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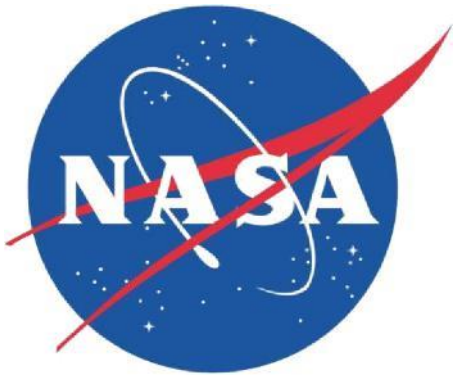

National Aeronautics and Space Administration
Office of Education
FY 2018 NASA Cooperative Agreement Notice (CAN)

Established Program to Stimulate Competitive Research (EPSCoR)

Rapid Response Research

Announcement Number: NNH18ZHA005C
Catalog of Federal Domestic Assistance (CFDA) Number: 43.008

Release Date:	**6/18/2018**
Closing Date	**6/18/2019**

NASA Headquarters
Office of Education
Washington, DC 20546-0001Summary of Key Information

Introduction
NASA's Office of Education, in collaboration with the Science Mission Directorate (SMD) and the Commercial Partnerships Office, solicits proposals for the 2018 NASA Established Program to Stimulate Competitive Research (EPSCoR) Rapid Response Research program.

The Rapid Response Research is a collaborative effort between EPSCoR and the Science Mission Director, Commercial Partners, and others. The purpose is to provide a streamlined method to address research issues important to NASA. The goal is for EPSCoR researchers to work for one year with NASA to solve problems (see appendices A and B). The EPSCoR project office will work with the NSSC and NSPIRES to process proposals rapidly and remove obstacles to implementing research within NASA. The proposals should be small (2-3 pages) and submitted to NSPIRES.

Each funded NASA EPSCoR proposal shall focus on developing competitive research and technology for the solution of scientific and technical problems of importance to NASA as defined the above collaborators. Proposals shall also contribute to the overall research infrastructure, science and technology capabilities of higher education, and/or economic development of the EPSCoR jurisdiction.

This Cooperative Agreement Notice (CAN) is designed to provide the EPSCoR Project Office with the ability to respond rapidly to proposals submitted by eligible jurisdiction NASA EPSCoR Directors.

Solicitation Availability
This announcement is accessible for a period of one (1) year through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) and through Grants.gov.

To access this announcement through NSPIRES, go to http://nspires.nasaprs.com and click on Solicitations.

To access this announcement through Grants.gov, go to https://www.grants.gov/web/grants/search-grants.html and select the link for NASA.

Eligibility
As stated in NASA EPSCoR legislation, jurisdictions eligible to compete for this opportunity are those jurisdictions eligible to compete in the National Science Foundation EPSCoR Research Infrastructure Improvement Grant Program (RII). The NSF eligibility is based on whether the most recent 3-year level of NSF research support is equal to or less than 0.75 percent. The most recent eligibility table may be found at:
https://www.nsf.gov/od/oia/programs/epscor/Eligibility_Tables/FY2018_Eligibility.pdf

Budget proposals will be accepted from the resident institution of the NASA EPSCoR Director in each jurisdiction. The 26 jurisdictions that are eligible for this opportunity are: Alabama, Alaska, Arkansas, Delaware, Guam, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Oklahoma, Puerto Rico, Rhode Island, South Carolina, South Dakota, US Virgin Islands, Vermont, West Virginia, and Wyoming.

Availability of Funds and Period of Performance
NASA's ability to make awards is contingent upon the availability of appropriated funds from which payment can be made.

It is anticipated that approximately five (5) awards of up to $100,000 for a period of performance not to exceed one year each, may be made under this CAN pursuant to the authority of Title 2 Code of Federal Regulations (CFR) Part 200 and Title 2 CFR Part 1800.

Proposal Submission
All information needed to respond to this solicitation is contained in this announcement and in the companion document entitled *Guidebook for Proposers Responding to a NASA Research Announcement (NRA) or Cooperative Agreement Notice (CAN) March, 2018 Edition* (hereafter referred to as the *NASA Guidebook for Proposers*). The latest PDF version is available through: http://www.hq.nasa.gov/office/procurement/nraguidebook

Proposers are cautioned that only the NASA NSSC Grants Officer has the authority to make commitments, obligations, or awards on behalf of NASA or authorize the expenditure of cooperative agreement funds. No commitment on the part of NASA should be inferred from technical or budgetary discussions with NASA managers, Mission Directorate employees, or other support staff. An organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by a NASA NSSC Grants Officer does so at its own risk.

Inquiries
Technical and scientific questions about programs in this CAN may be directed to:

EPSCoR
Jeppie R. Compton
Project Manager, NASA EPSCoR
NASA Kennedy Space Center, PX-E
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Commercial Partnerships
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New Frontiers Program (Juno and New Horizons)
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1.0 Description of Opportunity

1.1 Technical Description

The NASA Established Program to Stimulate Competitive Research (EPSCoR) is administered through NASA's Office of Education. The purpose of NASA EPSCoR is to strengthen the research capability of jurisdictions that have not in the past participated equably in competitive federal research and development activities.

This Cooperative Agreement Notice (CAN) solicits proposals of two (2) to three (3) pagges for the 2018 NASA EPSCoR Rapid Response Research program. Each funded NASA EPSCoR proposal shall focus on developing competitive research and technology for the solution of scientific and technical problems of importance to the Science Mission Directorate (SMD) and the Commercial Partnerships Office as listed in the appendices. The Rapid Response Research program is an attempt to implement research within NASA and commercial programs to address technical issues. It will allow EPSCoR researchers to work alongside of NASA and Commercial providers for up to one year and is intended strengthen the bonds between EPSCoR jurisdictions, NASA, the commercial partners and others. Our first attempt is with the SMD Planetary Science Research Program and the Commercial partnerships office.

The SMD Planetary Science Research Program sponsors research to explore the solar system to study its origins and evolution, including the origins of life within it. SMD related proposals that are submitted in response to this CAN shall be submitted in response to the science requirement described in Appendix A.

The Commercial Partnerships Office will assist commercial space industry in developing a long-term, sustained commercial Low-Earth Orbit (LEO) presence to ensure that the United States has access to an orbital platform for the purpose of conducting research and develop new technologies and prepare crews for missions near the Moon. This program will leverage the experience that NASA and its private sector partners have with the construction, deployment, operations, and use of orbital platforms to ensure that the United States will continue to have access to LEO in the mid-2020s and beyond. Commercial Partnerships Office related proposals in response to this CAN should be submitted in response to the science requirement described in Appendix B.

The program parameters, outlined in more detail below, are:

- Jurisdictions may submit one proposal consisting of two (2) to three (3) pages per NASA Technical Area listed;
- Maximum funding per proposal: $100,000 for a period of performance not to exceed one year;
- Cost-share is not required; and
- This solicitation is open for a period of one (1) year (i.e., there is no specific due date); Proposals are submitted at the discretion of the jurisdiction's NASA EPSCoR Director.

1.2 Funding and Cost-Sharing

The maximum funding that a jurisdiction can request from NASA is $100,000 per proposal to be expended in accordance with the budget details and budget narrative in the approved proposal.

The Period of Performance is one year. Cost-sharing is not required.

All awards made in response to proposals to this solicitation shall comply with the National Environmental Policy Act (NEPA). Thus, proposers are encouraged to plan and budget for any anticipated environmental impacts per instructions in the *NASA Guidebook for Proposers.*

1.3 Restrictions

All awards made in response to proposals to this solicitation shall comply with the National Environmental Policy Act (NEPA). Thus, proposers are encouraged to plan and budget for any anticipated environmental impacts per instructions in the *NASA Guidebook for Proposers*.

Per the *NASA Guidebook for Proposers, Title 2 CFR §1800,* and the *NASA Grant and Cooperative Agreement Manual* (GCAM), the following restrictions govern the use of the NASA provided EPSCoR funds and are applicable to this CAN:

- Funds shall not be used to fund research carried out by non-U.S. institutions. However, U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources. Subject to export control restrictions, a foreign national may receive remuneration through a NASA award for the conduct of research while employed either full or part time by a U.S. institution. For additional guidance on foreign participation, see Section 3.2 of the *NASA Guidebook for Proposers* and the NASA FAR Supplement (NFS) Part 1835.016-70.
- Domestic travel does not have a funding limit. Domestic travel, defined as that travel which does not require a passport, shall be appropriate and reasonable to conduct the proposed research.
- NASA EPSCoR funding shall not be used to purchase general purpose equipment, e.g. desktop workstations, office furnishings, reproduction and printing equipment, etc. as a direct charge. Special purpose equipment purchases (i.e., equipment that is used only for research, scientific, and technical activities directly related to the proposed research activities) are allowed and can be reflected as a direct charge as per cost principles cited in 2 CFR §1800.907, Equipment and Other Property.
- NASA EPSCoR funding shall not be used to support NASA civil service participation (FTE) in a research project. That funding is provided through a funding vehicle between the jurisdiction and NASA center, such as a Space Act Agreement or other reimbursable agreement. NASA EPSCoR shall not set aside funding from an award to send to a center for FTE support (including travel).
- NASA EPSCoR funds shall be expended on NASA EPSCoR institutions. If a Co-Investigator (Sc-I/Co-I) with an NASA EPSCoR award transfers to a non-EPSCoR institution, the EPSCoR funding amount, or the portion of it that remains unobligated at the time of Sc-I/Co-I transfer, shall not be transferred to the non-EPSCoR institution.
- All proposed funds shall be allowable, allocable and reasonable. Funds may only be used for the EPSCoR project. All activities charged under indirect cost shall be allowed under cost principles included in 2 CFR 200.
- Non-Federal entities may use one of the methods of procurement as prescribed in 2 CFR 200.320. As defined in 2 CFR 200.67, the micro-purchase threshold for acquisitions of

supplies or services made under grant and cooperative agreement awards issued to institutions of higher education, or related or affiliated nonprofit entities, or to nonprofit research organizations or independent research institutes is $10,000; or such higher threshold as determined appropriate by the head of the relevant executive agency and consistent with audit findings under chapter 75 of Title 31, United States Code, internal institutional risk assessment, or State law.

- Unless as otherwise directed in 2 CFR 200, for changes to the negotiated indirect cost rate that occur throughout the project period, the proposer/recipient shall apply the rate negotiated for that year, whether higher or lower than at the time the budget and application was awarded.
- Proposals shall not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.
- Any funds used for matching or cost-sharing shall be allowable under 2 CFR 200.

1.4 Access to Research Results

In keeping with the NASA Plan for Increasing Access to Results of Scientific Research, new terms and conditions, consistent with the Rights in Data term and conditions (2 CFR 1800.909), information about making manuscripts and data publically accessible may be attached to NASA EPSCoR Research awards. All proposals will be required to provide a Data Management Plan (DMP) or an explanation as to why one is not necessary given the nature of the work proposed. *The DMP shall be submitted by responding to the NSPIRES cover page question about the DMP (limited to 4000 characters).* Any research project in which a DMP is not necessary shall provide an explanation in the DMP block. Example explanations:

- *This is a development effort for flight technology that will not generate any data that my entity can release, so a DMP is not necessary.*
- *The data that our entity will generate will be ITAR.*
- *Or, your entity may simply explain why your project is not going to generate data.*

The proposal type that requires a DMP is described in the *NASA Plan for Increasing Access to Results of Scientific Research* (see above link). The DMP shall contain the following elements, as appropriate to the project:

- A description of data types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;
- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data; and
- A discussion of roles and responsibilities of team members in accomplishing the DMP. (If funds are required for data management activities, these should be included in the budget and budget justification sections of the proposal.).

Proposers that include a plan to archive data should allocate suitable time for this task. Unless otherwise stated, this requirement supersedes the data sharing plan mentioned in the *NASA Guidebook for Proposers*.

NASA is implementing a process to collect demographic data from grant applicants for the purpose of analyzing demographic differences associated with its award processes. Information collected shall include name, gender, race, ethnicity, and disability status. Submission of this information is voluntary, only available to NASA in aggregate form, and is not a precondition of award.

In addition, as part of an award term and conditions, researchers submitting NASA-funded articles in peer-reviewed journals or papers from conferences now shall make their work accessible to the public through NASA's *PubSpace* at https://www.nihms.nih.gov/db/sub.cgi. *PubSpace* provides free access to NASA funded and archived scientific publications. Research papers will be available within one year of publication for the public to download and read.

1.5 Foreign National Participation

All recipients shall work with NASA project/program staff to ensure proper credentialing for any individuals who need access to NASA facilities and/or systems. Such individuals include U.S. citizens and lawful permanent residents ("green card" holders). It should be noted that foreign nationals (individuals who are neither U.S. citizens nor permanent residents) are not normally allowed access to NASA facilities.

2.0 Proposal Submission Instructions

All proposals shall be submitted at the NASA EPSCoR Director's discretion via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at: (http://nspires.nasaprs.com).

Proposers shall carefully note the following requirements for submission of an electronic proposal.

2.1 Announcement of Updates/Amendments to Solicitation

Additional programmatic information for this CAN may be made available before the proposal due date. If so, such information will be added as a formal amendment to this CAN as posted at its homepage on http://nspires.nasaprs.com.

Any clarifications or questions and answers regarding this CAN will be posted at its homepage on http://nspires.nasaprs.com.

Each prospective proposer has the responsibility to regularly check this CAN's homepage for any and all updates.

2.2 Cancellation of Program Announcement

NASA Office of Education reserves the right to not make any awards under this CAN and/or to cancel this CAN. NASA assumes no liability (including proposal costs) for cancelling the CAN or for any entity's failure to receive such notice of cancellation.

2.3 Registration in NSPIRES

Every organization that intends to submit a proposal to NASA in response to this opportunity shall be registered in NSPIRES. The organization's electronic business point-of-contact in the System for Award Management (SAM) shall perform the registration in NSPIRES.

While every effort is made to ensure the reliability and accessibility of the websites and to maintain a help center via email and telephone, difficulties may arise at any point on the internet, including with the user's own equipment. Therefore, proposers are urged to familiarize themselves with the NSPIRES sites and to submit the required proposals materials well in advance of the proposal submission deadline**.**

Note: Respondents who experience difficulty using NSPIRES may contact the Help Desk at nspires-help@nasaprs.com or call 202- 479-9376 between 8:00 a.m. and 6:00 p.m., Eastern Time (ET), Monday through Friday (except for federal holidays). Proposals received after the due date may be returned without review.

2.3 Inquiries

Inquiries regarding the submission of electronic proposal materials to NSPIRES should be addressed to:

Ms. Althia Harris
NASA Research and Education Support Services (NRESS)
Phone: 202-479-9030 x310
E-mail: aharris@nasaprs.com

All other inquiries about this training cooperative agreement announcement should be addressed to:

Mr. Jeppie Compton
National Project Manager, NASA EPSCoR
Office Phone: 321-867-6988
Cell Phone: 321-360-6443
E-mail: jeppie.r.compton@nasa.gov

3.0 Review and Selection Processes

Review of proposals submitted in response to this CAN shall be consistent with the general policies and provisions contained in the *NASA Guidebook for Proposers*, Appendix D. . Selection procedures shall be consistent with the provisions of the *NASA Guidebook for Proposers*, Section 5. However, the evaluation criteria described in this CAN under Section 4.0, Proposal Evaluation, takes precedence over the evaluation criteria described in Section 5 of the *NASA Guidebook for Proposers*. The selecting official for this CAN is the EPSCoR Project Manager or their appointed representative. The NASA EPSCoR Grants Officer will conduct a pre-award review of risk associated with the proposer as required by 2 CFR 200.205. For all proposals selected for award, the Grants Officer will review the submitting organization's information available through the Federal Awardee Performance and Integrity Information System (FAPIIS) and the System for Award Management (SAM) to include checks on entity core data, registration expiration date, active exclusions, and delinquent federal debt.

Limited Release of Proposers Confidential Business Information

For proposal evaluation and other administrative processing NASA may find it necessary to release information submitted by the proposer to individuals not employed by NASA. Business

information that would ordinarily be entitled to confidential treatment may be included in the information released to these individuals. Accordingly, by submission of this proposal the proposer hereby consents to a limited release of its confidential business information (CBI).

Except where otherwise provided by law, NASA will permit the limited release of CBI only pursuant to non-disclosure agreements signed by the assisting NASA support contractor or subcontractor, and their individual employees who may require access to the CBI to perform the support contract with NASA.

3.1 Selection Announcement

NASA's stated goal is to announce selections as soon as possible. However, NASA does not usually announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in NASA's budget process may result in a delay of the selection date(s). After 180 days past the proposal's submitted date, proposers may contact the NASA EPSCoR Project Manager for a status.

A proposer has the right to be informed of the major factor(s) that led to the acceptance or rejection of the proposal. Debriefings will be available upon request. Again, it is emphasized that non-selected proposals should be aware that proposals of nominally high intrinsic and programmatic merits may be declined for reasons entirely unrelated to any scientific or technical weaknesses.

3.2 Notice of Award

For selected proposals, a NASA Grants Officer will contact the business office of the proposer's institution. The NASA Grants Officer is the only official authorized to obligate the Government. For a grant or cooperative agreement, any costs that the proposer incurs within 90 calendar days before an award are at the recipient's risk in accordance with 2 CFR § 1800.209.

3.3 Administrative and National Policy Requirements

All administrative and national policy requirements may be found at Title 2 CFR Part 200, Title 2 CFR Part 1800, and the NASA Grant and Cooperative Agreement Manual (all available at http://prod.nais.nasa.gov/pub/pub_library/srba/index.html).

3.4 Award Reporting Requirements

Recipients shall submit a report to the NSSC, with copies to Agency-EPSCoR and to the supported organization on the results pertaining to this award no later than 90 days after the project's end date. The reporting requirements for awards made through this CAN will be consistent with the 2 CFR § 1800.902.

4.0 Proposal Evaluation

Proposals will be evaluated based on the proposed research approach (intrinsic merit) and budget involved that addresses the research presented in Appendices A and B.

Appendix A: NASA SMD Planetary Division Research Topics to Address

SMD requests that EPSCoR include research opportunities in the area of Extreme Environments applicable to Venus, Io, Earth volcanoes and deep sea vents.

Specifically for the planet Venus which has important scientific relevance to understanding Earth, the Solar System formation, and Exoplanets. For EPSCoR technology projects Venus highly acidic surface conditions is a unique extreme environment with temperatures (~900F or 500C at the surface) and pressures (90 earth atmospheres or equivalent to pressures at a depth of 1 km in Earth's oceans). Further Information on Venus's challenging environment needs for its exploration can be found on the Venus Exploration Analysis Group (VEXAG) website: https://www.lpi.usra.edu/vexag/.

In particular, the technology requirements and challenges related to Venus exploration are discussed in the Venus Technology Roadmap at:
https://www.lpi.usra.edu/vexag/reports/Venus-Technology-Plan-140617.pdf

Two examples of areas of technology development highlighted for an EPSCOR extreme environment call are described below:

A. **High-Temperature Subsystems and Components for Long-Duration (months) Surface Operations:** Advances in high-temperature electronics and power generation would enable long-duration missions on the surface of Venus operating for periods as long as a year, where the sensors and all other components operate at Venus surface ambient temperature. These advances are needed for both the long-duration lander and the lander network. Development of high-temperature electronics, sensors, thermal control, mechanisms, and the power sources designed for operating in the Venus ambient will be enabling for future missions.

   For example, Venus surface landers could investigate a variety of open questions that can be uniquely addressed through in-situ measurements. The Venus Exploration Roadmap describes a need to investigate the structure of Venus's interior and the nature of current activity, and potentially conduct the following measurements: 1). Seismology over a large frequency range to constrain interior structure; 2). Heat flow to discriminate between models of current heat loss; 3). Geodesy to determine core size and state. Landers with sample return capability would be of great interest.

B. **Aerial Platforms for Missions to Measure Atmospheric Chemical and Physical Properties:**
   More than three decades ago, two small (3.5 m) VEGA balloons launched by the Soviet Union completed two day flights around Venus, measuring wind speeds, temperature, pressure, and cloud particle density. The time is ripe for modern NASA efforts to explore the Venus atmosphere with new technology.

   Aerial platforms have a broad impact on science for Venus. Examples of science topics they could investigate include: 1). the identity of the unknown UV absorber; 2). properties of the cloud particles in general; 3). abundances atmospheric gas species (including trace gases and noble gases); 4). the presence of lightning; 5). properties of the surface mapped aerially.

Aerial vehicles that operate at a variety of high and low altitudes in the middle atmosphere are needed to enable mid-term and far-term Venus missions addressing these issues. A platform able to operate close to the Venusian surface would be able to provide close surface monitoring but would require major development to operate in the hot dense lower atmosphere. Miniaturized guidance and control systems for aerial platform navigation for any altitudes are needed to track probe location and altitude.

Other topics of interest include high pressure and acidic environments for technology development, which would be of interest to include in the $750K level EPSCoR opportunity.

Appendix B: NASA Commercial Spaceflight Development Division Topics to Address

Research Request Number: CSCO-2017-01

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Characterization of C-18150 Additively Manufactured material
3) **Research Overview:**

NASA is requesting proposals to perform the task below which it has identified as important for furthering the engineering knowledgebase of material properties used in spaceflight.

NASA is evaluating a copper-alloy, C-18150 (Cu-Cr-Zr), as a low-cost material for additive manufacturing of regeneratively-cooled combustion chambers and nozzles. This material is being developed using the selective laser melting (SLM) process at industry vendors. Material properties and usability are highly dependent on build parameters using the SLM process, but also upon the hot isostatic pressure (HIP) conditioning and solution treatment and aging (STA) to obtain full mechanical properties as required in design. The purpose of this task is to characterize the material in the as-built condition and optimize the heat treatment through the STA conditioning to maximize material properties. NASA is completing some basic studies on HIP and STA and data available as a starting reference. The task shall include the following at a minimum:

1. Micrograph characterization of AM C-18150 material relative to grains, grain size, orientation, porosity, and general observations in comparison to wrought material.
2. Complete heat treatment studies on AM material to optimize tensile properties in comparison to wrought properties
3. Complete SEM characterization of C-18150 material in comparison to wrought
4. Complete mechanical testing of the following samples
    a. (5) RT tensile samples
    b. (5) 800F tensile samples
    c. (15) RT samples to determine effects of heat treatments
    d. (7) 800F tensile specimens following heat treatment optimization
    e. (5) RT Low Cycle Fatigue (LCF) specimens
    f. (5) 400F LCF Specimens
    g. (5) 800F LCF specimens
    h. (3) reserve
5. Complete micrograph characterization of large-scale part to determine variations in material following HIP and STA. This shall include a minimum of 30 specimens in various orientations and locations within the SLM build.
6. Recommendations provided during process development, interim and final reports.

4) **NASA Contact**
    a. Name: Warren Ruemmele
    b. Organization: Commercial Space Capabilities Office (CSCO)/UA3
    c. Work Phone: 281-483-3662
    d. Cell Phone: 832-221-1367
    e. Email: warren.p.ruemmele@nasa.gov

5) **Commercial entity:**
   a. Company Name: n/a
   b. Contact Name: n/a
   c. Work Phone: n/a
   d. Cell Phone: n/a
   e. Email: n/a

6) **Partner contribution**
   No NASA Partner contributions

7) **Intellectual property management:**
   a. No NASA Partner intellectual property concerns

8) **Additional Information:**
   NASA CSCO will coordinate support from NASA Marshall Space Flight Center (MSFC) as needed.

Research Request Number: CSCO-2017-02

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Characterization of Inconel 625 Blown Powder Freeform Deposition material
3) **Research Overview:**

NASA is requesting proposals to perform the task below which it has identified as important for furthering the engineering knowledgebase of material properties used in spaceflight.

NASA is evaluating freeform blown powder deposition, or directed energy deposition (DED), technology as a large-scale additive manufacturing technology for large scale rocket components. This technology has been demonstrated on development subscale components and at the coupon level to evaluate vendor capabilities using variations of the DED process. Additive manufacturing of Inconel 625 (UNS N06625, Alloy 625) typically completes hot isostatic pressure (HIP) conditioning and solid-solution strengthening using the selective laser melting (SLM) process. However, with increased scale of parts using the DED process, HIP processing may not be available and solution strengthening may be challenging due to scale. The purpose of this task is to evaluate the Inconel 625 material in the as-built condition from a series of industry vendors, evaluate HIP and solution heat treatments and how they might affect material and associated mechanical, properties. At a minimum the task shall include the following:

1. Micrograph characterization of DED Inconel 625 material relative to grains, grain size, orientation, porosity, and general observations in comparison to wrought material. This would include a minimum of (2) samples from each of (4) different vendors.
2. Development of etchant techniques for Inconel 625.
3. Complete heat treatment studies on AM DED Inconel 625 material to optimize tensile properties in comparison to wrought solution properties
4. Complete SEM characterization of DED Inconel 625 material in comparison to wrought for each vendor.
5. Complete mechanical testing of samples provided by each of (4) vendors. Although final matrix will be finalized, a minimum of (25) samples from each of the (4) vendors will be provided. Basic information relative to tensile properties should be evaluated in addition to some elevated temperature tensile (800, 1200, 1500F) and some initial Low Cycle Fatigue (LCF) specimens at room temperature and elevated.
6. Micrograph characterization of DED Inconel 625 material from a demonstrated nozzle build to determine differences in orientations and various feature types (thin-wall, ribs, ID surface, OD surface).
7. Recommendations provided during process development, interim and final reports.

4) **NASA Contact**

f. Name: Warren Ruemmele
g. Organization: Commercial Space Capabilities Office (CSCO)/UA3
h. Work Phone: 281-483-3662
i. Cell Phone: 832-221-1367
j. Email: warren.p.ruemmele@nasa.gov

5) **Commercial entity:**
   a. Company Name: n/a
   b. Contact Name: n/a
   c. Work Phone: n/a
   d. Cell Phone: n/a
   e. Email: n/a

6) **Partner contribution**
   No NASA Partner contributions

7) **Intellectual property management:**
   a. No NASA Partner intellectual property concerns

8) **Additional Information:**
   NASA CSCO will coordinate support from NASA MSFC as needed.

Research Request Number: CSCO-2017-03

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Characterization of GLIDCOP Additively Manufactured material
3) **Research Overview:**

NASA is requesting proposals to perform the task below which it has identified as important for furthering the engineering knowledgebase of material properties used in spaceflight.

NASA is evaluating a dispersion strengthened copper-alloy, GLIDCOP (Cu-Al), as a low-cost material for additive manufacturing of regeneratively-cooled combustion chambers and nozzles. This material is being developed using the selective laser melting (SLM) process at industry vendors. Material properties and usability are highly dependent on build parameters using the SLM process, but also upon the hot isostatic pressure (HIP) conditioning to obtain full mechanical properties as required in design. The purpose of this task is to characterize the material in the as-built condition and also optimize the hot isostatic pressure (HIP) conditioning to maximize material properties. NASA is completing some basic studies on HIP as a starting reference. At a minimum, the task shall include the following:

1. Micrograph characterization of AM GLIDCOP material relative to grains, grain size, orientation, porosity, and general observations in comparison to wrought material.
2. Complete heat treatment studies on AM material to optimize tensile properties in comparison to wrought properties
3. Complete SEM characterization of GLIDCOP material in comparison to wrought
4. Complete mechanical testing to include elevated temperature tensile specimens, room temperature and elevated temperature Low Cycle Fatigue (LCF), room temperature and elevated temperature High Cycle Fatigue (HCF). Temperatures should include a range up to 1000F to determine if any ductility dips occur as experienced with wrought material.
5. Complete micrograph characterization of small-scale part to determine variations in material following HIP. This shall include a minimum of 15 specimens in various orientations and locations within the SLM build.
6. Recommendations provided during process development, interim and final reports.

4) **NASA Contact**
   k. Name: Warren Ruemmele
   l. Organization: Commercial Space Capabilities Office (CSCO)/UA3
   m. Work Phone: 281-483-3662
   n. Cell Phone: 832-221-1367
   o. Email: warren.p.ruemmele@nasa.gov

5) **Commercial entity:**
   a. Company Name: n/a
   b. Contact Name: n/a
   c. Work Phone: n/a
   d. Cell Phone: n/a
   e. Email: n/a

6) **Partner contribution**
No NASA Partner contributions

7) **Intellectual property management:**
   f. No NASA Partner intellectual property concerns

8) **Additional Information:**
NASA CSCO will coordinate support from NASA MSFC as needed.

Research Request Number: CSCO-2017-04

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Characterization of Bimetallic Joints using Copper-based alloys
3) **Research Overview:**

NASA is requesting proposals to perform the task below that the agency has identified as important for furthering the engineering knowledgebase of material properties used in spaceflight.

NASA is evaluating bimetallic joints for propulsion applications using a variety of joining methods. These joints are bimetallic joints and include the use of copper-alloys (C-18150 and GRCop-84) as one material and a 300 Series Stainless Steel or Inconel-based superalloy as the other material. Processes used for these joints include Explosive Bonding or Explosive Welding (EXW), Inertia welding, and laser cladding deposition. NASA has an interest to aid in characterizing these joints and perform detailed studies of optimization of heat treatments to maximize material properties trading the limitations of both materials. The following samples may be provided as part of the characterization and mechanical testing study to aid with sample evaluation and heat treatment studies:

a) Explosively Bonded C-18150 to Stainless 347
b) Inertia Welded C-18150 to Stainless 304/316
c) Laser Cladded Deposition Inconel 625 onto C-18150
d) (option) SLM Inconel 625 to GRCop-84
e) (option) Laser Deposited Inconel 625 to GRCop-84

At a minimum the task shall include the following:

1. Micrograph characterization of each of the bimetallic material combinations relative to grains, grain size, orientation, porosity, and general observations.
2. Complete heat treatment studies on bimetallic material combinations to optimize tensile and fatigue properties trading limits of both materials (ie. Inconel 625 cannot be fully homogenized / solution treated with the melt limit of copper-alloy).
3. Complete SEM characterization of bimetallic material combinations at interface
4. Complete mechanical testing to include room temperature, elevated temperature tensile specimens, room temperature and elevated temperature Low Cycle Fatigue (LCF), room temperature and elevated temperature High Cycle Fatigue (HCF). Temperatures should include a range up to 1000F to determine if any ductility dips occur at any temperature ranges.
5. Recommendations provided during process development, interim and final reports.

4) **NASA Contact**
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   c. Work Phone: 281-483-3662
   d. Cell Phone: 832-221-1367
   e. Email: warren.p.ruemmele@nasa.gov

5) Commercial entity:

a. Company Name: n/a
b. Contact Name: n/a
c. Work Phone: n/a
d. Cell Phone: n/a
e. Email: n/a

6) Partner contribution

No NASA Partner contributions

7) Intellectual property management:

a. No NASA Partner intellectual property concerns

8) Additional Information:

NASA has identified the following potential ESPCoR institutions (jurisdictions) with probable current capability – there may be others with capability:
NASA CSCO will coordinate support from NASA MSFC as needed.

Research Request Number: CSCO-2017-05

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Investigate potential of Mars and Lunar resources
3) **Research Overview:**

NASA is requesting research proposals in this area to further autonomy from Earth resources for space exploration and commercialization efforts, by enabling extending surface stays and/or supporting off-Earth/Moon/Mars economies and/or efficiencies. NASA has not identified specific tasks in this area.

Proposals shall consider the following:

A. Resources that are of interest include those to: form propellant, support human ECLS/life, create shelters, provide energy, or are of other economic value. For example:
   a. Investigate Mars methane indications to assess abiotic sources and possible prevalence in water and CO2 ice formations
      i. Possibility that are processes on Mars that are producing a constant source of methane that could be exploited as a fuel resource
      ii. Possibility that this is concentrated in water/CO2 ice deposits, possibly as Clathrates.
B. Investigate existing and scheduled sensing capabilities (e.g. SHARAD, THEMIS, ESA-TGO)
   a. NOTE: outcome of this work may recommend future sensors, but this is not a call for new sensor proposals
C. Propose method by which above existing/scheduled sensing capabilities and/or other available data/observations (historical, meteorites, recent craters) can be used to identify resources of interest
D. Compare and contrast proposed work against prior and existing work that may be going on (NASA, Commercial, etc) for relevancy and benefit. Identify knowledge gaps. Describe proposed Institution's relevant capabilities/prior work.

The proposed task shall include the following:

1. Develop method by which above existing/scheduled sensing capabilities and/or other available data/observations (historical, meteorites, recent craters) are used to identify resources of interest, and perform data analysis
   a. Estimate resource levels, assess NASA exploration plans (e.g. current and future planned rovers/orbiters) to see if instruments can help quantify and if not what instrument would be recommended
   b. Help define data request for any needed sensed data (e.g. from NASA or NASA International Partner systems)
   c. Develop data base maps of resources including info about availability/prevelance (depth from surface, quantity, purity, type of overburden, physical form, etc).
2. Produce final report

4) NASA Contact

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5) Commercial entity:

a. Company Name: n/a
b. Contact Name: n/a
c. Work Phone: n/a
d. Cell Phone: n/a
e. Email: n/a

6) Partner contribution

No NASA Partner contributions

7) Intellectual property management:

a. No NASA Partner intellectual property concerns

8) Additional Information:

NASA has identified the following potential ESPCoR institutions (jurisdictions) with probable current capability – there may be others with capability:
University of Idaho (ID) https://www.uidaho.edu/news/here-we-have-idaho-magazine/geology-goes-to-mars
University of Alaska (AK)(https://www.researchgate.net/profile/Vladimir_Romanovsky2

NASA CSCO will coordinate support from within NASA as needed.

Related references:
--- *general*
https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160005963.pdf
http://www.lpi.usra.edu/science/staff/spudis/
--- *methane*
https://en.wikipedia.org/wiki/Methane_clathrate
https://www.youtube.com/watch?v=U46XOoU0DrM (USGS Gas Hydrates Lab)
https://phys.org/news/2009-07-hydrocarbons-deep-earth.html
https://en.wikipedia.org/wiki/Coal_Oil_Point_seep_field
http://seeps.geol.ucsb.edu/
http://science.sciencemag.org/content/323/5917/1041
https://phys.org/news/2004-09-inexhaustible-source-energy-methane-deep.html#nRlv
https://www.nasa.gov/jpl/msl/pia19088/
http://www.planetary.org/blogs/guest-blogs/2014/1216-like-a-bad-penny-methane-on-mars.html

http://science.sciencemag.org/content/323/5917/1041
http://www.sciencedirect.com/science/article/pii/S003206330300165X/pdfft?md5=de0d2919a89c4af3469bb7a2fa28aba8&pid=1-s2.0-S003206330300165X-main.pdf
NTRS: 20040191774
"THE ORIGIN AND DISTRIBUTION OF METHANE HYDRATE IN THE MARTIAN CRUST
Michael D. Max1 and Steve Clifford2, 1MDS Research, 1601 3rd St. South, St. Petersburg, FL 33701
<mmax@mdswater.com>, 2LPI, 3600 Bay Area Blvd. Houston TX 77058
clifford@lpi.usra.edu"

NTRS: 20040196353 "THE IDENTIFICATION OF GAS HYDRATE RESOURCES ON MARS:
IMPLICATIONS FOR HUMAN EXPLORATION AND LONGTERM HABITATION
M.D. Max' and S. Clifford'
'Marine Desalination Systems, L.L.C. 1601 3d St. South, St. Petersburg, FL 33701, mmax@mdswater.com, 'Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058,
clifford@lpi.usra.edu."

NTRS: 20040061999 "GAS HYDRATE STABILITY AT LOW TEMPERATURES AND HIGH PRESSURES
WITH APPLICATIONS TO MARS AND EUROPA. G. M. Marion1, J. S. Kargel2, and D. C.
Catling3, 1Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512, Giles.Marion@dri.edu, 2U.S.
Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, jkargel@usgs.gov, 3Box 351640, University of
Washington, Seattle, WA 98195, dcatling@u.washington.edu."

Research Request Number: CSCO-2017-06

1) **Program:** Commercial Space Capabilities Office
2) **Research Title:** Investigation of Mars Compatible Plants
3) **Research Overview:**

NASA is requesting research proposals in this area to further resource's autonomy from Earth for space exploration and commercialization efforts, by enabling extending surface stays and/or supporting off-Earth/Moon/Mars economies/efficiencies. NASA has not identified specific tasks in this area.

Proposals may consider the following:

a. Investigation of whether any plant species beneficial to Human Exploration could be grown on Mars at low pressure for long term food and/or oxygen production.
b. Utilization of Mars ambient/CO2 partial pressure. May assume thermal conditions can be changed (e.g. an unpressurized hothouse, in-taking Mars atmosphere). Determine threshold pressure for plant growth.
c. Whether food and oxygen, can be produced (ultimate goal), and if not both, whether oxygen can be produced.
d. Low pressure is being sought to reduce mass and volume of structures that would enclose the plant growth area and potentially enable use of transparent materials to utilize ambient light.
e. Path of inquiry and approaches
f. Compare and contrast proposed work against prior and existing work that may be going on (NASA, Commercial, etc.) for relevancy and benefit. Identify knowledge gaps. Describe proposed Institution's relevant capabilities/prior work.

The proposed task shall include the following:

1. Investigation/demonstration of the proposed plant growth towards goal.
    a. Determine needed pressure, temperatures, water, and light levels (and whether ambient or artificial)
    b. Is Martian soil sufficient to sustain life or is nutrient augmentation needed. Is adjustment of gas partial pressure(s) and/or humidity needed.
    c. Assess different species and/or hybridize, genetic engineering to achieve goals or improve efficiencies
2. Produce final report

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5) **Commercial entity:**
    a. Company Name: n/a
    b. Contact Name: n/a
    c. Work Phone: n/a

d. Cell Phone: n/a
e. Email: n/a

6) Partner contribution

No NASA Partner contributions

7) Intellectual property management:

a. No NASA Partner intellectual property concerns

8) Additional Information:

NASA CSCO will coordinate support from within NASA as needed.

Appendix C: Certification of Compliance

The AOR's signature on the Proposal Cover Page automatically certifies that the proposing organization has read and is in compliance with all certifications, assurances, and representations as detailed in 2 CFR 1800 Appendix A.

Also see the Certifications and Assurances link on the NASA Grant and Cooperative Agreement page and Appendix E of the *NASA Guidebook for Proposers*. Both can be found at the following site: http://naistst1.nais.nasa.gov/pub/pub_library/srba/certs.html.