Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602105A *I Materials Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	81.950	29.640	28.600	-	28.600	28.823	31.268	33.017	34.894	0.000	268.192
H7B: *Advanced Materials Initiatives (CA)*	-	51.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.000
H7G: *Nanomaterials Applied Research*	-	3.321	3.107	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.428
H84: *Materials*	-	27.629	26.533	24.100	-	24.100	23.823	25.672	27.079	28.613	0.000	183.449
XW4: *Manufacturing Science*	-	0.000	0.000	4.500	-	4.500	5.000	5.596	5.938	6.281	0.000	27.315

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts fundamental research relevant to the Soldier focused on new materials, properties and phenomena in four research areas: (1) lightweight materials and hybrid assemblies for enhanced expeditionary operations, (2) materials and mechanisms that mitigate effects from blast and ballistic threats, (3) materials for augmented soldier protection and situational awareness, and (4) multifunctional materials with integrated structure, power storage, communications, sensing,and/or propulsion to provide system level efficiencies. This project funds collaborative applied research and integration of government, academic, and industry scientific research to advance innovative capabilities.

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

Work in this PE builds on the materials research transitioned from PE 0601102A and 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 S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the Research, Development, and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	31.533	29.640	29.120	-	29.120
Current President's Budget	81.950	29.640	28.600	-	28.600
Total Adjustments	50.417	0.000	-0.520	-	-0.520
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	51.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.575	-			
• Adjustments to Budget Years	-	-	-0.520	-	-0.520
• FFRDC	-0.008	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Congressional Program Increase*	31.000	-
Congressional Add: *High Performance Polymers Research*	20.000	-
Congressional Add Subtotals for Project: H7B	51.000	-
Congressional Add Totals for all Projects	51.000	-

Change Summary Explanation

FY 17 Congressional increase in H7B Materials Technology

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H7B / *Advanced Materials Initiatives (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
H7B: *Advanced Materials Initiatives (CA)*	-	51.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.000

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase ***FY 2017 Accomplishments:*** N/A	31.000	-
Congressional Add: High Performance Polymers Research ***FY 2017 Accomplishments:*** N/A	20.000	-
Congressional Adds Subtotals	51.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army										Date: February 2018		
Appropriation/Budget Activity 2040 / 2				R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H7G / *Nanomaterials Applied Research*				
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
H7G: *Nanomaterials Applied Research*	-	3.321	3.107	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.428

Note

Project ended in FY18.

A. Mission Description and Budget Item Justification

This Project 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 Program Element (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 S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Nanomaterials Applied Research ***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, such as scale-up of processes and fabrication into woven materials, to enable revolutionary future Soldier capabilities.	3.321	-	-
Title: Emerging Materials for Soldier Protection ***Description:*** Identify, exploit, scale-up, and accelerate the transition of promising breakthroughs in materials research, including nanomaterials, biotechnology, multifunctional materials, and processing science research, via collaborative government, academia, and industry to deliver new materials technologies that revolutionize soldier capabilities and enable expeditionary operations. ***FY 2018 Plans:***	-	3.107	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7G / *Nanomaterials Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Investigate and down-select promising materials technologies, and fund research focused on achieving protection materials that enable a 20% reduction in weight relative to current systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Research ends in FY18.			
Accomplishments/Planned Programs Subtotals	3.321	3.107	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H84 / *Materials*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
H84: *Materials*	-	27.629	26.533	24.100	-	24.100	23.823	25.672	27.079	28.613	0.000	183.449

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and evaluates a variety of materials (e.g. 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 Maneuver, Lethality, and Soldier portfolios.

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from Program Element (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 0602105A (Materials Technology), 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Structural Armor Materials	5.300	3.996	3.953
Description: Conduct applied research to design and evaluate lightweight armor materialsand structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. Explore ground vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping).			
FY 2018 Plans: Establish new processing science to produce transparent composites using material composition to control and optimize ballistic performance; further mature new methods to modify surfaces and interfaces in composite and nanocomposite systems and produce small scale bulk composites with enhanced structural and ballistic materials.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate new magnesium alloy compositions that offer improved, lightweight ballistic resistance using first principles methods and techniques; will assess the causes of delayed cracking in high hardness armor steel by performing stress corrosion cracking characterization on a statistically significant number of armor plates. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reducing investment as methods to modify surfaces and interfaces in composite and nanocomposite systems has matured.			
Title: Soldier-Borne Armor Materials ***Description:*** Utilizing understanding of defeat mechanisms from PE 0602618A/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 2018 Plans:*** Explore synthetic scale-up for potential protection system design application; using computational models, produce and characterize unidirectional laminates; using validation results of multiscale models, adjust models to improve accuracy of deformation and failure predictions. ***FY 2019 Plans:*** Will demonstrate efficient and complete synthesis of boron suboxide (B6O) armor ceramics, quantify effects of powder morphology, size and size distribution, and characterize the critical mechanical properties versus reactive hot pressing process conditions; develop processing pathways to fabricate armor ceramic with novel multiscale heterogeneity and characterize ballistic performance. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in modeling efforts to support acceleration of Synthetic Training Environmental senior leader priorities.	6.754	7.042	4.927
Title: Lethality Materials Technology ***Description:*** This effort involves applied research to develop innovative materials solutions aimed at achieving leap-ahead increases in lethality and weapons effectiveness through dramatic improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology. ***FY 2018 Plans:*** Validate iron based alloy and characterize integrity through a lethality application demonstration; produce prototype high energy density polymeric materials and demonstrate their capability as energetic binders. ***FY 2019 Plans:***	4.400	3.738	3.818

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will finalize alloy selection and process development of novel, non-cobalt containing, binders for tungsten carbide based armor piercing projectiles; will utilize atmospheric plasma chemical vapor deposition to synthesize films of metastable material phases for use in energetics applications. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to support CSA priorities of Soldier Lethality.			
Title: Multifunctional Armor Materials ***Description:*** This effort researches novel multifunctional armor materials and associated processing science aimed at enabling critical Army applications in survivability and sustainment. Research efforts include multifunctional protective films and coatings, joining of dissimilar materials, and additive manufacturing of multifunctional materials. Soldier personnel protection materials transition to PE 0602786A/project H98. Vehicle armor materials transition to PE 0602618A/project H80 and PE 0602601A/project C05 ***FY 2018 Plans:*** Use newly enhanced computational capabilities that link additive manufacturing processes to desired structure and properties to produce small scale material; identify specific electromagnetic processes to control specific microstructures to produce materials with optimized microstructures and desired properties using low temperature, low pressure electromagnetic processes; use modeling tools to further design and mature ceramics exhibiting desired, predicted structures and properties. ***FY 2019 Plans:*** Will apply multi-objective topological optimization algorithms to develop multi-functional design in critical components to address lightweighting goals; will develop stimuli-responsive methods to change material stiffness using low power mechanisms that also provide faster response times; will develop three-dimensional phase diagrams that incorporate magnetic field influence over phase formation by visualizing temperature-composition-field relationships; and will develop metamaterial structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Due to the level of maturity of this research, the investments in multifunctional armor was decreased to support advanced materials with capabilities to respond and adapt to a wide range of external stimuli.	9.200	9.697	6.143
Title: Nanomaterials ***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 PE 062105A (Materials Technology) / Project H7G (Nanomaterials Applied Research). ***FY 2018 Plans:***	1.975	2.060	2.072

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Produce bulk material for active/adaptive armor and/or weapon material from newly developed hybrid, multifunctional polymer coatings, composites, and films with enhanced dielectric and electromagnetic properties. ***FY 2019 Plans:*** Will develop scalable mechanical alloying methods for nanocrystalline copper-tantalum (Cu-Ta) with parametric variation of phase chemistry, sintering time, temperature, texture evolution, grain size refinement, and secondary phase formation/distribution; will investigate the processing of aluminum alloys with novel chemistries for the generation of hydrogen through nano-galvanic cell formation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increase due to inflation.			
Title: Bio-enabled Materials and Processes ***Description:*** Fundamental research through the application of biotechnology advances to develop materials with capabilities to respond and adapt to a wide range of external stimuli and biological processes. ***FY 2019 Plans:*** Will conduct rapid design, selection and production of peptide reagents for potential applications such as the improvement of sensor devices, and logistics and sustainment; and will design and develop specialty materials via synthetic biology for potential applications that will improve safety, cost, logistics, robustness, and create new abilities to adapt existing materiel. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New effort to support CSA priorities for Soldier Lethality.	-	-	3.187
Accomplishments/Planned Programs Subtotals	27.629	26.533	24.100

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*	Project (Number/Name) XW4 / *Manufacturing Science*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
XW4: *Manufacturing Science*	-	0.000	0.000	4.500	-	4.500	5.000	5.596	5.938	6.281	0.000	27.315

Note

This is a new start for FY19.

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable rapid development and certification of lightweight, multifunctional materials technologies for protection, maneuver, and situational awareness. Research conducted enables new manufacturing capabilities through the development of high performance feedstock materials (polymers, metals, ceramics), physics-based process models, and in situ process monitoring that can be integrated with process models to enable real-time control and manipulation of materials structure and properties. The goal of this work is to develop robust predictive model and simulation tools linking manufacturing processes with materials structure, properties, and performance to accelerate the rate of innovative material adaptations (protection, power, sensing, signature management) necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

This Project sustains Army science and technology efforts supporting the Ground Maneuver, Lethality, and Soldier portfolios.

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from Program Element (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 0602105A (Materials Technology), 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 S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Agile Expedient Manufacturing	-	-	4.500
Description: Conduct applied research to develop innovative materials technologies that enable new protection, power, sensing, and signature management capabilities utilizing additive manufacturing and related methods to rapidly respond to emerging and unknown threats in a battlefield environment. Efforts include the development of new feedstock materials, engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities, new processing capabilities that revolutionize additive manufacturing and enable production of lightweight materials systems for protection and maneuverability that cannot be produced through traditional manufacturing methods, integrated process models and real-time			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** XW4 / *Manufacturing Science*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
monitoring for closed-loop control and optimal production of lightweight materials, and abilities to design and produce optimal materials at the point of need using available materials, energy sources, etc. ***FY 2019 Plans:*** Will quantify processing-structure-property relationships in additively manufactured steel alloys; validate continuum scale finite element-based model of laser-metal powder bed additive manufacturing process and mesoscale phase field model of microstructure prediction. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort supports the acceleration of the quantification and validation effort of additively manufactured steel alloys.			
Accomplishments/Planned Programs Subtotals	-	-	4.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A