NASA SBIR Ignite 2025

Audience Q&A: Advanced Manufacturing & Robotics for Space Applications AMA

Advanced Manufacturing

Subtopic I01.01 Advanced Real Time Monitoring and Control Technologies for Additive Manufacturing

Q: How does NASA define “additive manufacturing” (AM)? Is it limited to 3D printing?

- NASA uses a broad definition that includes Laser powder bed fusion (LPBF), Directed energy deposition (DED), and other metal additive processes.
- While polymer-based processes exist, the primary focus here is on metallic materials.
- Additive manufacturing is not limited to 3D printing.

Q: Are non-fusion AM processes (e.g., solid state) included, especially for in situ monitoring?

Yes. Non-fusion processes are within scope, especially if they enable better real-time monitoring or characterization.

Q: Are you also considering post-processing technologies, or is the focus solely on in-process control to reduce the need for post-processing?

Regarding in-situ monitoring and control, the focus is solely on data generated during the AM build.

Q: Are you using only built-in sensors, or also considering external sensors for real-time AM monitoring?

Both. NASA is developing multi-modal sensing systems that integrate data from embedded machine sensors and external sensors (e.g., optical, x-ray) to monitor build quality and process integrity in real time.

Q: Does the AM topic require closed-loop real-time control systems, or are enabling technologies acceptable?

The goal is to eventually support closed-loop control, but developing the enabling components (like sensors or real-time monitoring technologies) is absolutely in scope.

Q: Is this topic limited to specific AM processes (e.g., LPBF, DED)?

LPBF and DED are the primary focus, especially for metallic materials, though broader AM methods may be considered if aligned with the objectives.

Q: Can proposals include additional control techniques, such as using ultrasonic vibration to influence microstructure formation?

Proposals may incorporate additional control techniques if they are integrated in a way that supports process stability and enhances the ability to assess build quality in real time.

Q: Is the AM to be monitored expected to occur primarily on the lunar surface, or will it also include operations in orbit?

While in-space manufacturing remains a long-term objective, our current focus is on developing in-situ monitoring technology for terrestrial applications. These efforts aim to begin qualifying the technology as a viable nondestructive evaluation method. If you are considering technology that can transfer to in-space applications, it can be suggested to investigate solutions that can characterize the interaction between the laser and material to assess build integrity throughout the AM process.

Subtopic I01.02 Computational Design of New Materials, Processes, and Products Leveraging the Microgravity Environment of Space

Q: What materials are in scope—metallic, non-metallic, or semiconductors?

The primary focus is on metallic materials. Semiconductors are also being considered, and analog materials may be used in some test cases. ICME (Integrated Computational Materials Engineering) is being used extensively for material development.

Q: Does this include AI-driven materials discovery for space applications?

Yes. AI/ML has the potential to accelerate materials discovery—from atomistic modeling to performance prediction and qualification. Using AI to optimize for sustainability, radiation resistance, biodegradability, etc., is highly encouraged.

Q: Are manufacturing processes in low Earth orbit (LEO) in scope, or just material development?

Yes, LEO-based manufacturing processes are within scope, even though the SBIR timeline may not allow for full orbital implementation during the performance period.

Q: What does "in situ" mean in this context? Is post-build inspection acceptable?

"In situ" refers to *in-process* or *online* monitoring during manufacturing—not post-processing. The goal is to move toward qualifying parts as they are built, using techniques like optical tomography or x-ray systems embedded in the machine.

Q: Are you only interested in computational work, or would an experimental proposal also be considered?

While the focus is computational work, an experimental proposal integrating or demonstrating techniques to extrapolate or interpolate the limited microgravity dataset are encouraged. This could include a combination of in-situ process instrumentation, post-process microstructure and/or porosity characterization and ML-based interpolation or extrapolation of the resulting data. Experimental techniques or instrumentation that will allow field-interpretation (shop floor or in-orbit) of processing performance are particularly sought. Ease of use, throughput, and portability would be key characteristics of IoT/characterization devices of interest.

Q: Are there specific material performance metrics—such as tensile strength, decomposition rate, or structural stability—that need to be modeled differently when designing zero-waste biomanufacturing products in microgravity, especially those derived from waste-based microbial processes?

Although NASA has interest in biomanufacturing products, and there is potential for ICME to play a role in designing microgravity-tailored microbial processing of biowaste, this is out of scope for the present opportunity.

Robotics

Subtopic I04.01: Modular, Scalable Robotic Subcomponents for Manufacturing & Assembly in Remote, Challenging Environments

Q: Is the robotic subtopic (actuators, motors, resolvers) specific to a type of manufacturing or more general?

- They're more general. We're interested in systems that can address a wide range of needs. The goal is to develop technologies that can be applied across various manufacturing scenarios—particularly those relevant to planetary or orbital environments.
- For example, you might upgrade an existing actuator line for space use or design new space-grade components.
- Familiarity with future NASA missions can help you tailor solutions to likely use cases.

Q: Are you focused on full robotic systems, or are subsystems and components also of interest?

We're open to the full spectrum, from subsystems to individual components. The modularity concept (think LEGO-like configurability) is especially appealing, as it supports flexibility, reduces cost, and improves implementation across different missions.

Q: Are specialized subsystems (e.g., actuators or motors) encouraged, or are full systems preferred?

Both are encouraged. A modular system with multiple component sizes and configurations—such as actuators designed for different environmental challenges (e.g., radiation, vacuum, dust)—is valuable. Off-the-shelf plug-and-play solutions that can be widely adopted are particularly compelling.

Q: Are optical sensing technologies for robotics and spacecraft proximity operations within scope?

Yes, particularly if they support surface operations, manufacturing, or assembly. Optical sensing aligned with these goals is appropriate.

Q: Is the end goal to enable mass production and easy assembly in space?

Yes, those are some of the major goals. How that becomes implemented has many paths and scalable and sustainable robotic capabilities will be a core capability to enable this.

Q: Would a modular, autonomous communications system designed for remote and blackout environments be relevant under this topic?

Topics focused on addressing manipulation, sensing, architecture, and cost reduction problems for manufacturing and assembly will be higher priority.

Q: Would the further development of a fastener end effector—using space-qualified components—fall within the scope of the robotics topic?

- Yes, provided the design is scalable and adaptable to other applications.
- For example: (1) it could be resized easily with minimal re-engineering beyond dimensional adjustments, and (2) adaptors or other interface solutions could enable integration with different systems or use in various scenarios.

Q: Are there recommended interface standards we should be working toward, or is proposing the development of common interfaces considered valuable forward work?

There are currently a few existing standards in development but are not widely adopted. Developing a standard that can be widely adopted by industry, government, and academic organizations to enable a plug-and-play network would be of significant interest.

Q: What qualifies as preparing existing technology for space? Are there required tests or certifications?

Qualification depends on the target environment (LEO, GEO, lunar, Mars, etc.). NASA has reference documents—such as the Goddard Gold Rules, design guidelines, and handbooks—that outline environmental requirements. Understanding and referencing these early is important, even if full qualification comes later.

Q: Are space mining technologies or prospecting tools in scope?

- Prospecting and direct space mining tools are outside the current subtopic scope.
- However, if you're developing materials intended for in situ use (e.g., recycled or local space resources), that context can be referenced.