Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	73.136	83.586	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	156.722
H7B: *Advanced Materials Initiatives (CA)*	-	44.000	55.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	99.000
H7G: *Nanomaterials Applied Research*	-	2.982	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.982
H84: *Materials*	-	26.154	24.092	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	50.246
XW4: *Manufacturing Science*	-	0.000	4.494	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.494

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is being realigned with continuity of effort to the following PEs:
* 0602141A Lethality Technology
* 0602143A Soldier Lethality Technology
* 0602144A Ground Technology
* 0602145A Next Generation Combat Vehicle Technology

A. Mission Description and Budget Item Justification

This 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 PE also 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 (Defense Research Sciences) and 0601104A (University and Industry Research Centers). 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 Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

This work is performed by the United States Army Futures Command.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army					Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*			
B. Program Change Summary ($ in Millions)	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**
Previous President's Budget	29.640	28.600	28.823	-	28.823
Current President's Budget	73.136	83.586	0.000	-	0.000
Total Adjustments	43.496	54.986	-28.823	-	-28.823
• Congressional General Reductions	-0.011	-0.014			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	44.000	55.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.493	-			
• Adjustments to Budget Years	-	-	-28.823	-	-28.823

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Program Increase*	24.000	55.000
Congressional Add: *High end materials for military applications*	5.000	-
Congressional Add: *Materials technology for high performance polymers research*	15.000	-
Congressional Add Subtotals for Project: H7B	44.000	55.000
Congressional Add Totals for all Projects	44.000	55.000

Change Summary Explanation

FY18 increase related to $44.000 million of Congressional Add funding.
FY19 increase related to $55.000 million of Congressional Add funding.
FY20 decrease related to science and technology financial restructuring.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army												Date: March 2019
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
H7B: *Advanced Materials Initiatives (CA)*	-	44.000	55.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	99.000

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 2018	FY 2019
Congressional Add: Program Increase ***FY 2018 Accomplishments:*** Program Increase ***FY 2019 Plans:*** Program Increase	24.000	55.000
Congressional Add: High end materials for military applications ***FY 2018 Accomplishments:*** High end materials for military applications	5.000	-
Congressional Add: Materials technology for high performance polymers research ***FY 2018 Accomplishments:*** Materials technology for high performance polymers research	15.000	-
Congressional Adds Subtotals	44.000	55.000

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 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
H7G: *Nanomaterials Applied Research*	-	2.982	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.982

Note

Project H7G (Nanomaterials Applied Research) concluded in FY 2018.

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 PE 0601104A (University and Industry Research Centers) / 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 (University and Industry Research Centers). 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 Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Emerging Materials for Soldier Protection	2.982	-	-
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.			
Accomplishments/Planned Programs Subtotals	2.982	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7G / *Nanomaterials Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
H84: *Materials*	-	26.154	24.092	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	50.246

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602141A Lethality Technology)
* Project AH8 Lethality Materials and Processes Technology
PE 0602143A Soldier Lethality Technology
* Project AZ5 Soldier Protection Technology - Vulnerability
* Project BE6 Reactive/Resp Surfaces & Matls - Soldiers & Sys
PE 0602145A Next Generation Combat Vehicle Technology
* Project BI4 Materials Application and Integration Tech

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 PE 0601102A (Defense Research Sciences), Project H42 (Materials and Mechanics), and Project H43 (Research In Ballistics). The work complements and is fully coordinated with efforts in PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Ballistic Technology), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Structural Armor Materials	3.920	3.899	-
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			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping). ***FY 2019 Plans:*** 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 2019 to FY 2020 Increase/Decrease Statement:*** FY2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials Application and Integration Technology) as part of financial restructure.			
Title: Soldier-Borne Armor Materials ***Description:*** Utilizing understanding of defeat mechanisms from PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) 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 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 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology ? Vulnerability) as part of financial restructure.	6.966	4.873	-
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 2019 Plans:***	3.662	3.764	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602141A (Lethality Technology) / Project AH8 (Lethality Materials and Processes Technology) as part of financial restructure.			
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 (Warfighter Technology) / Project H98 (Clothing and Equipment Technology). Vehicle armor materials transition to PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) and PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research). ***FY 2019 Plans:*** Apply multi-objective topological optimization algorithms to develop multi-functional design in critical components to address lightweight 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 meta material structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The Multifunctional Armor Materials effort is being realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials and Manufacturing Research Technology), and PE 0602143A (Soldier Lethality Technology / Project AZ5 (Soldier Protection Technology - Vulnerability) as part of financial restructure.	9.621	6.089	-
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 0602105A (Materials Technology) / Project H7G (Nanomaterials Applied Research). ***FY 2019 Plans:***	1.985	2.018	-

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
Develop scalable mechanical alloying methods for nanocrystalline copper-tantalum 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 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials Application and Integration Technology) as part of financial restructure.			
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 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602143A (Soldier Lethality Technology) / Project BE6 (Reactive/Responsive Surfaces and Materials ? Soldier and Systems) as part of financial restructure.	-	3.133	-
Title: FY 2019 SBIR / STTR Transfer ***Description:*** FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer	-	0.316	-
Accomplishments/Planned Programs Subtotals	26.154	24.092	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
XW4: *Manufacturing Science*	-	0.000	4.494	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.494

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602144A Ground Technology
* Project BL1 Materials and Manufacturing Research Technology

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, and 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, and 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 PE 0601102A (Defense Research Sciences) / Project H42 (Materials and Mechanics), and Project H43 (Research In 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 Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Agile Expedient Manufacturing	-	4.330	-
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 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 funds realigned to PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology) as part of financial restructure.			
Title: FY 2019 SBIR / STTR Transfer ***Description:*** FY 2019 SBIR / STTR Transfer ***FY 2019 Plans:*** FY 2019 SBIR / STTR Transfer ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2019 SBIR / STTR Transfer	-	0.164	-
Accomplishments/Planned Programs Subtotals	-	4.494	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A