PE NUMBER: 0602102F
PE TITLE: Materials

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602102F Materials

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	107.233	119.498	74.156	78.620	80.183	79.534	80.086	80.579	Continuing	TBD
4347	Materials for Structures, Propulsion, and Subsystems	62.966	72.909	42.499	46.522	47.696	45.328	45.561	45.757	Continuing	TBD
4348	Materials for Electronics, Optics, and Survivability	18.905	22.141	12.139	12.405	12.534	13.216	13.365	13.509	Continuing	TBD
4349	Materials Technology for Sustainment	15.893	17.667	17.060	17.190	17.421	18.311	18.450	18.575	Continuing	TBD
4915	Deployed Air Base Technology	9.469	6.781	2.458	2.503	2.532	2.679	2.710	2.738	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program develops advanced materials, processing, and inspection technologies to reduce life cycle costs and improve performance, affordability, supportability, reliability, and survivability of current and future Air Force systems and operations. The program has four projects that develop: (1) structural, propulsion, and sub-systems materials and processes technologies; (2) electronic, optical, and survivability materials and processes technologies; (3) sustainment materials, processes technologies, and advanced non-destructive inspection methodologies; and (4) air base operations technologies including deployable base infrastructure, force protection, and fire fighting capabilities. Note: In FY 2005, Congress added $1.0 million for Computational Tools for Materials Development, $2.6 million for Advanced Wide Bandgap Materials for RF [Radio Frequency] Technology, $1.7 million for Advanced Silicon Carbide Device Technology, $2.0 million for Domestic Titanium Powder Manufacturing Initiative, $1.0 million for Cost-Effective Composite Materials for Manned and Unmanned Flight Structures, $2.4 million for Blast Resistant Barriers for Homeland Defense, $2.1 million for Advanced Magnetic Random Access Memory Modules, $1.0 million for Optimal Design of Materials Processes, $2.8 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Systems, $2.5 million for Titanium Matrix Composites, $3.6 million for Nanostructured Materials for Advanced Air Systems, $2.5 million for Gallium Nitrate RF Power Technology, $2.1 million for Thermal Sprays for Structural Protection, $2.5 million for ONAMI [Oregon Nanoscience and Microtechnologies Institute] Safer Nanomaterials and Nanomanufacturing, $1.0 million for Non-Linear Optical Materials, $1.0 million for Durable Hybrid Coatings for Aircraft Systems, $1.1 million for Material Science Laboratory, $3.5 million for Advanced Manufacturing Technologies for Metals, Composites (UMR), and $10.5 million for Strategic Partnership for Research in Nanotechnology. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

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(U) B. Program Change Summary ($ in Millions)

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	109.222	73.660	71.548	77.516
(U)	Current PBR/President's Budget	107.233	119.498	74.156	78.620
(U)	Total Adjustments	-1.989	45.838		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-1.062		
	Congressional Increases		46.900		
	Reprogrammings				
	SBIR/STTR Transfer	-1.989			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification		DATE: February 2005
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	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4347	Materials for Structures, Propulsion, and Subsystems	62.966	72.909	42.499	46.522	47.696	45.328	45.561	45.757	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for aircraft and missiles to improve affordability, maintainability, and performance of current and future Air Force systems. A family of affordable lightweight materials is being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide upgraded capabilities for existing aircraft, missile, and propulsion systems to meet the future system requirements. Develops high-temperature turbine engine materials that will enable engine designs to double the turbine engine thrust to weight ratio. Advanced high temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet aerospace and missile requirements. Alternative or replacement materials are being developed to maintain the performance of aging operational systems. Friction and wear-resistant materials, paints, coatings, and other pervasive nonstructural materials technologies are being developed for propulsion and subsystems on aircraft, spacecraft, and missiles. Concurrently develops advanced processing methods to enable adaptive processing of aerospace materials.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop ceramics and ceramic matrix composite technologies for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures.	4.635	4.991	4.138	3.620

(U) In FY 2004: Designed new advanced ceramics and ceramic composites with improved durability and fracture resistance for aircraft applications. Developed advanced analytical techniques to predict the life of advanced ceramic composites containing stress concentration sites. Developed advanced analytical models to design integrally woven, actively cooled ceramic composite structures for advanced combustor applications. Designed advanced ceramic composites for severe environments using the best available fiber-matrix interface technology.

(U) In FY 2005: Develop damage resistant advanced ceramic composites for high friction and fracture-prone environments. Test tip rub tolerant concepts for ceramic blades. Update the advanced ceramic composites life prediction model to permit prediction of its durability under stress gradients, temperature gradients, and long-term thermal exposure. Fabricate and test integrally cooled ceramic composite sub-elements and small components. Develop laboratory-scale advanced fiber-matrix interface concepts, optimizing the robustness of these state-of-the-art ceramic composites in severe environments.

(U) In FY 2006: Design, fabricate, and test advanced ceramic composite coupons and sub-elements for demonstration of durability. Expand the ceramic composite life prediction model to account for complex component shapes and apply to complex turbine component shapes. Develop material/component

acceptance criteria. Validate advanced weaving and design methodology of integrally cooled ceramic composites by designing, fabricating, and testing an annular trapped vortex combustor. Scale up advanced fiber-matrix interface coating concepts and apply to state-of-the-art ceramic composites.

(U) In FY 2007: Demonstrate advanced ceramic composite performance through testing under real and simulated engine service life conditions. Incorporate environmental degradation analysis into the ceramic composite life prediction model to address time dependent degradation associated with environmental exposure and validate the model. Demonstrate the severe environment durability of advanced ceramic composite systems with advanced interfaces via mechanical testing.

(U)

(U) MAJOR THRUST: Develop materials processing technologies involving process models, advanced control methods, and advanced non-invasive sensors. Note: In FY 2005, this effort was incorporated into the next major thrust.	2.425	0.000	0.000	0.000

(U) In FY 2004: Evaluated the use of evanescent microwave sensors for evaluating laser damage and subsurface corrosion. Established baseline parameters for selected techniques for generating large-scale dynamic and phase behavior simulations for nanomaterial process design. Investigated process control of optical deposition for scale-up and stress control of optical and multi-functional coatings for transfer to industry. Initiated studies of processing relationships to produce variation in composites. Investigated nucleation and growth mechanism for single wall carbon nanotubes in order to optimize manufacturing ability.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop enabling polymeric materials for diverse aerospace structural applications including enhanced aircraft canopies, micromechanical devices, advanced wiring concepts, and improved low-observable platforms. Note: This effort includes Congressional Add funding of $15.2 million in FY 2004 and $13.0 million in FY 2005 ($2.5 million for ONAMI Safer Nanomaterials and Nanomanufacturing and $10.5 million for Strategic Partnership for Research in Nanotechnology).	17.698	16.449	3.906	4.233

(U) In FY 2004: Tested clay-infiltrated nanostructured polymeric materials for impermeability of gas and fluids. Developed rapid fabrication of nanoscale three-dimensional structures for Air Force conducting, structural, and electromechanical applications. Tested hybrid thin wires under rigorous environmental conditions and extreme mechanical stresses. Scaled up and completed advanced evaluation of two photon absorbing (TPA) polymer materials for night vision goggle protection. Developed the curing

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process for and initiated testing of composites containing advanced resins. Developed nanostructured polymer materials for low-observable and electromagnetic interference applications.

(U) In FY 2005: Establish the enhanced performance of nanostructured polymeric materials for gas and fluid containment. Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Complete development of a hybrid thin wire making process. Complete development of TPA polymer materials for night vision goggle and sensor protection applications. Test the durability of water borne conductive nanocomposites. Enhance conductive polymeric nanocomposites for use in elimination of secondary conductive coatings for aircraft lightning strike protection. Show the feasibility of lightweight radio frequency polymer substrates for reduced aperture size, conformal radar, and antenna systems.

(U) In FY 2006: Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Develop second-generation TPA materials for night vision goggle and optical limiting applications. Investigate use of photonic crystals to enhance second- and third-order nonlinear optical properties for use in optical limiting applications. Demonstrate improved life for Air Force aircraft tires by incorporation of nanostructured polymeric materials. Validate aromatic hyperbranched polymers as viscosity-lowering additives for structural component manufacture via solvent-free processes. Investigate microfabrication of organic-inorganic nanophotonic structures that have the potential to impact Air Force electromagnetic applications for reduced aperture size, conformal radar, and antenna systems. Begin development of adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Scale up improved polymer proton exchange membranes for high efficiency, long life, lightweight, fuel cell applications. Demonstrate polymer photovoltaic materials for high efficiency, long life, lightweight, solar cell applications.

(U) In FY 2007: Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Continue to develop second-generation TPA materials for night vision goggle and optical limiting applications. Demonstrate optical limiting with improvements in nonlinear optical properties using photonic crystals. Demonstrate improved life nanostructured aircraft tires. Demonstrate aromatic hyperbranched polymers as rheology-modifying additives for structural component manufacture via resin transfer molding processes. Demonstrate organic-inorganic nanostructured materials for Air Force electromagnetic applications. Continue development of adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Demonstrate polymer proton exchange membranes for Air Force fuel cell applications. Demonstrate polymer photovoltaic materials for high efficiency, long life, lightweight, solar cell applications.

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(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures for aerospace subcomponents and other structures requiring thermal and/or structural management for environmental control. Note: This effort includes Congressional Add funding of $5.5 million in FY 2004 and $8.5 million in FY 2005 ($1.0 million for Cost-Effective Composite Materials for Manned and Unmanned Flight Structures, $1.1 million for Materials Science Laboratory, $3.6 million for Nanostructured Materials for Advanced Air Systems, and $2.8 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Systems).	12.930	17.998	10.014	11.075
(U)	In FY 2004: Continued to develop an understanding of degradation mechanisms and life prediction capabilities for aircraft turbine engine and exhaust-washed structures as a function of their environments. Validated materials, processing, and fabrication scale-up of high-temperature organic matrix composites for turbine engines, aircraft and high-speed vehicle applications. Evaluated nanomaterials technologies for multifunctional properties required by military aircraft and satellites. Evaluated innovative carbon materials, such as carbon foams, and processing techniques for aircraft thermal management applications.				
(U)	In FY 2005: Develop life prediction capabilities for high temperature turbine engines and airframe hot structures. Optimize materials and processing scale-up of high temperature organic matrix composites for affordable turbine, aircraft structures, and high-speed vehicle applications. Develop materials and processes for nanomaterials as matrix additives and/or high performance composites with tailored and multi-functional capabilities. Test materials and processes at the subcomponent level for improved reliability and performance for thermal management applications.				
(U)	In FY 2006: Continue development of life prediction capabilities for high temperature turbine engine and airframe hot structures. Demonstrate high temperature organic matrix composites onto relevant DoD platforms. Investigate and assess future requirements for material development as applied to next generation high-speed vehicle applications. Continue development of materials and processes for nanotailored composites with multifunctional capabilities. Initiate nanomaterial modeling efforts. Continue demonstration of novel materials and processes that enhance the reliability and performance of thermal management subsystems.				
(U)	In FY 2007: Demonstrate tools and methodologies required for life prediction of materials in high temperature turbine engine and airframe structures environments. Continue demonstration of high temperature organic matrix composites onto relevant DoD platforms. Initiate new material development and affordable processing for space and high-speed vehicle applications. Continue development of new materials and processes for nanotailored composites with multifunctional capabilities. Continue nanomaterial modeling and technology efforts. Continue development and demonstration of advanced				

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material concepts and processes for thermal management applications.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop nonstructural materials for fluids, lubricants, aircraft topcoat and corrosion resistant coatings, and specialty treatments to improve system performance and reduce life cycle costs. Note: This effort includes Congressional Add funding of $1.2 million in FY 2004 and $1.0 million in FY 2005 for Durable Hybrid Coatings for Aircraft Systems.	7.948	9.035	9.282	10.052

(U) In FY 2004: Formulated the most promising electrically conductive elastomers for specific electrostatic discharge control gap treatments. Continued to develop advanced analytical techniques to predict the optical properties of specialty coatings. Developed non-chromate surface treatments with advanced performance coatings for aircraft corrosion protection systems. Developed environmentally friendly corrosion protection systems with a 30-year life expectancy. Evaluated nanostructured multifunctional coatings to control friction and wear in extreme environments. Refined candidate surface treatments for friction, stiction, and wear control in micro-devices.

(U) In FY 2005: Fabricate candidate materials for use in electrostatic discharge control gap treatments. Refine the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Continue to develop non-chromate surface treatments with advanced performance coatings for aircraft corrosion protection systems. Continue to develop environmentally friendly corrosion protection systems with a 30-year life expectancy. Design and develop nanostructured multifunctional coatings to control friction and wear in extreme environments. Fabricate and test surface treatments for friction, stiction, and wear control in micro-devices.

(U) In FY 2006: Evaluate candidate materials for use in electrostatic discharge control gap treatments. Validate the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Demonstrate non-chromate surface treatments via flight test. Continue to develop environmentally friendly corrosion protection systems with a 30-year life expectancy. Continue to develop nanostructured multifunctional coatings to control friction and wear in extreme environments. Continue testing of surface treatments for friction, stiction, and wear control in micro devices.

(U) In FY 2007: Demonstrate candidate gap treatment materials on air vehicles. Complete validation of the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Continue to demonstrate and validate the non-chromate surface treatments for aircraft corrosion protection systems. Formulate chrome-free primer for corrosion protection systems with a 30-year life expectancy. Validate multifunctional coatings on engineering components. Downselect surface treatment candidates for further development for friction, stiction, and wear control in micro devices.

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(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable lightweight metallic materials, behavior and life prediction technologies, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition costs, increased durability, and improved reliability for Air Force weapon systems. Note: This effort includes Congressional Add funding of $3.9 million in FY 2004 and $10.0 million in FY 2005 ($3.5 million for Advanced Manufacturing Technologies for Metals, Composites (UMR), $2.0 million for Domestic Titanium Powder Manufacturing Initiative, $2.5 million for Titanium Matrix Composites, $1.0 million for Computational Tools for Materials Development, and $1.0 million for Optimal Design of Materials Processes).	17.330	24.436	15.159	17.542
(U)	In FY 2004: Initiated development of new life prediction technologies for improving aircraft turbine engine rotor durability in thermal-mechanical fatigue design systems. Continued to develop and analyze second-generation high-temperature structural materials that are nickel- and molybdenum-based for turbine engine applications. Developed computational methods for modeling mechanical properties of metals and alloys and validated these tools so that they can be used to reduce the amount of proof testing required to release metals for final component production. Identified processes and protocols for unitized manufacturing of aerospace components.				
(U)	In FY 2005: Develop reliable life extension capabilities for turbine engine rotors. Evaluate performance of high-temperature structural materials through preliminary certification testing and/or ground-based engine rig testing. Initiate concept identification of advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Develop and mature computational methods of modeling mechanical properties to metal suppliers and vendors to enable cost and schedule savings due to reduced amount of proof and release testing. Evaluate processes and protocols for unitized manufacturing of aerospace components.				
(U)	In FY 2006: Demonstrate reliable life extension capability for turbine engine rotors. Explore materials-damage predictive approaches for engine health determination and life extension capability. Explore advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Explore computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems. Continue the identification of processes and protocols for unitized manufacturing of aerospace components.				
(U)	In FY 2007: Develop materials-damage predictive approaches for engine health determination and life extension capability. Continue exploration of advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Develop computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems. Demonstrate processes and protocols for unitized manufacturing of				

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aerospace components.

(U)	Total Cost					62.966	72.909	42.499	46.522	

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0603112F, Advanced Materials for Weapon Systems.										
(U) PE 0603211F, Aerospace Technology Dev/Demo.										
(U) PE 0603202F, Aerospace Propulsion Subsystems Integration.										
(U) PE 0603216F, Aerospace Propulsion and Power Technology.										
(U) PE 0602500F, Multi-Disciplinary Space Technology.										
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

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	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4348	Materials for Electronics, Optics, and Survivability	18.905	22.141	12.139	12.405	12.534	13.216	13.365	13.509	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops materials technologies for surveillance and situational awareness systems and subsystems for aircraft and missile applications, including sensor, microwave, and infrared detection and countermeasures devices used for targeting, electronic warfare, and active aircraft protection. Materials for protection of aircrews, sensors, and aircraft from laser and high-power microwave directed energy threats are also developed. Electronic and optical materials are being developed to enable surveillance and situational awareness with faster operating speeds, greater tunability, higher power output, improved thermal management (including higher operating temperatures), greater sensitivity, and extended dynamic range. New materials are being developed to counter the most prominent laser threats and to respond to emerging and agile threat wavelengths without impairing mission effectiveness.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop, evaluate, and mature infrared (IR) detector materials and materials processing technologies to enable improved performance, affordability, and operational capability of Air Force surveillance, tracking, targeting, and situational awareness systems.	0.464	0.500	0.658	0.663

(U) In FY 2004: Validated the military utility of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Exploited validated processing techniques to develop enhanced IR detector materials performance and improve military utility. Demonstrated the process control required for growth of complex IR detector materials that require control on an atomic level to structure their detection properties. Investigated potential nano-scale materials solutions for detectors for a broad range of Air Force sensing needs including the detection of chemical threats.

(U) In FY 2005: Continue development of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Validate the materials properties of complex IR detector materials that require control on an atomic level to structure their detection properties. Develop promising innovative nano-scale materials as potential IR materials for a broad range of Air Force sensing needs including the detection of chemical threats.

(U) In FY 2006: Provide prototype growth, characterization, and analyses of potential IR materials systems to determine unique properties of interest to Air Force users. Develop the process control to enable ordered growth of two-dimensional, abrupt compositional interfaces in multiple wavelength materials. Validate the optical properties of advanced IR materials by optical characterization and evaluation of complex IR detector materials that have been produced by atomic level control. Explore methods of controlling materials composition, shape, and size on a nano-scale level and validate by structural

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	characterization.				
(U)	In FY 2007: Validate optical, structural, and electronic properties of innovative IR materials to determine their ability to provide unique IR detection properties of interest to the Air Force. Characterize and evaluate the utility of single element multispectral IR materials with responses to more than two discrete wavelengths. Investigate the potential for three-dimensional material growth to exploit unique detection properties of complex IR materials. Validate promising materials growth technologies for nano-scale IR detection materials.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate materials technologies to enhance the safety and survivability of aircrews and related assets. Note: This effort includes Congressional Add funding of $1.0 million in FY 2005 for Non-Linear Optical Materials.	4.836	6.747	4.920	5.033
(U)	In FY 2004: Investigated growth and processing techniques for nonlinear optical crystals including surface coatings and nanostructuring for generating radiation with significantly higher energy per pulse for future infrared countermeasures (IRCM). Optimized the performance of promising nonlinear absorbing materials in candidate host materials and tested their improved performance in the Air Force Optical Limiting Testbed for the protection of personnel eyes, viewing systems, and night vision goggles.				
(U)	In FY 2005: Develop growth and processing techniques for nonlinear optical crystals for generating radiation at significantly higher energies. Characterize the performance of the optimized nonlinear absorbing materials in candidate host materials and document the test results obtained for the protection of personnel eyes and viewing systems.				
(U)	In FY 2006: Continue to characterize the performance of optimized nonlinear absorbing materials into device concepts for eye and sensor system protection.				
(U)	In FY 2007: Incorporate optimized nonlinear optical limiter materials for damage protection of eyes and sensor systems.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate materials and process technologies for power generation, power control, and microwave components to provide improved performance, affordability, and operational capability for Air Force surveillance, tracking, targeting, situational awareness, and lethal and non-lethal weapon systems. Note: This effort includes Congressional Add funding of $4.3 million in FY 2004 and $8.9 million in FY 2005 ($2.6 million for Advanced Wide Bandgap Materials, $2.5 million for Gallium Nitrate RF Power Technology, $1.7 million for Advanced Silicon Carbide Device Technology, and $2.1 million for Advanced Magnetic Random Access Memory Modules).	8.150	13.052	4.760	4.866
(U)	In FY 2004: Continued evaluation of materials and materials processing technologies to enable				

increased Air Force systems reliability and temperature capability, while reducing power consumption, weight, cost, cooling, complexity, and size. Continued development and testing of materials and processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Completed scale-up and maturation of baseline materials and materials process technologies for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Explored materials and materials process technologies for Terahertz components to provide the bandwidth required for the next order of magnitude leap in speed of Air Force sensor and communication systems.

(U) In FY 2005: Enhance specific baseline materials and materials processing technologies to enable increased Air Force systems reliability and temperature capability, while reducing power consumption, weight, cost, cooling, complexity, and size. Investigate advanced materials and materials processing technologies to provide capabilities beyond those achievable with baseline materials. Optimize and scale up materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Complete assessment of baseline materials and materials process technologies for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Develop advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes. Develop and analyze materials and materials process technologies for Terahertz components to provide the bandwidth required for the next order of magnitude leap in speed of Air Force sensor and communication systems.

(U) In FY 2006: Demonstrate scale-up of materials and materials processes for power control systems, advanced radar, and electronic countermeasures. Continue development of advanced materials and materials process technologies to enable airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft, and an order of magnitude improvement in speed for Air Force sensor and communication systems. Demonstrate scale-up of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Continue development of advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Continue development of materials and materials process technologies for Terahertz components supporting order of magnitude improvement in speed for Air Force sensor and communication systems. Identify most promising materials approaches for application to initial prototype evaluation.

(U) In FY 2007: Demonstrate capabilities of advanced materials and materials process technologies to

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enable airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Validate and demonstrate selected materials and materials process technologies for use in Terahertz components. Continue to demonstrate scale-up of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Demonstrate capabilities of advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Validate and demonstrate selected materials and materials process technologies for use in Terahertz components, supporting high speed communications and advanced sensors.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensors and viewing systems. Note: This effort includes Congressional Add funding of $3.8 million in FY 2004.	5.455	1.842	1.801	1.843
(U) In FY 2004: Validated the performance of liquid crystal materials employed in autonomous tunable filters. Fabricated laboratory samples of high optical density, multiple-wavelength switchable filter stacks.				
(U) In FY 2005: Design a representative brassboard protection system using liquid crystal-based tunable filters. Characterize the optical performance of high optical density, multiple-wavelength switchable filter stacks.				
(U) In FY 2006: Develop photorefractive materials for passive protection applications and develop device concepts that utilize photorefractive materials. Optimize the performance of high optical density, multiple-wavelength switchable filter technology for Air Force applications.				
(U) In FY 2007: Optimize photorefractive materials properties for Air Force passive protection applications. Incorporate switchable filter technology into device concepts for eye and sensor system protection.				
(U) Total Cost	18.905	22.141	12.139	12.405

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0603112F, Advanced										
(U) Materials for Weapon Systems.										
(U) PE 0602202F, Human										

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(U) C. Other Program Funding Summary ($ in Millions)

(U) Effectiveness Applied Research.

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603231F, Crew Systems and Personnel Protection Technology.

(U) PE 0603211F, Aerospace Technology Dev/Demo.

(U) PE 0602500F, Multi-Disciplinary Space Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602102F Materials	PROJECT NUMBER AND TITLE: 4349 Materials Technology for Sustainment	

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4349	Materials Technology for Sustainment	15.893	17.667	17.060	17.190	17.421	18.311	18.450	18.575	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops materials and materials processing technologies to support operational Air Force mission areas by providing the ability to inspect the quality of delivered systems, transitioning more reliable and maintainable materials, establishing a capability to detect and characterize performance threatening defects, characterizing materials processes and properties necessary for materials transition, and providing quick reaction support and failure analysis to the operational commands and repair centers. Repair techniques and nondestructive inspection/evaluation (NDI/E) methods are developed that are needed for metallic and non-metallic structures, coatings, corrosion control processes, and to support integration of composite structures for aerospace systems. Various NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, propulsion, and missile systems. These NDI/E methods are also essential to monitor and detect the onset of any service-initiated damage and/or deterioration due to aging of operational systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop NDI/E technologies to identify and characterize damage in aging aerospace structures, propulsion systems, and complex, low-observable (LO) materials and structures.	3.320	3.759	3.747	3.837

(U) In FY 2004: Improved methods to inspect and maintain the integrity of aging aerospace structures and propulsion systems. Developed electromagnetic methods to rapidly detect and characterize multi-site damage and cracks in large-area, aging structures. Developed computer simulations and models of NDI/E technique response, which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection NDI/E methods. Evaluated technology concepts for measuring complex electromagnetic material properties beneath dielectric tiles in LO applications. Developed residual stress gradient measurement capability for selected turbine engine materials to increase measurement depth capabilities on shot peened surfaces.

(U) In FY 2005: Evaluate electromagnetic methods to rapidly detect and characterize multi-site damage and cracks in large area, aging structures. Evaluate computer simulations and models of NDI/E technique response, which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection NDI/E methods. Develop sensor technologies for measuring complex electromagnetic material properties beneath dielectric tiles. Continue development of a residual stress gradient measurement capability for selected turbine engine materials for shot peened surfaces.

(U) In FY 2006: Demonstrate electromagnetic technology to detect and characterize multi-site damage and

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	cracks in large area, aging structures. Develop computer simulations and models of NDI/E technique response to enable rapid assessment of multiple NDI/E technologies for depot level inspections. Initiate efforts to explore and develop NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Evaluate feasibility of advanced LO NDI/E methods and systems for use in battle damage assessment and for inspection following battle damage repair. Transition sensor technology for measuring complex electromagnetic material properties beneath dielectric tiles.				
(U)	In FY 2007: Continue to develop computer simulations and models of NDI/E technique response to enable rapid assessment of multiple NDI/E technologies for depot level inspections. Develop NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Develop advanced LO NDI/E methods and systems for use in battle damage assessment and for inspection following battle damage repair.				
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(U)	MAJOR THRUST: Develop enabling technologies to reduce the Air Force LO maintenance burden.	3.693	4.007	4.068	3.991
(U)	In FY 2004: Completed development of NDI/E point inspection device capability. Developed a standardized LO repair kit for use on multiple aircraft systems, which will result in standardization of aircraft repair processes that includes conductive gap fillers, radar absorbing material (RAM) repair materials, RAM removal equipment, radar absorbing structure (RAS) repair materials, and NDI/E equipment and software.				
(U)	In FY 2005: Optimize technologies for an integrated, standardized LO repair kit that includes conductive gap fillers, RAM repair materials, RAM removal equipment, RAS repair materials, and NDI/E equipment and software.				
(U)	In FY 2006: Develop multispectral/multipurpose tool for inspection of LO systems on aircraft. Investigate program for improved maintainability of advanced LO materials and designs including conductive outer-mold-line, applique, door edges and seals, multifunctional systems, and embedded LO NDI/E.				
(U)	In FY 2007: Design prototype multispectral/multipurpose tool for inspection of LO systems on aircraft. Develop technologies for improved maintainability of advanced LO materials and designs including conductive outer-mold-line, applique, door edges and seals, multifunctional systems, and embedded LO NDI/E.				
(U)					
(U)	MAJOR THRUST: Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis of components.	3.610	4.001	4.110	4.141
(U)	In FY 2004: Continued performing failure analysis and materials investigations for field, acquisition, and depot organizations. Developed electrostatic discharge protection technologies for emerging				

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avionics subsystems. Developed new test methodologies for analyzing structural failures of replacement materials for aging Air Force systems. Investigated materials technologies effort to replace aging wiring in Air Force aircraft subsystems.

(U) In FY 2005: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Continue to develop electrostatic discharge protection technologies for emerging avionics subsystems. Validate new test methodologies for analyzing structural failures of replacement materials for aging Air Force systems. Develop materials technologies effort to replace aging wiring in Air Force aircraft subsystems.

(U) In FY 2006: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Demonstrate electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Evaluate new test methodologies for analyzing structural failures of emerging materials for Air Force systems. Evaluate wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.

(U) In FY 2007: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Continue demonstration of electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Validate new test methodologies for analyzing structural failures of emerging materials for Air Force systems. Evaluate/validate wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.

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(U) MAJOR THRUST: Develop support capabilities, information, and processes to resolve problems with materials in the repair of aircraft structures and to reduce aircraft corrosion.	5.270	5.900	5.135	5.221

(U) In FY 2004: Developed and evaluated methodologies to determine corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Identified failure mechanisms in micro-electro-mechanical systems (MEMS) used in hybrid, multifunctional, or status monitoring structures and subsystems.

(U) In FY 2005: Mature methodologies to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Evaluate methodologies to test failure limits for MEMS structures and subsystems. Develop specification for laser additive manufacturing of non flight critical parts. Demonstrate effectiveness of low plasticity burnishing of landing gear components. Assess effectiveness of corrosive preventative compounds for various Air Force applications.

(U) In FY 2006: Apply methodologies to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Continue to evaluate methodologies to test failure limits for MEMS structures and subsystems. Evaluate effects of defects in laser additive manufactured parts.

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(U) In FY 2007: Continue to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Continue to evaluate methodologies to test failure limits for MEMS structures and subsystems. Validate effects of defects in laser additive manufactured parts.

(U) Total Cost	15.893	17.667	17.060	17.190

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0603112F, Advanced Materials for Weapons Systems.										
(U) PE 0603211F, Aerospace Technology Dev/Demo. This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT NUMBER AND TITLE: 4915 Deployed Air Base Technology

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4915	Deployed Air Base Technology	9.469	6.781	2.458	2.503	2.532	2.679	2.710	2.738	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs, and to improve protection and survivability of deployed Air Expeditionary Force (AEF) warfighters. Affordable, efficient technologies are developed for base infrastructure, fire fighting, and force protection to improve deployed operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations. Note: This effort includes Congressional Add funding of $1.2 million in FY 2004.	2.201	1.143	1.279	1.302

(U) In FY 2004: Matured deployable fuel cell power system to advanced technology development. Continued development of high-efficiency, solid state solar cell technology. Initiated development of an advanced, compact integrated shelter/utility system that will integrate fuel cell and solar power with heat pump technologies to provide highly efficient, individual systems for deployable shelters. Initiated research on polymer-clay stabilization technology for rapid airfield expansion that will reduce the time required to prepare aircraft operating surfaces at contingency bases. Initiated research on catalysis and degradation of Air Force materials that will provide cleaner and lower cost advanced materials.

(U) In FY 2005: Develop high-efficiency, solid state solar cell technology. Develop advanced heat and mass transfer technologies and thin film catalytic technologies to improve deployed energy system performance. Develop an advanced work-recovery rotary expansion device to improve deployed air conditioning performance. Develop polymer-clay stabilization agents for rapid airfield expansion that will reduce time to prepare aircraft operating surfaces. Evaluate catalysis and degradation technologies to provide cleaner, lower cost advanced materials.

(U) In FY 2006: Investigate fabrication techniques to integrate solid state solar cell technology into deployable shelter fabrics. Continue to develop advanced heat and mass transfer technologies and thin film catalysis for logistic fuel processing planar technology. Continue to develop an advanced work-recovery rotary expansion device to improve deployed air conditioning performance. Demonstrate polymer-clay stabilization agents for rapid airfield expansion. Refine ground penetrating radar interpretation capability to improve man-portable rapid airfield assessment. Develop biomaterials that produce similar effects as chemical catalysts for improved reactive production of aerospace materials.

(U) In FY 2007: Develop high-efficiency solar shelter fabrics. Continue development of advanced heat and mass transfer technologies and demonstrate logistic fuel processing planar technology. Investigate

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behavior of soil and stabilizer interaction with airfield matting and begin model development. Develop non-radar wave methods of nondestructive inspection of airfield surface anomalies. Synthesize polymer materials using biocatalysts and reagents for producing reduced cost, tailored characteristics in aerospace materials.

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(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable technologies to provide force protection and survivability to Air Expeditionary Force (AEF) deployed warfighters and infrastructure. Note: This effort includes Congressional Add funding of $6.4 million in FY 2004 and $4.5 million in FY 2005 ($2.4 million for Blast Resistant Barriers for Homeland Defense and $2.1 million for Thermal Sprays for Structural Protection).	7.268	5.638	1.179	1.201

(U) In FY 2004: Continued development of fire fighting foam agents in conjunction with combined fire suppressant equipment and advanced blast protection materials to protect deployed warfighters. Developed and evaluated polymer-based retrofit technologies for expeditionary and permanent structures to protect the warfighter.

(U) In FY 2005: Develop more effective fire fighting agents and application methodologies for protection of warfighters. Develop technologies for increased firefighter situational awareness, improved synergy, and greater on-site duration. Initiate research on resilient infrastructure technologies for more effective protection of structures and inhabitants. Characterize ballistic and fragmentation aspects of improvise explosive device threats for development of protective measures. Characterize the atmospheric and surface action and interaction of asymmetric threat agents for protection of aerospace warfighters and equipment.

(U) In FY 2006: Develop fire fighting agents with increased versatility by combining agents and application methodologies. Continue developing technologies for increased fire fighter situational awareness, improved synergy, and greater on-site duration. Continue research on resilient infrastructure technologies for more effective protection of structures and inhabitants. Develop technologies to protect against the ballistic and fragmentation effects of improvised explosive device threats and characterize high energy weapons threats. Model atmospheric and surface phenomenon of in-theater chemicals and asymmetric threats for tailored response protection.

(U) In FY 2007: Demonstrate emerging fire suppression technologies for integrated crash/rescue capability. Integrate individual fire fighter effectiveness technologies for a combined technology demonstration. Demonstrate resilient structural materials and methodologies for improved protection of structures and inhabitants. Continue developing technologies to protect against the ballistic and fragmentation effects of improvised explosive device threats, and initiate protective material development against high energy threats. Develop characterization data for atmospheric models for protection of deployed warfighters from asymmetric threats.

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(U) Total Cost	9.469	6.781	2.458	2.503

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0603112F, Advanced (U) Materials for Weapon Systems. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.