Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force											Date: February 2020	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602102F / *Materials*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	172.109	215.851	140.781	0.000	140.781	132.522	127.914	130.928	133.385	Continuing	Continuing
624347: *Materials for Structures, Propulsion, and Subsystems*	-	83.861	103.844	53.433	0.000	53.433	48.230	46.714	47.852	48.761	Continuing	Continuing
624348: *Materials for Electronics, Optics, and Survivability*	-	35.561	56.507	37.740	0.000	37.740	35.982	34.191	34.991	35.600	Continuing	Continuing
624349: *Materials Technology for Sustainment*	-	52.687	55.500	49.608	0.000	49.608	48.310	47.009	48.085	49.024	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops advanced materials, processing, and inspection technologies to reduce life cycle costs and improve performance, sustainability, availability, affordability, supportability, reliability, and survivability of current and future Air Force systems and operations. The program has three projects that develop: structural, propulsion, and sub-systems materials and processes technologies; electronic, optical, and survivability materials and processes technologies; and sustainment materials, processes technologies, and advanced non-destructive inspection methodologies. Efforts in the program have been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 1206601SF, and 0602298F.

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	181.373	128.851	126.436	0.000	126.436
Current President's Budget	172.109	215.851	140.781	0.000	140.781
Total Adjustments	-9.264	87.000	14.345	0.000	14.345
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	87.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.854	0.000			
• Other Adjustments	-6.410	0.000	14.345	0.000	14.345

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: 624347: *Materials for Structures, Propulsion, and Subsystems*		
Congressional Add: *Program increase - Certification of advanced composites*	14.764	15.000
Congressional Add: *Program Increase - Thermal Protection for Hypersonic Vehicles*	9.843	0.000
Congressional Add: *Program Increase - High Temperature Material Technologies for Turbine Engines*	4.921	0.000
Congressional Add: *Program Increase - High Performance Materials*	7.874	8.000
Congressional Add: *Program Increase - Turbine Airfoil Demonstration*	2.953	0.000
Congressional Add: *Program Increase - Additive Manufacturing*	0.000	20.000
Congressional Add: *Program Increase - Advanced aerospace composite structures*	0.000	8.000
Congressional Add: *Program Increase - Molybdenum silicon boron research*	0.000	3.000
Congressional Add Subtotals for Project: 624347	40.355	54.000
Project: 624348: *Materials for Electronics, Optics, and Survivability*		
Congressional Add: *Program Increase - Biosensor Materials*	4.921	0.000
Congressional Add: *Program Increase - Minority leaders program*	0.000	8.500
Congressional Add: *Program Increase - Deployable passive cooling*	0.000	5.000
Congressional Add: *Program Increase - Human monitoring capabilities*	0.000	9.500

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Air Force	Date: February 2020
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add Subtotals for Project: 624348	4.921	23.000
Project: 624349: *Materials Technology for Sustainment*		
Congressional Add: *Program Increase - Coating Technologies*	9.843	10.000
Congressional Add Subtotals for Project: 624349	9.843	10.000
Congressional Add Totals for all Projects	55.119	87.000

Change Summary Explanation

Decrease in FY 2019 in Other Adjustments of $6.410 million is due to realignment of funds to PE 0602212F to support Research and Development Projects, 10 U.S.C. Section 2363, an amendment to PL 110-417, 10 U.S.C. Section 2358 and 10 U.S.C. 2805(d)(1)(B).

Increase in FY 2021 of $14.345 million is due to the following:
1) Civilian pay repricing adjustments
2) Initiating Joint Service 1000 Molecules activities to support the sustainable transition of critical synthetic biology capabilities
3) Realignment of the Pervasive and Affordable Metals Technologies effort from PE 0603112F, Advanced Materials for Weapons Systems, Project 633946, Materials Transition, Pervasive and Affordable Metals Technologies, to PE 0602102F, Materials, Project 624347, Materials for Structures, Propulsion, and Subsystems.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602102F / *Materials*	Project (Number/Name) 624347 / *Materials for Structures, Propulsion, and Subsystems*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
624347: *Materials for Structures, Propulsion, and Subsystems*	-	83.861	103.844	53.433	0.000	53.433	48.230	46.714	47.852	48.761	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for aircraft, spacecraft, launch systems, 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 and nonmetallic composites, and hybrid materials to provide upgraded capabilities for existing aircraft, missile, and propulsion systems to meet the future system requirements. The project develops high-temperature turbine engine materials that will enable engine designs to improve turbine engine thrust-to-weight ratio, specific fuel consumption and affordability. 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. The project concurrently develops advanced processing methods to enable adaptive processing of aerospace materials.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Ceramics and Composites	25.669	29.552	28.319
Description: Develop ceramic, ceramic matrix composite, and hybrid materials technologies for performance and supportability improvement in propulsion systems and high temperature aerospace structures.			
FY 2020 Plans: Demonstrate and mature new advanced processing methods, coating technologies, and behavioral life prediction concepts for current and future higher capability polymer and ceramic matrix composites. Continue in-depth analyses and assessment of severe environment durability of advanced composite systems via mechanical testing. Continue developing and testing the new ceramic and polymer matrix composite materials and processes with higher temperature capability for next generation propulsion systems and aerospace structures. Continue to advance and integrate the computational material science infrastructure for composite materials to model, characterize, and accelerate the development and certification of advanced composite materials. Continue to verify and validate damage progression models on increasingly complex polymer matrix composite structural applications. Continue newer testing and assessment methods to development composite damage progression models for application in an engineering environment. Develop and refine modeling tools to link processing to performance of organic/ polymer matrix composites and expand damage mechanics models to increasingly complex composite materials. Develop and validate the development and exploration of materials to meet evolving requirements for structural hardening.			
FY 2021 Plans: Continue to demonstrate and mature new advanced processing methods, coating technologies, and behavioral life prediction concepts for current and future higher capability polymer and ceramic matrix composites. Continue in-depth analyses and			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624347 / *Materials for Structures, Propulsion, and Subsystems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
assessment of severe environment durability of advanced composite systems via mechanical testing. Continue validating, developing, and testing the new ceramic and polymer matrix composite materials and processes with higher temperature capability for next generation propulsion systems and aerospace structures. Continue to advance and integrate the computational material science infrastructure for composite materials in tools to model, characterize, and accelerate the development and certification of advanced composite materials. Continue to verify and validate damage progression models on increasingly complex polymer matrix composite structural applications. Continue developing newer testing and assessment methods on composite damage progression models for application in an engineering environment. Continue to develop and validate advanced materials to meet evolving requirements for structural hardening. Initiate development of Enhanced Physics-based Prognosis techniques and inspection methods for ceramics matrix composites. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 decreased compared to FY 2020 by $1.233 million. Funding decreased due to reduced emphasis on computational material science infrastructure and technologies.			
Title: Metals ***Description:*** Develop lightweight and high temperature metallics, life prediction, and metals processing technologies for increased affordability, durability, and reliability. ***FY 2020 Plans:*** Continue demonstration and implementation of advanced computation methods to support material development and characterization modeling. Continue to analyze relationships between microstructure, processing, properties, and performance of affordable metallic and high performance gradient metallic materials. Validate integrated material/manufacturing and component analysis for life management and development of affordable structural metals and low cost processes. Continue to advance reliable affordable metallic structural components through computational methods. Validate the value of integrated analytical tools in the optimization of design and certification of additively manufactured metallic components. Continue development and refine low cost processing methods and affordable metals for low cost, attritable propulsion systems. Initiate development of enhanced life management practices to incorporate effects of engineered residual stress. Continue research on application of advanced data science, artificial intelligence and machine learning on materials science problems. ***FY 2021 Plans:*** Continue to demonstrate and implement advanced computation methods to support faster material development and characterization modeling. Continue to analyze relationships between microstructure, processing, properties, and performance of affordable metallic and high performance gradient metallic materials. Continue to validate integrated material/manufacturing and component analysis for life management and development of affordable structural metals and low cost processes. Continue to advance reliable affordable metallic structural components through computational methods. Continue to validate the value of	13.487	15.283	16.564

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624347 / *Materials for Structures, Propulsion, and Subsystems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
integrated analytical tools in the optimization of design and certification of additively manufactured metallic components. Continue development of novel capabilities via metallic additive manufacturing to be used as an alternative process when applicable. Continue to develop and refine low cost processing methods and affordable metals for low cost, attritable propulsion systems. Continue development of enhanced life management practices to incorporate effects of engineered residual stress. Continue research on application of advanced data science, artificial intelligence and machine learning on materials science problems. Initiate research on engine lifing for sustainment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $1.281 million. Funding increased due to civilian pay reprice adjustments.			
Title: Thermal Protection Materials ***Description:*** Develop and evaluate lightweight, active, adaptive, multifunctional, high temperature, and durable material systems for extreme environments and hypersonic applications. ***FY 2020 Plans:*** Mature processing methods for fabricating materials required for expendable hypersonic applications. Validate, develop and refine unique experimental techniques to assess mechanical properties and time-dependent behavior. Continue to validate and demonstrate material properties and performance to meet design needs for control surfaces, leading edges, aero shells, and apertures. Further the development of computational models to assess environmental degradation of materials in a hypersonic environment. Initiate development of materials to meet emerging requirements of systems for effective nuclear deterrence. ***FY 2021 Plans:*** Continue to mature processing methods for fabricating materials required for expendable hypersonic applications. Continue to validate, develop and refine unique experimental techniques to assess mechanical properties and time-dependent behavior. Continue to validate and demonstrate material properties and performance to meet design needs for control surfaces, leading edges, aero shells, and apertures. Further the development of computational models to assess environmental degradation of materials in a hypersonic environment. Continue the development of materials to meet emerging requirements of systems for effective nuclear deterrence. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.334 million. Funding increased due to civilian pay reprice adjustments.	4.350	5.009	5.343
Title: Pervasive and Affordable Metals Technologies ***Description:*** Develop and demonstrate affordable, novel high temperature powder processing materials/structures and additive metals technology concepts to enable future defense capabilities, air vehicle propulsion, and computational prediction models.	0.000	0.000	3.207

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624347 / *Materials for Structures, Propulsion, and Subsystems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: For FY 2020 and prior, this work is performed under the Pervasive and Affordable Metals Technologies effort in PE 0603112F, Advanced Materials for Weapons Systems, Project 633946, Materials Transition. ***FY 2021 Plans:*** Continue to demonstrate affordable metallic turbine engine disks made through powder processing technologies through high temperature, aggressive environment testing. Continue to develop low cost, complex shape metallic component made through additive manufacturing for advanced weapon system component prototypes. Continue to develop computational methodologies that incorporate impact of surface residual stress on ability to extend life and lower life cycle cost of air vehicle propulsion system components. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $3.207 million. Funding increased due to the realignment of the Pervasive and Affordable Metals Technologies effort from PE 0603112F, Advanced Materials for Weapons Systems, Project 633946, Materials Transition, to this effort.			
Accomplishments/Planned Programs Subtotals	43.506	49.844	53.433

	FY 2019	FY 2020
Congressional Add: Program increase - Certification of advanced composites ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Conducted Congressionally directed efforts.	14.764	15.000
Congressional Add: Program Increase - Thermal Protection for Hypersonic Vehicles ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Not Applicable	9.843	0.000
Congressional Add: Program Increase - High Temperature Material Technologies for Turbine Engines ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Not Applicable	4.921	0.000
Congressional Add: Program Increase - High Performance Materials	7.874	8.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624347 / *Materials for Structures, Propulsion, and Subsystems*

	FY 2019	FY 2020
FY 2019 Accomplishments: Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Conducted Congressionally directed efforts.		
Congressional Add: Program Increase - Turbine Airfoil Demonstration ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Not Applicable	2.953	0.000
Congressional Add: Program Increase - Additive Manufacturing ***FY 2019 Accomplishments:*** Not Applicable ***FY 2020 Plans:*** Conducted Congressionally directed efforts.	0.000	20.000
Congressional Add: Program Increase - Advanced aerospace composite structures ***FY 2019 Accomplishments:*** Not Applicable ***FY 2020 Plans:*** Conduct Congressionally directed efforts.	0.000	8.000
Congressional Add: Program Increase - Molybdenum silicon boron research ***FY 2019 Accomplishments:*** Not Applicable ***FY 2020 Plans:*** Conduct Congressionally directed efforts.	0.000	3.000
Congressional Adds Subtotals	40.355	54.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602102F / *Materials*	Project (Number/Name) 624348 / *Materials for Electronics, Optics, and Survivability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
624348: *Materials for Electronics, Optics, and Survivability*	-	35.561	56.507	37.740	0.000	37.740	35.982	34.191	34.991	35.600	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops materials technologies for Intelligence, Surveillance, and Reconnaissance (ISR), situational awareness, and low-observable systems and subsystems for aircraft and missile applications, including sensor, microwave, and short, mid, and long-wave infrared (SWIR, MWIR, LWIR) 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. The project develops nanostructured and biological materials for aircraft structures, munitions, air vehicle subsystems, and personnel. The project develops novel materials for electromagnetic interactions with matter for electromagnetic pulse, high power microwave, and lightning strike protection.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Infrared Detector and Electromagnetic Device Materials	10.111	11.090	11.354
Description: Develop infrared (IR) detector and Electro-magnetic device materials and processes technologies for performance, affordability, and operational capability of surveillance, tracking, targeting, and situational awareness systems.			
FY 2020 Plans: Continue advanced development, demonstration and validation of materials and processes for control and detection of electromagnetic radiation for Intelligence, Surveillance, Reconnaissance (ISR) technologies. Further the development, testing, and assessment of materials for use in high resolution imaging by electromagnetic radiation and demonstrate the results. Proceed with advanced demonstration of nanoscale materials, meta materials, and models for use in producing detectors. Continue to utilize all aspects of computational materials science to improve performance prediction and reliability models, as well as analyzing quantum materials for aerospace applications. Continue specific development and demonstration of short wave infrared detector materials and hyper-spectral long wave infrared materials. Verify and validate materials and processes for integration of radio frequency and optical signals as well as concepts for novel optical devices and components. Validate generated data and continue development of photonics for air vehicle applications, and demonstrate nanostructured materials for components to enable agile radio frequency capability.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Continue advanced development, demonstration and validation of materials and processes for control and detection of electromagnetic radiation for Intelligence, Surveillance, Reconnaissance (ISR) technologies. Further the development, testing, and assessment of materials for use in high resolution imaging by electromagnetic radiation and demonstrate the results. Continue advanced demonstration of nanoscale materials, metamaterials, and models for use in producing detectors. Continue to utilize all aspects of computational materials science to improve performance prediction and reliability models, as well as analyzing quantum materials for aerospace applications. Continue specific development and demonstration of short wave infrared detector materials and hyper-spectral long wave infrared materials. Continue to verify and validate materials and processes for integration of radio frequency and optical signals as well as concepts for novel optical devices and components. Continue to validate generated data and continue development of photonics for air vehicle applications, and demonstrate nanostructured materials for components to enable agile radio frequency capability. Initiate development of techniques using quantum materials and processes. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.264 million. Funding increased due to civilian pay reprice adjustments.			
Title: Directed Energy Hardened Materials	11.643	12.672	13.075
Description: Develop and demonstrate technologies to enhance the safety, survivability, and mission effectiveness of aircrews, sensors, viewing systems, and related assets. ***FY 2020 Plans:*** Continue to analyze and validate the comprehensive generated data of materials and technologies to protect against directed energy threats. Develop and demonstrate advanced optical limiter materials for damage protection, enhanced hybrid materials for advanced applications, and continue to assess response of new materials for high-energy laser interactions. Continue developing the novel approaches for integration of multi-modal hardening into structures and devices. Continue to assess data and validate repeatability and utilize computational materials science to enhance multi-scale modeling for design of robust, reliable integrated protection. Initiate development of proven selected advanced materials technologies to protect against nuclear flash blindness. ***FY 2021 Plans:*** Continue to analyze and validate the comprehensive generated data of materials and technologies to protect against directed energy threats. Continue to develop and demonstrate advanced optical limiter materials for damage protection, enhanced hybrid materials for advanced applications, and continue to assess response of new materials for high-energy laser interactions. Continue developing the novel approaches for integration of multimodal hardening into structures and devices. Continue to assess data and validate repeatability and utilize computational materials science to enhance multi-scale modeling for design of robust,			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624348 / *Materials for Electronics, Optics, and Survivability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
reliable integrated protection. Continue development of proven selected advanced materials technologies to protect against nuclear flash blindness. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.403 million. Funding increased due to civilian pay reprice adjustments.			
Title: Laser Source Materials ***Description:*** Develop materials to enable higher performance high power laser sources (quasi-Continuous Wave to Continuous Wave) with emphasis on laser output in the mid-InfraRed spectral region (2-5 microns). ***FY 2020 Plans:*** Continue to validate materials and process technologies to control and generate directed electromagnetic energy for survivability and other applications. Further demonstrate and model materials processes for controlling laser beam direction and focus with optical components, and materials for frequency conversion, high power optical isolators, mid-wave infrared laser sources and high power microwave sources for directed energy sources. ***FY 2021 Plans:*** Continue to validate materials and process technologies to control and generate directed electromagnetic energy for survivability and other applications. Further demonstrate and model materials processes for controlling laser beam direction and focus with optical components, and materials for frequency conversion, high power optical isolators, mid-wave infrared laser sources and high power microwave sources for directed energy sources. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $0.032 million. Funding increased due to civilian pay reprice adjustments.	1.226	1.344	1.376
Title: Nanostructured and Biological Materials ***Description:*** Develop enabling and foundational biotechnologies for guidance and control, rapid tagging, tracking, and identification of targets, and bio-integrated electronics and sensing for Air Force applications. ***FY 2020 Plans:*** Continue to validate and verify engineering, scientific and processing methods for nano and biological materials to address unique requirements for Air Force man-machine integration, and electronic components. Explore sustainability demand biotechnology to assess the impact of microbes and fungi on Air Force systems. Continue to study more robust and reliable materials and processes to optimize components for compact, flexible, stretchable multi-functional devices, and validate materials and process for functional additive manufacturing of electronic components. Demonstrate methods to assess reliability and field resiliency of	7.660	8.401	11.935

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
nano and bio materials and processes. Continue to support Flexible Hybrid Electronics Institute for Manufacturing Innovation and the NanoBio Manufacturing Consortium for collaborative teaming. ***FY 2021 Plans:*** Continue to validate and verify engineering, scientific and processing methods for nano and biological materials to address unique requirements for Air Force man-machine integration, and electronic components. Continue to explore biotechnology to assess the impact of microbes and fungi on Air Force systems. Continue to study more robust and reliable materials and processes to optimize components for compact, flexible, stretchable multi-functional devices, and validate materials and process for functional additive manufacturing of electronic components. Continue to demonstrate methods to assess reliability and field resiliency of nano and bio materials and processes. Continue to support the Flexible Hybrid Electronics Institutes for Manufacturing Innovation and the NanoBio Manufacturing Consortium for collaborative teaming. Initiate development of advanced materials for human-machine applications. Initiate Joint Service 1000 Molecules activities to support the sustainable transition of critical synthetic biology capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $3.534 million. Funding increased due to civilian pay reprice adjustments and emphasis on synthetic biology capabilities.			
Accomplishments/Planned Programs Subtotals	30.640	33.507	37.740

	FY 2019	FY 2020
Congressional Add: Program Increase - Biosensor Materials ***FY 2019 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2020 Plans:*** Not Applicable	4.921	0.000
Congressional Add: Program Increase - Minority leaders program ***FY 2019 Accomplishments:*** Not Applicable ***FY 2020 Plans:*** Conduct Congressionally directed efforts.	0.000	8.500
Congressional Add: Program Increase - Deployable passive cooling ***FY 2019 Accomplishments:*** Not Applicable ***FY 2020 Plans:*** Conduct Congressionally directed efforts.	0.000	5.000
Congressional Add: Program Increase - Human monitoring capabilities	0.000	9.500

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624348 / *Materials for Electronics, Optics, and Survivability*

	FY 2019	FY 2020
FY 2019 Accomplishments: Not Applicable ***FY 2020 Plans:*** Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	4.921	23.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force			Date: February 2020
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602102F / *Materials*	Project (Number/Name) 624349 / *Materials Technology for Sustainment*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
624349: *Materials Technology for Sustainment*	-	52.687	55.500	49.608	0.000	49.608	48.310	47.009	48.085	49.024	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops materials and 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Material State Awareness	14.996	16.022	17.363
Description: Develop Materials State Awareness technologies to identify and characterize materials and/or damage regardless of scale for managing the health of aging structures, propulsion systems, and low-observable materials/structures, plus enabling advanced materials qualification.			
FY 2020 Plans: Continue to validate and demonstrate non-destructive evaluation modeling capabilities and use these competencies to drive improvements in capability to detect, characterize and quantify damage in realistic aerospace structures and engine components. Continue to analyze approaches to address the variability inherent in aerospace systems and materials and begin to quantify the impact of that variability on nondestructive inspection capability and reliability. Validate advanced sensing technologies to detect and characterize changes in material properties, damage evolution, and other factors that detrimentally affect aerospace systems. Continue development and validation of damage state awareness approaches and methodologies for use on aerospace structures and engine components. Validate and continue development of advanced methods to monitor and evaluate material state awareness. Continue development of augmented reality technologies to improve the process of performing nondestructive evaluation tasks, acquiring and archiving data and reporting results.			
FY 2021 Plans: Continue to validate and demonstrate non-destructive evaluation modeling capabilities and use these competencies to drive improvements in capability to detect, characterize and quantify damage in realistic aerospace structures and engine components. Continue to analyze approaches to address the variability inherent in aerospace systems and materials and begin to quantify			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624349 / *Materials Technology for Sustainment*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
the impact of that variability on nondestructive inspection capability and reliability. Continue to validate advanced sensing technologies to detect and characterize changes in material properties, damage evolution, and other factors that detrimentally affect aerospace systems. Continue development and validation of damage state awareness approaches and methodologies for use on aerospace structures and engine components. Continue to improve methods to acquire and analyze data to facilitate improved characterization, registration, and tracking of degradation and damage of special materials that enables/ensures more affordable coatings assessment. Validate tools to improve characterization and failure modes of specialty multilayer coatings. Continue to develop automation and robotic technologies for visual inspections that will realize human-assisted inspection capabilities and begin to provide capabilities for automated multi-spectral characterization. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $1.341 million. Funding increased due to civilian pay reprice adjustments.			
Title: Production and Repair Technologies	11.139	11.625	12.898
Description: Develop support capabilities, information, and processes to resolve problems with materials in the production and repair of systems components and structures. ***FY 2020 Plans:*** Develop best practices to ensure repeatability of advanced materials and processes technology to repair and extend the life of Air Force systems. Further refine through demonstration the understanding of material durability and repair limits for emerging Air Force systems. Advance the analysis and development of improved lifecycle prediction test methods and techniques to understand effects of service environments, corrosion, residual stresses, and material processes on structural and functional materials. Continue to improve the service life of advanced materials, processes and designs for improved repair and maintainability and life cycle cost of outer-moldline coatings, access panel treatments, and multifunctional systems. Further advance specialty material affordability technologies and processes to reduce maintenance costs of specialty materials. ***FY 2021 Plans:*** Develop and communicate to the field best practices to ensure repeatability of advanced materials and processes technology to repair and extend the life of Air Force systems. Further refine through demonstration the understanding of material durability and repair limits for emerging Air Force systems. Continue to advance the analysis and development of improved lifecycle prediction test methods and techniques to understand effects of service environments, corrosion, residual stresses, and material processes on structural and functional materials. Continue to improve the service life of advanced materials, processes and designs for improved repair and maintainability and life cycle cost of outer-moldline coatings, access panel treatments, and multifunctional systems. Further advance specialty material affordability technologies and processes to reduce maintenance costs of specialty materials. ***FY 2020 to FY 2021 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624349 / *Materials Technology for Sustainment*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2021 increased compared to FY 2020 by $1.273 million. Funding increased due to civilian pay reprice adjustments.			
Title: Failure Analysis Technologies	16.709	17.853	19.347
Description: Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis of components. ***FY 2020 Plans:*** Continue to perform and increase efficiency of quick response failure analyses and materials investigations. Further the development and investigate improved analysis techniques to determine and prevent root cause materials failure/degradation. Continue to develop and provide advanced materials and processing solutions to ensure warfighter system availability and safety of flight. Refine development of functional materials failure analysis capabilities. Continue to analyze and validate advanced electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Transition advanced test and characterization methods for analyzing electrical and structural failures of emerging materials. Continue development and demonstrate new, more durable materials and protection for high power wiring technologies, and advanced materials. ***FY 2021 Plans:*** Continue to perform and increase efficiency of quick response failure analyses and materials investigations. Further the development and investigate improved analysis techniques to determine and prevent root cause materials failure/degradation. Continue to develop and provide advanced materials and processing solutions to ensure warfighter systems availability and safety of flight. Continue to refine development of functional materials failure analysis capabilities. Continue to analyze and validate advanced electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Continue to transition advanced test and characterization methods for analyzing electrical and structural failures of emerging materials. Continue development of new, more durable materials and protection for high power wiring technologies, and advanced materials. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY 2021 increased compared to FY 2020 by $1.494 million. Funding increased due to civilian pay reprice adjustments and additional emphasis on materials analysis research.			
Accomplishments/Planned Programs Subtotals	42.844	45.500	49.608

	FY 2019	FY 2020
Congressional Add: Program Increase - Coating Technologies	9.843	10.000
FY 2019 Accomplishments: Conducted Congressionally directed efforts.		
FY 2020 Plans: Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	9.843	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Air Force		Date: February 2020
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624349 / *Materials Technology for Sustainment*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.