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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2020 Air Force **Date:** February 2019

<b>Appropriation/Budget Activity</b> 3600: <i>Research, Development, Test &amp; Evaluation, Air Force I BA 2: Applied Research</i>					<b>R-1 Program Element (Number/Name)</b> PE 0602102F / <i>Materials</i>							
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
Total Program Element	-	143.900	181.373	128.851	0.000	128.851	126.436	130.469	135.447	138.498	Continuing	Continuing
624347: <i>Materials for Structures, Propulsion, and Subsystems</i>	-	62.934	88.375	49.844	0.000	49.844	45.959	47.385	49.193	50.337	Continuing	Continuing
624348: <i>Materials for Electronics, Optics, and Survivability</i>	-	30.523	37.475	33.507	0.000	33.507	34.248	35.546	36.939	37.782	Continuing	Continuing
624349: <i>Materials Technology for Sustainment</i>	-	50.443	55.523	45.500	0.000	45.500	46.229	47.538	49.315	50.379	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, 1206601F, and 0602298F.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2018 Air Force penalty total is \$14.373M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

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.

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<b>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
Previous President's Budget	124.264	125.373	136.526	0.000	136.526
Current President's Budget	143.900	181.373	128.851	0.000	128.851
Total Adjustments	19.636	56.000	-7.675	0.000	-7.675
• Congressional General Reductions	-0.025	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	25.000	56.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.567	0.000			
• Other Adjustments	-2.772	0.000	-7.675	0.000	-7.675

**Congressional Add Details (\$ in Millions, and Includes General Reductions)**

**Project: 624347: *Materials for Structures, Propulsion, and Subsystems***

Congressional Add: *Program increase - Structures, propulsion, and subsystems*

Congressional Add: *Program increase - Certification of advanced composites*

Congressional Add: *Program Increase - Thermal Protection for Hypersonic Vehicles*

Congressional Add: *Program Increase - High Temperature Material Technologies for Turbine Engines*

Congressional Add: *Program Increase - High Performance Materials*

Congressional Add: *Program Increase - Turbine Airfoil Demonstration*

Congressional Add Subtotals for Project: 624347

**Project: 624348: *Materials for Electronics, Optics, and Survivability***

Congressional Add: *Program Increase - Biosensor Materials*

Congressional Add Subtotals for Project: 624348

**Project: 624349: *Materials Technology for Sustainment***

Congressional Add: *Program Increase - Coatings*

Congressional Add: *Program Increase - Coating Technologies*

Congressional Add Subtotals for Project: 624349

	<b>FY 2018</b>	<b>FY 2019</b>
	4.914	0.000
	14.742	15.000
	0.000	10.000
	0.000	5.000
	0.000	8.000
	0.000	3.000
	19.656	41.000
	0.000	5.000
	0.000	5.000
	4.914	0.000
	0.000	10.000
	4.914	10.000

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<b>Congressional Add Details (\$ in Millions, and Includes General Reductions)</b>		<b>FY 2018</b>		<b>FY 2019</b>
	Congressional Add Totals for all Projects	24.570		56.000

**Change Summary Explanation**

Decrease in FY 2018 in Other Adjustments is due to realignment of funds to PE 0602212F to support Research and Development Projects, 10 U.S.C. Section 2358.

Decrease in FY 2020 due to the realignment and consolidation of Air Force Applied Research Science and Technology funding for Future Air Force Capabilities Applied Research efforts.

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<b>Appropriation/Budget Activity</b> 3600 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602102F / <i>Materials</i>				<b>Project (Number/Name)</b> 624347 / <i>Materials for Structures, Propulsion, and Subsystems</i>			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
624347: <i>Materials for Structures, Propulsion, and Subsystems</i>	-	62.934	88.375	49.844	0.000	49.844	45.959	47.385	49.193	50.337	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)**

**Title:** Ceramics and Composites

**Description:** Develop ceramic, ceramic matrix composite, and hybrid materials technologies for performance and supportability improvement in propulsion systems and high temperature aerospace structures.

**FY 2019 Plans:**

Demonstrate and mature new advanced processing methods, coating technologies, and behavioral life prediction for higher temperature capable organic and ceramic matrix composites. Continue to analyze severe environment durability of advanced composite systems via mechanical testing. Continue development of 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 an effort to 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 development of composite damage progression models for application in an engineering environment.

**FY 2020 Base 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

<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
25.585	27.951	29.552	0.000	29.552

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>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.</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$1.601 million. Funding increased due to added emphasis and demand for high temperature ceramics and composite technologies for hypersonic vehicles.</p>					
<p><b>Title:</b> Metals</p> <p><b>Description:</b> Develop lightweight and high temperature metallics, life prediction, and metals processing technologies for increased affordability, durability, and reliability.</p> <p><b>FY 2019 Plans:</b> Continue demonstration and implementation of advanced computation methods to support material development and characterization modeling. Continue to validate quantitative, predictive models for performance of metallic based thermal management systems through coupon testing. Continue to analyze relationships between microstructure, processing, properties, and performance of metallic, hybrid, nanoscale, and gradient metallic materials. Validate and continue development of affordable integrated material/manufacturing and component analysis for life management and development of affordable structural materials innovative research. Continue to advance development of next generation turbine engine disk and 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 for low cost, attritable propulsion systems.</p> <p><b>FY 2020 Base Plans:</b></p>	13.268	14.686	15.283	0.000	15.283

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>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.</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.597 million. Funding increased due to added emphasis in computational models to speed up research on metal testing and behavior predictability.</p>					
<p><b>Title:</b> Thermal Protection Materials</p> <p><b>Description:</b> Develop and evaluate lightweight, active, adaptive, multifunctional, high temperature, and durable material systems for extreme environments and hypersonic applications.</p> <p><b>FY 2019 Plans:</b> Mature processing methods for fabricating materials required for expendable hypersonic applications. Continue to validate, and 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, and apertures. Continue to develop computational models to assess environmental degradation of materials in a hypersonic environment.</p> <p><b>FY 2020 Base Plans:</b> 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</p>	4.425	4.738	5.009	0.000	5.009

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
assess environmental degradation of materials in a hypersonic environment. Initiate development of materials to meet emerging requirements of systems for effective nuclear deterrence.  <b>FY 2020 OCO Plans:</b> Not Applicable  <b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.271 million. Justification for the increase is described in the plans above.					
<b>Accomplishments/Planned Programs Subtotals</b>	43.278	47.375	49.844	0.000	49.844

	<b>FY 2018</b>	<b>FY 2019</b>
<b>Congressional Add:</b> Program increase - Structures, propulsion, and subsystems <b>FY 2018 Accomplishments:</b> Conducted Congressionally directed efforts. <b>FY 2019 Plans:</b> Not Applicable	4.914	0.000
<b>Congressional Add:</b> Program increase - Certification of advanced composites <b>FY 2018 Accomplishments:</b> Conducted Congressionally directed efforts. <b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.	14.742	15.000
<b>Congressional Add:</b> Program Increase - Thermal Protection for Hypersonic Vehicles <b>FY 2018 Accomplishments:</b> Not Applicable <b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.	0.000	10.000
<b>Congressional Add:</b> Program Increase - High Temperature Material Technologies for Turbine Engines <b>FY 2018 Accomplishments:</b> Not Applicable <b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.	0.000	5.000
<b>Congressional Add:</b> Program Increase - High Performance Materials <b>FY 2018 Accomplishments:</b> Not Applicable <b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.	0.000	8.000
<b>Congressional Add:</b> Program Increase - Turbine Airfoil Demonstration	0.000	3.000

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	FY 2018	FY 2019
<b>FY 2018 Accomplishments:</b> Not Applicable		
<b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.		
<b>Congressional Adds Subtotals</b>	19.656	41.000

**C. Other Program Funding Summary (\$ in Millions)**

N/A

**Remarks**

**D. Acquisition Strategy**

N/A.

**E. Performance Metrics**

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
624348: <i>Materials for Electronics, Optics, and Survivability</i>	-	30.523	37.475	33.507	0.000	33.507	34.248	35.546	36.939	37.782	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)**

	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<b>Title:</b> Infrared Detector and Electromagnetic Device Materials	10.403	10.716	11.090	0.000	11.090
<b>Description:</b> 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.					
<b>FY 2019 Plans:</b> Continue to develop and demonstrate materials and processes for control and detection of electromagnetic radiation for Intelligence, Surveillance, Reconnaissance (ISR) technologies. Continue to develop and demonstrate materials for use in high resolution imaging by electromagnetic radiation. Continue to demonstrate nanoscale materials, meta materials, and models for use in producing detectors. Continue to utilize computational materials science to improve performance prediction and reliability models. Continue to analyze quantum materials for aerospace applications. Continue to develop and demonstrate SWIR detector materials and hyper-spectral LWIR materials. Continue to validate materials and processes for integration of radio frequency and optical signals as well as concepts for novel optical devices and components. Validate and					

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>continue development of photonics for air vehicle applications. Continue to demonstrate nanostructured materials for components to enable agile radio frequency capability.</p> <p><b>FY 2020 Base Plans:</b> 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.</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.374 million. Funding increased due to added emphasis in electromagnetic radiation, nanoscale materials, and meta materials.</p>					
<p><b>Title:</b> Directed Energy Hardened Materials</p> <p><b>Description:</b> Develop and demonstrate technologies to enhance the safety, survivability, and mission effectiveness of aircrews, sensors, viewing systems, and related assets.</p> <p><b>FY 2019 Plans:</b> Analyze and validate a plethora of materials and technologies to protect against directed energy threats. Develop, validate, and demonstrate advanced optical limiter materials for damage protection, enhanced hybrid materials for advanced applications in airborne, space, and personnel systems. Continue to assess response of new materials for high-energy laser interactions. Continue to develop approaches for integration of multi-modal</p>	10.979	12.341	12.672	0.000	12.672

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>hardening into structures and devices. Continue to validate repeatability and continue to utilize computational materials science to enhance multi-scale modeling for design of robust, reliable integrated protection.</p> <p><b>FY 2020 Base Plans:</b> 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.</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.331 million. Justification for the increase is described in the plans above.</p>					
<p><b>Title:</b> Laser Source Materials</p> <p><b>Description:</b> 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).</p> <p><b>FY 2019 Plans:</b> Validate materials and process technologies to control and generate directed electromagnetic energy for survivability and other applications. Continue to demonstrate and model materials processes for controlling laser beam direction and focus with optical components. Continue to develop materials for frequency conversion, high power optical isolators, Mid-wave infrared (MWIR) Laser Sources and high power microwave sources for directed energy sources.</p> <p><b>FY 2020 Base Plans:</b> 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</p>	1.261	1.299	1.344	0.000	1.344

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>					
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.					
<b>FY 2020 OCO Plans:</b> Not Applicable					
<b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.045 million. Justification for the increase is described in the plans above.					
<b>Title:</b> Nanostructured and Biological Materials					
<b>Description:</b> 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.					
<b>FY 2019 Plans:</b> Continue to validate 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 reliable materials and processes to optimize components for compact, flexible, stretchable multi-functional devices. Continue to validate materials and process for functional additive manufacturing of electronic components. Continue to demonstrate methods to assess reliability of nano and bio materials and processes. Continue to support Flexible Hybrid Electronics Institute for Manufacturing Innovation and the NanoBio Manufacturing Consortium.					
<b>FY 2020 Base Plans:</b> 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 nano and bio materials and processes. Continue to support Flexible Hybrid Electronics Institute for Manufacturing Innovation and the NanoBio Manufacturing Consortium for collaborative teaming.					
<b>FY 2020 OCO Plans:</b>					
	7.880	8.119	8.401	0.000	8.401

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<b>Appropriation/Budget Activity</b> 3600 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602102F / <i>Materials</i>	<b>Project (Number/Name)</b> 624348 / <i>Materials for Electronics, Optics, and Survivability</i>

<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
Not Applicable					
<b><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i></b> FY 2020 increased compared to FY 2019 by \$0.282 million. Funding increased due to added emphasis in nano and biological materials development.					
<b>Accomplishments/Planned Programs Subtotals</b>	30.523	32.475	33.507	0.000	33.507
	<b>FY 2018</b>	<b>FY 2019</b>			
<b><i>Congressional Add:</i></b> Program Increase - Biosensor Materials	0.000	5.000			
<b><i>FY 2018 Accomplishments:</i></b> Not Applicable					
<b><i>FY 2019 Plans:</i></b> Conduct Congressionally directed efforts.					
<b>Congressional Adds Subtotals</b>	0.000	5.000			

**C. Other Program Funding Summary (\$ in Millions)**

N/A

**Remarks**

**D. Acquisition Strategy**

N/A.

**E. Performance Metrics**

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2020 Air Force										<b>Date:</b> February 2019		
<b>Appropriation/Budget Activity</b> 3600 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602102F / <i>Materials</i>				<b>Project (Number/Name)</b> 624349 / <i>Materials Technology for Sustainment</i>			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>	<b>FY 2021</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
624349: <i>Materials Technology for Sustainment</i>	-	50.443	55.523	45.500	0.000	45.500	46.229	47.538	49.315	50.379	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)**

**Title:** Material State Awareness

**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.

In 2019, the effort was named "Sensing Technologies"

**FY 2019 Plans:**

Continue to validate and demonstrate non-destructive evaluation modeling capabilities and use these competencies to drive improvements in capability to detect and characterize damage in realistic aerospace structures and engine components. Continue approaches to address the variability inherent in aerospace systems and materials and begin to quantify the impact of that variability on non-destructive 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.

**FY 2020 Base Plans:**

<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
13.689	15.933	16.022	0.000	16.022

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>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 non-destructive 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 non-destructive evaluation tasks, acquiring and archiving data and reporting results</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.089 million. Funding increased due to added emphasis in non-destructive technologies for sustainment.</p>					
<p><b>Title:</b> Production and Repair Technologies</p> <p><b>Description:</b> Develop support capabilities, information, and processes to resolve problems with materials in the production and repair of systems components and structures.</p> <p><b>FY 2019 Plans:</b> Continue to substantiate repeatability and demonstrate advanced materials and processes technology to repair and extend the life of Air Force systems. Continue to 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. 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. Continue to further advance specialty material affordability technologies and processes to reduce maintenance costs of these materials.</p> <p><b>FY 2020 Base Plans:</b></p>	13.244	11.836	11.625	0.000	11.625

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
<p>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.</p> <p><b>FY 2020 OCO Plans:</b> Not Applicable</p> <p><b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.066 million. Funding increased due to added emphasis in predictive analysis for residual stress and specialty materials.</p>					
<p><b>Title:</b> Failure Analysis Technologies</p> <p><b>Description:</b> Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis of components.</p> <p><b>FY 2019 Plans:</b> Continue to perform and increase efficiency of quick response failure analyses and materials investigations. Continue to develop and investigate improved analysis techniques to determine and prevent root cause materials failure/degradation, provide advanced materials 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. Continue the transition of 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 for Air Force weapon systems. Continue research, development and characterization of advanced materials.</p> <p><b>FY 2020 Base Plans:</b> 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</p>	18.596	17.754	17.853	0.000	17.853

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>FY 2020 Base</b>	<b>FY 2020 OCO</b>	<b>FY 2020 Total</b>
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.  <b>FY 2020 OCO Plans:</b> Not Applicable  <b>FY 2019 to FY 2020 Increase/Decrease Statement:</b> FY 2020 increased compared to FY 2019 by \$0.099 million. Justification for the increase is described in the plans above.					
<b>Accomplishments/Planned Programs Subtotals</b>	45.529	45.523	45.500	0.000	45.500
	<b>FY 2018</b>	<b>FY 2019</b>			
<b>Congressional Add:</b> Program Increase - Coatings <b>FY 2018 Accomplishments:</b> Conducted Congressionally directed efforts. <b>FY 2019 Plans:</b> Not Applicable	4.914	0.000			
<b>Congressional Add:</b> Program Increase - Coating Technologies <b>FY 2018 Accomplishments:</b> Not applicable <b>FY 2019 Plans:</b> Conduct Congressionally directed efforts.	0.000	10.000			
<b>Congressional Adds Subtotals</b>	4.914	10.000			

**C. Other Program Funding Summary (\$ in Millions)**

N/A  
**Remarks**

**D. Acquisition Strategy**  
Not Applicable.

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<b>Appropriation/Budget Activity</b> 3600 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602102F / <i>Materials</i>	<b>Project (Number/Name)</b> 624349 / <i>Materials Technology for Sustainment</i>

**E. Performance Metrics**

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.