stacked multi-chip module approach to reduce interconnect length and increase physical connectivity between layers of electronics.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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COST (In Millions)	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Biologically Based Materials and Devices MBT-02	111.261	110.398	132.225	130.511	130.335	130.335	105.335

(U) Mission Description:

(U) This project acknowledges the growing and pervasive influence of the biological sciences on the development of new materials, devices and processes as well as the commensurate influence of materials, physics and chemistry on new approaches to biology and biochemistry. Contained in this project are thrusts in the application of biomimetic materials and devices for Defense, the development of biochemical materials to maintain performance, the use of biology's unique fabrication capabilities to produce structures that cannot be made any other way, the application of magnetic materials in biological applications, and the development of manufacturing tools that use biological components and processes for materials synthesis. It also supports a major thrust that will revolutionize the development of prosthetics for wounded soldiers.

(U) Program Accomplishments/Planned Programs:

	FY 2005	FY 2006	FY 2007
Bioinspired and Bioderived Materials	48.111	44.000	48.000

(U) The Bioderived Materials thrust explores the application of biomimetic principles to materials and devices of interest to the DoD. Specifically, the unique characteristics of biologically derived materials and devices will be exploited through understanding, control and emulation of the structure and chemistry of the interface between man-made and biotic materials. This includes an effort to develop synthetic optics that mimics the advantages and adaptability of biological lenses. Other efforts seek to understand the principles of locomotion and sensing capabilities of biological organisms and implement them in man-made materials for robotics and other Defense applications. Also, the fundamental operating principles of biomolecular motors will be developed and exploited for designing nano- to macro-scale devices having unparalleled energy efficiency. Finally, the physical interfaces necessary for interacting and controlling biology will be developed and exploited.

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(U) Program Plans:

- Demonstrate biomimetic sensory prototypes and materials that collect electromagnetic olfactory and visual inputs.
- Define new, malleable materials that utilize biomimetic principles of design (e.g., emulate skin, bone, muscle, nerve endings and self repair features) for locomotion and actuation.
- Explore new bioinspired locomotion in robotic systems and develop power efficient, systems level bio-locomotion for mobility in rough/loose terrain and in environments not usually used for locomotion, i.e., vertical (>60°) and inverted surfaces.
- Develop new biomimetically based swimming devices that will double the speed for SEALs while decreasing energy consumed by a factor of eight.
- Develop new materials that will allow the demonstration of lightweight, compact, bio-inspired optical devices. Demonstrations will include a 30X zoom lens of a size to fly on the Pointer unmanned air vehicle (UAV) and a variable field of view (90-180 degrees) lens that will fly on the Dragon Eye UAV.
- Develop an initial understanding of fish (bony and elasmobranch) sensory and sensory-motor capabilities to provide the basis for developing associated biomimetic sensor systems.
- Develop a preliminary understanding of basic sensory and motor responses using both external and internal stimulation.
- Develop biomimetic sensor systems and demonstrate complex tasks such as acoustic and chemical homing and geometric search patterns.
- Demonstrate an integrated surveillance system using biomimetic sensor systems.
- Determine and quantify the mechanism of motor function, motor performance, and efficiency for several types of biomolecular motors through computational models and experimental measurements.
- Demonstrate the utility of biomotors for specific DoD applications including high sensitivity biosensors, high efficiency solar cells and the emulation of natural muscle activity.
- Exploit stealthy sentinels, including the development of critical materials/device interfaces to address teleoperation and autonomous navigation, for their ability to be remotely guided to operationally relevant sites and generate environmental information (chemical, biological, and visual).
- Develop material systems based on biological principles that distribute the force and displacement capability of a hydraulic system continuously throughout a structure. Demonstrate these materials in systems that require large forces at moderate bandwidth such as helicopter blades.

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- Develop signal transduction technology that directly converts biological macromolecular activity (sensing/binding/conformation changes) into an appropriate electrical or optical signal output for the development of biomimetically-based sensors (uncooled IR, optical, etc.).

	FY 2005	FY 2006	FY 2007
Biochemical Materials	48.000	43.398	53.225

(U) The Biochemical Materials thrust examines how breakthroughs in the understanding of biochemistry can drastically improve the survivability of soldiers. For example, examining the biochemistry of the brain during sleep deprivation can lead to new approaches for maintaining the cognitive function of soldiers in the face of sleep deprivation. The application of biochemical principles can also lead to techniques to allow the principles of biological organisms that survive in extreme environments to be exploited for the preservation of tissue and cells of interest to DoD. Finally, understanding the biochemical behavior of organs and tissues, including the interaction of energy with biology, can lead to significant advances in the medical treatment of the soldier on the battlefield.

(U) Program Plans:

- Demonstrate induced desiccation strategies for platelets and red blood cells that allow prolonged periods (> 24 months) of dry storage and recovery and evaluate efficacy of the blood products.
- Develop self-care medical technology to enable the warfighter in the battlefield to accelerate wound healing, internal clotting and pain relief to increase a soldier's survivability on the battlefield.
- Develop an understanding of the biochemical and physiological causes of decreased cognitive performance during sleep deprivation through studying animal model systems, synaptic function, and transcranial magnetic stimulation (TMS).
- Demonstrate and validate approaches to develop biomaterials and other concepts that extend the cognitive performance capabilities of warfighters during extended periods of sleep deprivation and stress.
- Develop methods that are applicable to the battlefield environment for maintaining physical performance by nutritional and physical methods.
- Develop methods for regulating core body temperature and hydration to maintain physical performance and endurance when training.

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- Develop a lightweight version of the Life Support for Trauma and Transport (LSTAT) portable intensive care platform with innovative technologies to make the system available in the far forward battlefield for combat casualty care of wounded soldiers.
- Demonstrate full 3-D visual image representation carried on electronic dog tag that can be used to predict likelihood of survival from potentially lethal battlefield wound. Extend 3-D imaging approaches to a virtual autopsy capable of a more rapid and accurate post mortem wound assessment.
- Define and demonstrate new operating room technologies for the battlefield that reduce the needs for operating personnel.
- Develop devices to locate bleeding and stimulate the clotting process using acoustic energy.
- Develop methods for selectively reducing metabolic requirements in a reversible manner following injury in order to extend the period of survival from injury to initiation of treatment.
- Develop a device to allow automatic initiation of intravenous catheter in a battlefield environment even by unskilled personnel.
- Develop novel biochemical feedback mechanisms and nanotechnology based delivery systems to create auto-regulation feedback for any therapeutic or biochemical agent in order to prevent side effects due to variability in dosage.
- Implement new non-invasive biological sensors to create practical, prototype devices for using neurological signals to improve the throughput and accuracy of intelligence imagery analysis.

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		FY 2005	FY 2006	FY 2007
Bio-Fabrication		5.000	2.000	2.000

(U) The Bio-Fabrication (B-FAB) program will demonstrate the feasibility of using biochemical processes as a new nanofabrication toolset to synthesize and manufacture chemicals, materials, and devices of high value to the DoD. Such approaches would be useful as part of the nanostructure for highly efficient solar cells. Other targets for demonstration within this program include scalable technologies for opto-electronic materials and devices (GaN-InGaN-AlGaP and InP-GaP-AlP-AlInGaP materials; ultra-low-k dielectrics; Rf and photo-emissive devices), mechanical materials (super-tough fibers and associated composites), and site-directed-synthesis (in-package device fabrication). Key elements of this program include the development and utilization of biological components and/or processes for the fabrication of device-grade quality electronic/optical/mechanical materials, further development of these processes for electronic or optical doping, site-directed synthesis, and nanostructure process control, and finally the integration of the B-FAB process capabilities with current micro- and nano-fabrication tools for the fabrication of full-scale integrated electronic, optical, or mechanical proof-of-technology devices.

(U) Program Plans:

- Develop bioenabled routes for the fabrication of relevant electronic, optical, or structural materials. Demonstrate the essential capacity for the fabrication of the materials at the scale of interest (2-20nm range control).
- Develop computational, fabrication, and process control tools for the design, manipulation, and optimization of the bioprocess or bio-pathway with the target properties necessary for the fine-scale manipulation of bio-fabrication.
- Develop and demonstrate the capability to produce bio-fabricated materials with chemically and/or spatially modulated properties, possibly including controlled doping (n-type, p-type), stacked nano-layers, quantum dots, or 3-D articulated structures in a candidate electronic, optical, or mechanical device material.
- Demonstrate the integrability of bio-fabrication processes with current fabrication and/or micro-fabrication toolsets.
- Design, develop, and demonstrate integrated bio fabricated electronic, optical, or mechanical devices with improved or otherwise unattainable performance or cost characteristics.

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	FY 2005	FY 2006	FY 2007
Bio-Magnetic Interfacing Concepts (BioMagnetICs)	10.150	6.000	4.000

(U) The Bio-Magnetic Interfacing Concepts (BioMagnetICs) Materials program will develop and demonstrate novel capabilities for integrating nanomagnetism with biology and will demonstrate the advantages of magnetism as a powerful new transduction mechanism for detecting, manipulating, and controlling biological function in single cells and biomolecules. The state-of-the-art research “tools” that have allowed researchers to observe the most fundamental units of biology (cells, DNA, proteins, etc.) do not possess the resolution, precision, or high throughput capacity to enable manipulation and/or functional control of large numbers of cells and biomolecules. Such a capability would have a pervasive and paradigm shifting impact on future military and civilian applications of biotechnology including chem-bio detection, therapeutics, and medical diagnostics. Nanoscale magnetism offers the promise of a robust, non-invasive, non-destructive, multiplexing, and high throughput interface that is compatible with the nanometer scale at which the biochemistry of cellular function exists.

(U) Program Plans:

- Develop and demonstrate a portable, magnetism-based DNA detection and readout capability for rapid determination of specific biological warfare agents.
- Develop and demonstrate remotely addressable, magnetism-based biochemical sensors.
- Develop the capability to use magnetism to rapidly filter biotoxins from humans.

	FY 2005	FY 2006	FY 2007
Revolutionizing Prosthetics	0.000	15.000	25.000

(U) The goal of this program is to dramatically change the state of the art of prosthetics, moving them from crude devices with minimal capabilities to fully integrated, fully functional limb replacements. Current prosthetic technology generally provides only gross motor functions, with very crude approaches to control—essentially switches. This often makes it difficult for wounded soldiers to return to a normal life, let alone return to military service. The needed advances will be accomplished by exploiting the dramatic breakthroughs of the Human Assisted Neural

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Devices program (PE 0601101E, Project BLS-01) as well as advances in biointerfaces, structural and smart materials, microelectronics and MEMS, and information sciences.

- (U) Program Plans:
- Demonstrate the ability to implement brain/neural control with sensory feedback in a control architecture that combines the kinetics and mechanics (degrees of freedom) of natural movement, including the realization of proprioception and reflex activity.
 - Develop and demonstrate new materials, microprocessors, sensors and actuators that are both biocompatible and emulate form, function and response of natural biological limbs.
 - Develop and demonstrate new distributed power sources that greatly improve the longevity of limb operation.
 - Develop and demonstrate new approaches to limb healing and prosthetic integration that will dramatically decrease healing time and alleviate the discomfort of wearing prosthetic devices.
 - Demonstrate a neurally controlled prosthetic limb that has the full functionality of a natural limb and transition to Walter Reed Medical Center.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

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