Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*					R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	37.707	29.041	26.585	-	26.585	29.955	31.013	32.280	33.344	Continuing	Continuing
H7B: *Advanced Materials Initiatives (CA)*	-	7.968	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
H7G: *Nanomaterials Applied Research*	-	5.156	4.912	3.989	-	3.989	5.622	6.696	7.789	8.393	Continuing	Continuing
H84: *Materials*	-	24.583	24.129	22.596	-	22.596	24.333	24.317	24.491	24.951	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

FY12 reprogramming of Congressional add for Silicon Carbide research to PE 0602705A

A. Mission Description and Budget Item Justification

This program element (PE) evaluates materials for lighter weight and more survivable armor and for more lethal armaments. Project H7G researches and explores nanostructure materials properties and exploits the strength and durability of these materials to enable lighter weight, increased performance in Soldier weapons and protection applications. Project H84, researches a variety of materials and designs, fabricates and evaluates performance of components for lighter weight Soldier and vehicle armors, armaments, and electronics.

Work in this PE builds on the materials research transitioned from PE 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics) and PE 0601104A (University and Industry Research Centers), project J12 (Institute for Soldier Nanotechnologies). This work complements and is fully coordinated with PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Ballistics Technology), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), and PE 0708045A (Manufacturing Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

Work is performed by the Army Research Laboratory (ARL), Adelphi, MD and Aberdeen Proving Ground, MD, and the Massachusetts Institute of Technology.

Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army					DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*			R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*		
B. Program Change Summary ($ in Millions)	**FY 2012**	**FY 2013**	**FY 2014 Base**	**FY 2014 OCO**	**FY 2014 Total**
Previous President's Budget	50.679	29.041	26.592	-	26.592
Current President's Budget	37.707	29.041	26.585	-	26.585
Total Adjustments	-12.972	0.000	-0.007	-	-0.007
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-12.500	-			
• SBIR/STTR Transfer	-0.472	-			
• Adjustments to Budget Years	-	-	-0.007	-	-0.007

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H7B: *Advanced Materials Initiatives (CA)*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H7B: *Advanced Materials Initiatives (CA)*	-	7.968	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Nanotechnology Research	7.968	0.000	0.000
Description: This was Congressional Interest Item.			
FY 2012 Accomplishments: Congressional add funding for Nanotechnology Research			
Accomplishments/Planned Programs Subtotals	7.968	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H7G: *Nanomaterials Applied Research*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H7G: *Nanomaterials Applied Research*	-	5.156	4.912	3.989	-	3.989	5.622	6.696	7.789	8.393	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This effort conducts nanoscience research relevant to the Soldier focused on new materials, properties and phenomena in five research areas: (1) lightweight, multifunctional nanostructured materials and hybrid assemblies, (2) soldier medicine, (3) multiple blast and ballistic threats, (4) hazardous substances sensing, recognition, and protection, and (5) nanosystem integration for protected communications, diagnostic sensing, and operational flexibility in complex environments. This project funds collaborative applied research and integration of government, academic, and industry scientific research on nanomaterials derived from PE 0601104A/ project J12 (Institute for Soldier Nanotechnologies (ISN)) to advance innovative capabilities.

This project sustains Army science and technology efforts supporting the Soldier portfolio.

Work in this project builds on the materials research transitioned from PE 0601104A. This work complements and is fully coordinated with PE 0602618A (Ballistics Technology), PE 0602786A (Warfighter Technology), and PE 0603001A (Warfighter Advanced Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD and Aberdeen Proving Ground, MD, the Massachusetts Institute of Technology, and the ISN industrial partners.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Nanomaterials Applied Research	5.156	4.912	3.989
Description: Devise and validate improved physics-based, materials property models and concepts for multifunctional, lightweight, and responsive materials. Exploit breakthroughs in nanomaterials and multifunctional fiber processing technologies (e.g., scale-up of processes and fabrication into woven materials) to enable revolutionary future Soldier capabilities.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H7G: *Nanomaterials Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Investigated the incorporation of nanoparticles, nanotubes and nanofibers into materials systems to produce novel sensing capabilities for enhanced situational awareness. ***FY 2013 Plans:*** Continue to design novel sensor and imaging devices based on carbon nanotube, quantum dot, and photonic crystal technologies; and scale-up nanometallic aluminum alloy processing to characterize performance as potential ballistic protective materials. ***FY 2014 Plans:*** Will develop quantum dot-based optical taggant system that will enable daylight visible tag, track, and locate (TTL) and combat identification capabilities; validate hydrophobic and antimicrobial coating technology on fabrics; and validate high rate response of nanometallic aluminum alloys for use in lightweight protection systems.			
Accomplishments/Planned Programs Subtotals	5.156	4.912	3.989

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army			DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H84: *Materials*	

COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H84: *Materials*	-	24.583	24.129	22.596	-	22.596	24.333	24.317	24.491	24.951	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project designs, fabricates, and evaluates a variety of materials (including metals, ceramics, polymers, and composites) that have potential to enable more survivable, lighter weight Soldier and vehicle armor, chemical and biological protection, armaments, and electronics. Research conducted focuses on unique and/or novel material properties, developing physics-based models, materials characterization techniques, non-destructive testing methods and advanced fabrication/processing methodologies.

This project sustains Army science and technology efforts supporting the Ground and Soldier portfolio.

Work in this project makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics) and project H43 (Ballistics). The work complements and is fully coordinated with efforts in PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Survivability and Lethality Technologies), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), and PE 0708045A (Manufacturing Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

The work is conducted by the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Title: Structural Armor	6.823	4.363	2.485
Description: Conduct applied research to design and evaluate lightweight armor materials and structures, investigate novel processing methodologies for cost effective manufacturing, and utilize existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications.			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H84: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Developed and validated model capability for composite materials that included high rate effects, thermal effects and fatigue; characterized the high rate properties of structural adhesives and synthesized novel adhesive compositions for inclusion in emerging armor solutions. ***FY 2013 Plans:*** Investigate novel mechanical deformation processing of magnesium alloy plates that potentially provide very lightweight metal structural materials; provide corrosion mapping for promising aluminum and magnesium alloys and investigate corrosion inhibitors to enable the alloys use for future applications; document materials properties information (such as adhesive strength) for an adhesive database to be used in close collaboration with manufacturers and research universities; fabricate novel boron sub-oxide ceramic materials for use in protection applications; and validate progressive failure analysis methods and progressive fatigue damage model of composites under various loadings and composite configurations to improve long term reliability of composite materials. ***FY 2014 Plans:*** : In ceramic armor materials will determine relationships between electronic signals from non-destructive characterization tools and microscopically observed structural details and develop analysis algorithms used for modeling, process feedback and ballistic characteristics; will develop aluminum alloys for blast and penetration resistance, emphasizing full scale fabrication for alloy chemistries optimized for the most beneficial metallurgical, mechanical and formability characteristics; develop novel processing strategies for polymer compositions to enable tunable mechanical response; apply processing science, and modeling and simulation to validate processing technology for the metallic encapsulation of ceramic armor tiles.			
Title: Soldier-Borne Armor Materials	2.759	3.252	5.398
Description: Utilizing understanding of defeat mechanisms from PE62618/Project H80, conduct applied research of emerging lightweight armor materials and structures to enable affordable design of multifunctional ballistic protective systems for the future Soldier. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new lethal mechanisms/protection schemes for the individual Warfighter. ***FY 2012 Accomplishments:*** Provided the capability to non-destructively characterize the relationship between ceramic tile quality and ballistic performance; and validated the synthesis of rate dependent soft material tissue surrogates for the development and characterization of personnel armor concepts. ***FY 2013 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H84: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Investigate novel materials such as three-dimensional ceramics and fabrics to provide breakthrough technologies for protecting the dismounted soldier under ballistic and blast conditions based on human tissue response data; design novel hybrid material systems with associated processing science to provide lighter, more flexible, more durable and affordable protection to Soldiers and vehicles; transition fabric ballistic modeling tools to armor designers at Natick Soldier Research, Development, and Engineering Center and Tank and Automotive Research, Development, and Engineering Center. ***FY 2014 Plans:*** Will develop synthesis and processing routes for low density boron-based ceramic compositions, provide model validation using high resolution electron microscopy; develop soft polymers through computational methods and experimental validation to match the rate dependent response of relevant human tissues; develop a robust fiber ballistic modeling tool to investigate penetration resistance of up to 10 layers of 2D fabric with multiple fiber or material architectures and validate with ballistic testing; develop a refined process model to describe the deformation characteristics and fiber-matrix adhesion, provide experimental validation.			
Title: Composites ***Description:*** This effort designs, models, validates, and optimizes advanced materials (such as ceramic, composite, polymers, lightweight and high-strength metals) including processing techniques for protection against smaller but more lethal penetrators/ warheads using affordable, lightweight, high performance armaments for revolutionary weapons effectiveness in urban and irregular operations. ***FY 2012 Accomplishments:*** Developed cold spray techniques to successfully deposit novel material compositions in confined spaces; validated methods for the composite cladding of advanced gun barrel designs; and validated improvements in gun barrel erosion. ***FY 2013 Plans:*** Evaluate composite cladding for reduced gun barrel erosion and transition to the Armaments Research, Development, and Engineering Center; demonstrate ordered structures in various media for active and passive wave mitigation and pulsation management for blast applications and acoustic damping. ***FY 2014 Plans:*** Will validate improved multi-hit ballistic capability of three-dimensional, through-thickness reinforced (3D-TTR) hybridized composite test coupons; through the use of computational and experimental methods, design and prepare polymer resins derived from renewable sources that provide properties at least equivalent to conventionally prepared polyether ether ketone (PEEK); develop materials models and experimental techniques to validate >50% improvement in the adhesion of dissimilar materials used in vehicle protection platforms.	3.916	3.000	2.932
Title: Electronic Materials	0.514	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H84: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Design and optimize electro-ceramic materials and processing techniques for integration by the Communications-Electronics Research, Development, and Engineering Command (CERDEC) into advanced antennas that will enable affordable and reliable command, control and communications (C3) for current and future force platforms. ***FY 2012 Accomplishments:*** Developed the material designs, fabrication methods, and process science protocols required for CERDEC to achieve high quality, affordable, performance consistent, tunable beam steering antenna elements.			
Title: Multifunctional Armor Materials ***Description:*** This effort researches novel multifunctional armor materials for Army applications such as structural energy storage, armor embedded C3 antennas, and self healing materials. Soldier personnel protection materials transition to PE 0602786A, project H98. Reactive armor and electromagnetic armor materials transition to PE 0602618A, project H80 and PE 0602601A, project C05. In FY 13, this effort supports Technology Enabled Capability Demonstration 1c: Force Protection-Occupant Centric Platform [Ultralightweight and Multifunctional Materials for Personnel and Vehicle Protection]. ***FY 2012 Accomplishments:*** Provided new multifunctional composite materials with structural and power storage capability; developed synthesis routes for soft polymer nano-composites with controllable electrical properties; and provided composite materials with improved damage tolerance for use in ultra-lightweight structures and armors. ***FY 2013 Plans:*** Design, synthesize, and characterize fiber materials based on biological material mechanics; transition new self-healing technologies to composite fabricators to enhance materials durability; create analytical models to design battery storage composites that can be used in future multifunctional structural composite materials that provide structure and energy storage; investigate improvements in resins, reinforcements, electrodes, and processing techniques to fabricate relevant-size structural capacitors for future multifunctional structural composite materials. ***FY 2014 Plans:*** Will research comprehensive armor materials technologies which include multifunctional batteries and/or capacitors (combined structural armor/power storage materials) with minimum of 1 Wh/kg (energy density), 100 mW/Kg (power density), 20 GPa strength (fiber direction); support total armor materials development via formulation of e chemical agent resistive coatings (CARC) to reduce corrosion, improve decontamination and lessen solar loading; assess non-local theory and numerical methods for the failure of complex materials subjected to strong electromagnetic fields, validate with experiments; determine synthetic viability of novel third generation chromophores for use in thick polymer laser protective materials.	9.027	11.778	9.977
Title: Nanomaterials	1.544	1.736	1.804

Exhibit R-2A, RDT&E Project Justification: PB 2014 Army		DATE: April 2013
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602105A: *MATERIALS TECHNOLOGY*	PROJECT H84: *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Description: Mature and scale-up nanomaterials processes, fabrication, characterization and performance measures to enable revolutionary concepts for future force lethality and survivability beyond those addressed for individual Soldier protection in project H7G. ***FY 2012 Accomplishments:*** Validated nanograined metallic structures fabrication process using thermodynamic techniques, and provided an initial validation of the improvement in the ballistic capability of transparent materials reinforced with natural cellulose nanofibers. ***FY 2013 Plans:*** Design synthetic, strain rate dependent polymers to mimic human body tissue; design and evaluate blast resistant cellular topologies using bio-inspired computational algorithms; demonstrate transparent, nano-architectured cellulose based composite materials; and investigate nano-tungsten materials to evaluate engineering properties for ballistic launch survivability. ***FY 2014 Plans:*** Will develop thermally stable, dispersible nanocrystalline cellulose for use in transparent materials to improve the stiffness by 25% without optical penalty; develop powder production technology for reliable, cost effective production of domestic nano-crystalline tungsten; identify tungsten carbide microstructures and properties for rigid body penetration of armor; develop environmentally friendly binder materials for tungsten carbide.			
Accomplishments/Planned Programs Subtotals	24.583	24.129	22.596

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.