Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	212.551	237.847	113.460	0.000	113.460	-	-	-	-	-	-
624347: *Materials for Structures, Propulsion, and Subsystems*	-	100.544	105.999	41.376	0.000	41.376	-	-	-	-	-	-
624348: *Materials for Electronics, Optics, and Survivability*	-	56.507	62.240	30.699	0.000	30.699	-	-	-	-	-	-
624349: *Materials Technology for Sustainment*	-	55.500	69.608	41.385	0.000	41.385	-	-	-	-	-	-

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 Department of the 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.

Funds in this PE may be used to investigate specified technology advancements in air, space and/or cyber domains.

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 2022 Air Force	Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	215.851	140.781	132.522	0.000	132.522
Current President's Budget	212.551	237.847	113.460	0.000	113.460
Total Adjustments	-3.300	97.066	-19.062	0.000	-19.062
• Congressional General Reductions	0.000	-0.434			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	97.500			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.413	0.000			
• SBIR/STTR Transfer	-3.713	0.000			
• Other Adjustments	0.000	0.000	-19.062	0.000	-19.062

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 624347: *Materials for Structures, Propulsion, and Subsystems*		
Congressional Add: *Program increase - Certification of advanced composites*	14.616	15.000
Congressional Add: *Program Increase - High Performance Materials*	7.795	8.000
Congressional Add: *Program Increase - Additive Manufacturing*	19.488	0.000
Congressional Add: *Program Increase - Advanced aerospace composite structures*	7.795	0.000
Congressional Add: *Program Increase - Molybdenum silicon boron research*	2.923	0.000
Congressional Add: *Program increase - classified additive manufacturing*	0.000	20.000
Congressional Add: *Program increase - ceramic matrix composites*	0.000	10.000
Congressional Add: *Program increase - thermal protection for hypersonic vehicles*	0.000	10.000
Congressional Add Subtotals for Project: 624347	52.617	63.000
Project: 624348: *Materials for Electronics, Optics, and Survivability*		
Congressional Add: *Program Increase - Technology for Broadband Operation*	0.000	10.000
Congressional Add: *Program Increase - Minority leaders program*	8.282	0.000
Congressional Add: *Program Increase - Deployable passive cooling*	4.872	5.000
Congressional Add: *Program Increase - Human monitoring capabilities*	9.257	9.500

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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 2020	FY 2021
Congressional Add Subtotals for Project: 624348	22.411	24.500
Project: 624349: *Materials Technology for Sustainment*		
Congressional Add: *Program Increase - Coating Technologies*	9.744	10.000
Congressional Add Subtotals for Project: 624349	9.744	10.000
Congressional Add Totals for all Projects	84.772	97.500

Change Summary Explanation

FY 2022 decreased by 19.062 million due to higher Department of the Air Force priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
624347: *Materials for Structures, Propulsion, and Subsystems*	-	100.544	105.999	41.376	0.000	41.376	-	-	-	-	-	-

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 Department of the 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 fielded operational systems. The project concurrently develops advanced processing methods to enable adaptive processing of aerospace materials.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Ceramics and Composites	28.416	22.789	23.584
Description: Develop ceramic, polymer, polymer and ceramic matrix composites, and hybrid materials technologies for performance and supportability improvement in propulsion systems and high temperature aerospace structures. ***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 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. ***FY 2022 Plans:*** Continue to validate, 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			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
and 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 and validating 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 and refine modeling tools to link processing to performance of organic/polymer matrix composites and expand damage mechanics models to increasingly complex composite materials. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.795 million. Funding increased due increased emphasis on computational material science infrastructure and technologies.			
Title: Metals ***Description:*** Develop lightweight and high temperature metallics, life prediction technologies, and metals processing technologies for increased affordability, durability, and reliability of Department of the Air Force systems. ***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 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 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 life prediction. ***FY 2022 Plans:*** Continue to validate, demonstrate and implement advanced computation methods to support faster material development and characterization modeling. Continue to analyze relationships between microstructure, processing, properties, and performance	14.695	13.330	14.077

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
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 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 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. Continue research on engine life prediction. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $0.747 million. Funding increased due to increase computational methods and characterization modeling.			
Title: Thermal Protection Materials	4.816	4.300	3.715
Description: Develop and evaluate lightweight, active, adaptive, multifunctional, high temperature, and durable material systems for extreme environments and hypersonic applications. ***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, aeroshells, and apertures. Further the development of computational models to assess environmental degradation of materials in a hypersonic environment. ***FY 2022 Plans:*** Continue to validate and 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, aeroshells, and apertures. Further the development of computational models to assess environmental degradation of materials in a hypersonic environment. ***FY 2021 to FY 2022 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2022 decreased compared to FY 2021 by $0.585 million. Funding decreased due to decreased emphasis in expendable hypersonic materials.			
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. ***FY 2021 Plans:*** Completed demonstration of affordable metallic turbine engine disks made via powder processing technologies through high temperature, aggressive environment testing. Completed development of low cost, complex shape metallic components made through additive manufacturing for advanced weapon system component prototypes. Completed development of computational methodologies that incorporate impact of surface residual stress on the ability to extend life and lower life cycle cost of air vehicle propulsion system components. ***FY 2022 Plans:*** Technical work in this effort completed in FY 2021. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $2.580 million. Funding decreased due to the completion of this effort in FY 2021.	0.000	2.580	0.000
Accomplishments/Planned Programs Subtotals	47.927	42.999	41.376

	FY 2020	FY 2021
Congressional Add: Program increase - Certification of advanced composites ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	14.616	15.000
Congressional Add: Program Increase - High Performance Materials ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	7.795	8.000
Congressional Add: Program Increase - Additive Manufacturing	19.488	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021
FY 2020 Accomplishments: Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Not applicable		
Congressional Add: Program Increase - Advanced aerospace composite structures ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Not applicable	7.795	0.000
Congressional Add: Program Increase - Molybdenum silicon boron research ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Not applicable	2.923	0.000
Congressional Add: Program increase - classified additive manufacturing ***FY 2020 Accomplishments:*** Not applicable ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	0.000	20.000
Congressional Add: Program increase - ceramic matrix composites ***FY 2020 Accomplishments:*** Not applicable ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	0.000	10.000
Congressional Add: Program increase - thermal protection for hypersonic vehicles ***FY 2020 Accomplishments:*** Not applicable ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	0.000	10.000
Congressional Adds Subtotals	52.617	63.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
624348: *Materials for Electronics, Optics, and Survivability*	-	56.507	62.240	30.699	0.000	30.699	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This project develops materials technologies for the Department of the Air Force's Intelligence, Surveillance, and Reconnaissance (ISR), situational awareness, and low-observable systems and subsystems for aerospace platforms and munitions. This includes sensors for microwave, short, mid, and long-wave infrared (SWIR, MWIR, LWIR) detection and countermeasures devices used for targeting, electronic warfare, and active aircraft protection. 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. Materials for protection of aircrews, sensors, and aerospace structures from laser and high-power microwave directed energy threats are also developed. 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 novel materials for electromagnetic interactions with matter for electromagnetic pulse, high power microwave, and lightning strike protection. The project develops nanostructured and biological materials for aerospace structures, munitions, aerospace vehicle subsystems, and personnel.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Infrared Detector and Electromagnetic Device Materials	11.285	11.354	9.516
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 for the Department of the Air Force.			
FY 2021 Plans: Continue advanced development, demonstration and validation of materials and processes for control and detection of electromagnetic radiation for Intelligence, Surveillance and Reconnaissance (ISR) technologies. Further the development, testing, and assessment of materials for use in high resolution imaging by electromagnetic radiation. 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 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 development of photonics for aerospace applications,			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
and demonstrate nanostructured materials for components to enable agile radio frequency capability. Initiate development of techniques using quantum materials and processes. ***FY 2022 Plans:*** Continue advanced development, demonstration and validation of materials and processes for control and detection of electromagnetic radiation for Intelligence, Surveillance and Reconnaissance (ISR) technologies. Further the development, testing, and assessment of materials for use in high resolution imaging by electromagnetic radiation. 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 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 development of photonics for aerospace applications, and demonstrate nanostructured materials for components to enable agile radio frequency capability. Continue development of techniques using quantum materials and processes. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $1.838 million. Funding decreased due to reduced efforts in materials for tactical Intelligence, Surveillance, and Reconnaissance (ISR).			
Title: Directed Energy Hardened Materials ***Description:*** Develop and demonstrate technologies to enhance the safety, survivability, and mission effectiveness of personnel, sensors, viewing systems, and related Department of the Air Force assets. ***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 the response of new materials for high-energy laser interactions. Continue developing novel approaches for integration of multimodal hardening into structures and devices. Continue to assess data, validate repeatability and utilize computational materials science to enhance multi-scale modeling for design of robust, reliable integrated protection. Continue development of proven selected advanced materials technologies to protect against nuclear flash blindness. ***FY 2022 Plans:*** Continue to analyze, validate and demonstrate 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 the response of new materials for high-energy laser	12.894	13.075	9.210

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
interactions. Continue developing novel approaches for integration of multimodal hardening into structures and devices. Continue to assess data, validate repeatability and utilize computational materials science to enhance multi-scale modeling for design of robust, reliable integrated protection. Continue development of proven selected advanced materials technologies to protect against nuclear flash blindness. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $3.865 million. Funding decreased due to reduced emphasis on optical coating materials and helmet mounted sensor protection.			
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 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 2022 Plans:*** Continue to demonstrate and 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 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $0.148. Funding decreased due to plans described above.	1.368	1.376	1.228
Title: Nanostructured and Biological Materials ***Description:*** Develop enabling and foundational biotechnologies for guidance and control, rapid tagging, tracking and identification of targets, bio-integrated electronics and sensing for the Department of the Air Force applications. ***FY 2021 Plans:*** Continue to validate and verify engineering, scientific and processing methods for nano and biological materials to address unique requirements for the Department of the Air Force human-machine integration and electronic components. Continue to explore biotechnology to assess the impact of microbes and fungi on Department of the Air Force systems. Continue to study more robust	8.549	11.935	10.745

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
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 biological 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 2022 Plans:*** Continue to validate and verify engineering, scientific and processing methods for nano and biological materials to address unique requirements for the Department of the Air Force human-machine integration and electronic components. Continue to explore biotechnology to assess the impact of microbes and fungi on Department of the 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 biological materials and processes. Continue to support the Flexible Hybrid Electronics Institutes for Manufacturing Innovation and the NanoBio Manufacturing Consortium for collaborative teaming. Initiate agile materials for basing, infrastructure and expeditionary operations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $1.190 million. Decreased funding due to decreased emphasis 1000 Molecule activities.			
Accomplishments/Planned Programs Subtotals	34.096	37.740	30.699

	FY 2020	FY 2021
Congressional Add: Program Increase - Technology for Broadband Operation ***FY 2020 Accomplishments:*** Not applicable ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	0.000	10.000
Congressional Add: Program Increase - Minority leaders program ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Not applicable	8.282	0.000
Congressional Add: Program Increase - Deployable passive cooling	4.872	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021
FY 2020 Accomplishments: Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.		
Congressional Add: Program Increase - Human monitoring capabilities ***FY 2020 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	9.257	9.500
Congressional Adds Subtotals	22.411	24.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
624349: *Materials Technology for Sustainment*	-	55.500	69.608	41.385	0.000	41.385	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This project develops materials and processing technologies to support operational Department of the Air Force mission areas by providing the ability to inspect the quality of delivered systems, transition more reliable and maintainable materials, establish a capability to detect and characterize performance threatening defects, characterize materials processes and properties necessary for materials transition, and provide 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 2020	FY 2021	FY 2022
Title: Material State Awareness	16.112	20.863	14.482
Description: Develop Materials State Awareness technologies to identify and characterize materials and/or damage regardless of scale for managing the health of fielded structures, propulsion systems, and low-observable materials/structures, plus enabling advanced materials qualification for Department of the Air Force systems.			
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 to quantify 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 specialty 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 2022 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
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 to quantify 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 specialty 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 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $6.381 million. Decreased funding due to reduced emphasis on engine component inspection.			
Title: Production and Repair Technologies	11.690	15.498	10.759
Description: Develop support capabilities, information, and processes to resolve problems with materials in the production and repair of systems components and structures for the Department of the Air Force. ***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 Department of the Air Force systems. Further refine, through demonstration, the understanding of material durability and repair limits for emerging Department of the Air Force systems. Continue to advance the analysis and development of improved life cycle 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, maintainability and life cycle costs, of outer mold line coatings, access panel treatments, and multifunctional systems. Further advance specialty material affordability technologies and processes to reduce maintenance costs of specialty materials. ***FY 2022 Plans:*** Continue to develop and communicate to the field best practices to ensure repeatability of advanced materials and processes technology to repair and extend the life of Department of the Air Force systems. Further refine through demonstration the understanding of material durability and repair limits for emerging Department of the Air Force systems. Continue to advance the analysis and development of improved life cycle prediction test methods and techniques to understand effects of service			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
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 mold line coatings, access panel treatments, and multifunctional systems. Continue to further advance specialty material affordability technologies and processes to reduce maintenance costs of specialty materials. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $4.739 million. Decreased funding is a result of reduced emphasis on multifunctional systems.			
Title: Failure Analysis Technologies ***Description:*** Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis for the Department of the Air Force. ***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 2022 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 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $7.104 million. Decreased funding is a result of reduced emphasis on advanced materials and processing technology.	17.954	23.247	16.144
Accomplishments/Planned Programs Subtotals	45.756	59.608	41.385

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602102F / *Materials*	**Project (Number/Name)** 624349 / *Materials Technology for Sustainment*

	FY 2020	FY 2021
Congressional Add: Program Increase - Coating Technologies	9.744	10.000
FY 2020 Accomplishments: Conducted Congressionally directed efforts.		
FY 2021 Plans: Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	9.744	10.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.