

ASTRAL MATERIALS Parabolic Flight Test STATEMENT OF WORK

The development of advanced semiconductor manufacturing techniques and materials aligned with the priorities of the “CHIPS for America” (<https://www.nist.gov/chips>) of the CHIPS and Science Act of 2021 is crucial for maintaining United States technological leadership in both terrestrial and space applications that require high performance semiconductors. NASA’s In Space Production Applications (InSPA) Portfolio enables commercially viable and sustainable business opportunities in low-Earth orbit (LEO) that advance solutions for national interest or public benefit by leveraging the capabilities and resources of the ISS. Astral Materials, Inc. has been awarded a NASA SBIR IGNITE Phase II contract to develop a ground prototype of a novel microgravity assisted crystal growth furnace designed to develop the first ever on-orbit silicon crystal growth. The following describes the manner in which Astral Materials, Inc. will develop and demonstrate a specialized crystal growth furnace for in-space manufacturing of low-defect wide-bandgap semiconductors. Parabolic flights will be utilized to de-risk critical technological and procedural gaps required for future low-Earth orbit (LEO) manufacturing demonstrations on the International Space Station (ISS) and other commercial spacecraft.

1. Objectives and Requirements

Astral Materials will develop hardware that will be used to commercialize ultra-high quality semiconductor crystal growth in microgravity, which will address a terrestrial market worth \$2B and is projected to reach \$10B by 2034. The utilization of the microgravity environment will address the technical challenges in scaling the growth of semiconductor substrates that are caused by Earth’s gravity. Building upon preliminary research that suggests gravitational effects influence crystal formation and defect density, this effort will utilize parabolic flight testing to validate key process parameters and system capabilities utilizing microgravity as a subsystem. This project will lay the foundation for future silicon crystal growth for enhanced semiconductor device manufacturing utilizing the microgravity environment and will validate and enhance the technological and procedural gaps needed to develop the in-space manufacturing of critical semiconductor materials.

The main objectives of this purchase order are to:

- (1) Test molten metal confinement in microgravity.
- (2) Test cooling systems in microgravity.
- (3) Validate thermal models in microgravity.
- (4) Validate hardware including:
 - a. Arc melting system for small volumes
 - b. Cameras and sensors

Astral Materials, Inc. shall purchase parabolic flight services to enable hardware validation and microgravity testing. After the parabolic flight tests are accomplished, Astral Materials, Inc. shall deliver a report on furnace functionality, lessons learned that will inform future parabolic and orbital flights, and on the quality of silicon samples synthesized during parabolic flight. The purpose of this flight is for hardware validation of a novel microgravity arc melting system. Due to the limited time in microgravity, Astral Materials does not expect significant material improvements from this first parabolic flight test. Key quality metrics to be evaluated include:

- Furnace operability in a microgravity environment,
- Furnace repeatability,
- Sample chamber modularity,
- Correlation of material quality parameters with processing conditions, particularly focusing on the relationship between gravitational conditions and crystal formation characteristics.

Results will be compiled into a detailed report correlating processing conditions with material quality improvements, providing an assessment of furnace functionality and any microgravity enhancement effects. This will help establish baseline performance metrics for future space-based processing development.

Astral Materials, Inc. shall provide NASA with pre- and post- flight silicon samples for use in independent test and evaluation to validate. Astral Materials, Inc. shall select pre- and post- flight samples that are representative of the most successful trials. As noted above, Astral Materials does not expect the first parabolic flight campaign to produce high quality crystals, and the primary goal of the first flight is hardware validation.

a. Shipping information:

[REDACTED]
 NASA Langley Research Center
 [REDACTED]
 Building 2104, Mail Stop 62
 22 West Taylor Street
 Hampton, VA 23681-2199
 [REDACTED]
 [REDACTED]

2. Specifications

The microgravity-assisted crystal growth furnace should:

- Heat silicon samples to a temperature of at least 1420 C for seconds at a time in a microgravity environment.
- Have functional sensors and cameras for crystal growth in-situ analysis.
- Demonstrate the ability to contain molten silicon samples at a fixed point in the furnace under microgravity conditions.
- Produce spherical silicon samples.

3. **Place of Performance:** Astral Materials, Inc.
 319 Bernardo Ave
 Mountain View, CA, 94043

4. **Period of Performance:** award thru February 2026

5. Schedule and Milestone Payments

The Estimated Completion Date (ECD) of milestones and payments shall be as follows:

Milestone	Description	Due Date	<div></div>
1	Kickoff Meeting and Zero-G Flight Reservation	Thirty (30) Days Following Award	<div></div>
2	Parabolic Design of Experiment Delivered to NASA	Ninety (90) Days Following Award	<div></div>
3	Safety Data Submitted to Zero-G Corp	Sixty (60) Days prior to Flight	<div></div>
4	Post-Flight Debrief to NASA	Two (2) weeks following flight	<div></div>
5	Final Report and Sample Delivery to NASA	Ninety (90) Days Following Parabolic Flight Completion	<div></div>