Fiscal Year:	FY 2023	**Task Last Updated:**	FY 01/10/2023
PI Name:	Pathak, Siddhartha Ph.D.		
Project Title:	Structure, Properties, and Performance of Solder Joints in Terrestrial vs. Reduced-Gravity Environments		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	MATERIALS SCIENCE--Materials science		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	50011	**Congressional District:**	4
Comments:	NOTE: PI moved in fall 2020 to Iowa State University from University of Nevada, Reno.		
Project Type:	Physical Sciences Informatics (PSI)	**Solicitation / Funding Source:**	2021 Physical Sciences NNH20ZDA014N: Use of the NASA Physical Sciences Informatics System – Appendix G
Start Date:	01/01/2023	**End Date:**	12/31/2024
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA MSFC
Contact Monitor:	Panda, Binayak	**Contact Phone:**	
Contact Email:	binayak.panda-1@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Napolitano, Ralph Ph.D. (Iowa State University, Ames)		
Grant/Contract No.:	80NSSC23K0279		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The investigation proposed here combines experiments and modeling to elucidate the fundamental mechanisms, phenomenology, and process conditions that govern the integrity and performance of solder joints produced in terrestrial vs. reduced gravity environments, such as the microgravity conditions on board the International Space Station (ISS). The technical research program plans to utilize solder samples from the In-Space Soldering Investigation (ISSI) experiments from the Physical Sciences Informatics (PSI) repository, as well as expand into other non-ISSI solder compositions, and combine space- and ground-based experiments with advanced 3D materials characterization, micromechanical testing, and mesoscale modeling. In particular, the project addresses the formation and persistence of porosity through the reflow/filling/freezing processes and the deleterious effects on microstructure and mechanical properties of the solder joint. It has been established that porosity arising from flux volatilization, which is dispersed and expelled from the solder joint under terrestrial gravity, may become entrapped within the freezing solder material under microgravity conditions, given the absence of buoyancy-driven convection. Our overall goals are (i) to advance the current qualitative understanding of this phenomenon into the realm of alloy/process-specific quantitative description and prediction, and (ii) to examine the effects of mechanically and acoustically stimulated flow patterns while assessing their potential effectiveness as porosity mitigation strategies for solder-based fabrication processes in space. Considering a range of potential applications and materials, 3 solder alloys will be investigated, including the ISSI lead-based (Pb-Sn) solders, as well as lead-free (Sn-Ag-Cu and Sn-Au) solders, which have recently shown promise for high-performance joint applications due to their thermal/electrical conductivities and excellent corrosion/fatigue resistance.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2023.
Bibliography Type:	Description: (Last Updated: 11/20/2020)