ISS NATIONAL LABORATORY PROJECT CONCEPT SUMMARY

In-Space Production Applications: Advanced Materials and Manufacturing

ISS National Lab Research Announcement 2023-6

(Do not exceed 3 pages when complete)

Proposed project name: **Exploring alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable.**	
Principal investigator (PI): ilakkuvaselvi manoharan	**Project type:** ☒ Flight ☐ Ground ☐ Other
Email address: ilakk2023@gmail.com	**Space experience:** ☐ High ☐ Low ✔ None
PI citizenship status: ☐ U.S. citizen ✔ Permanent resident ☐ Non-U.S. Person	**PI country of citizenship (if non-U.S.):**
Organization legal name:	
Organization status: ✔ U.S. Entity ☐ Non-U.S. Entity	**Organization address:** **990 Shoreline dr Aurora, IL 60504**
Organization type: ☐ Commercial ☐ Academic ☐ Government ✔ Nonprofit	
Organization Unique Entity ID: C7Y5XP1FBXY7 / **Organization CAGE code:** April 3, 2023	
Is this research or technology subject to U.S. export laws and regulations? ✔ No ☐ Yes, explain below	
How did you hear about this research announcement? ✔ ISS National Lab website ☐ Email ☐ News article ☐ Advertisement ☐ NASA ☐ NSF ☐ ISS Research and Development Conference ☐ Other conference ☐ Other (please describe):	

Objectives:

In this section, summarize the project. Explain the project vision and rationale and how it demonstrates effective use of the International Space Station (ISS) National Laboratory. Include goals and deliverables.

The proposed research aims to explore alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable. Quantum dots have unique optical and electronic properties that make them ideal for a variety of applications, including medical imaging, solar cells, and electronic devices.

However, the traditional methods for synthesizing quantum dots involve the use of toxic heavy metals, such as cadmium and lead, which can pose a risk to human health and the environment.

The proposed research will focus on developing new, sustainable methods for synthesizing quantum dots using non-toxic materials such as zinc, copper, and iron.

The team will also investigate the use of biodegradable polymers as a coating material for the quantum dots, which will make them safer to use in biomedical applications.

The team will use a combination of experimental and theoretical methods to study the properties of the new quantum dots, including their size, shape, and optical properties.

The expected outcomes of the research include the development of new, sustainable methods for synthesizing quantum dots that are less toxic and more environmentally friendly. These new methods will also provide an opportunity to tailor the properties of quantum dots for specific applications, including medical imaging and solar cells. Additionally, the research will contribute to the growing field of sustainable materials and provide a model for the development of other sustainable materials and processes.

- **State the project objectives, the starting and ending technology readiness level (TRL), and the starting and ending manufacturing readiness level (MRL), if applicable. (For an explanation of TRL and MRL, see the Instructions to Offerors for this NLRA.)**

Project objectives: The project aims to explore alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable. Specifically, the objectives of the project include:

- Identifying alternative materials to replace the toxic heavy metals used in the synthesis of quantum dots.
- Developing new methods for synthesizing quantum dots using sustainable and non-toxic materials.
- Evaluating the performance of the newly synthesized quantum dots in terms of their optical and electronic properties.
- Comparing the environmental impact and cost-effectiveness of the new quantum dots with those synthesized using traditional methods.

Starting Technology Readiness Level (TRL): The starting TRL for this project would be around TRL 3-4, as the project is focused on exploring alternative materials and methods for synthesizing quantum dots, which would require significant laboratory research and development.

Ending Technology Readiness Level (TRL): The ending TRL for this project would be around TRL 6-7, as the project aims to develop and demonstrate the feasibility of new materials and methods for synthesizing quantum dots in a laboratory setting.

Starting Manufacturing Readiness Level (MRL): The starting MRL for this project would be around MRL 1-2, as the project is focused on laboratory research and development and has not yet reached the stage of scaling up production.

Ending Manufacturing Readiness Level (MRL): The ending MRL for this project would be around MRL 3-4, as the project aims to demonstrate the feasibility of the new materials and methods for synthesizing quantum dots on a larger scale and to develop a manufacturing process that can produce the new quantum dots at a reasonable cost.

- **Describe how the project utilizes the conditions of a space-based laboratory or environment (e.g., extended access to microgravity, extreme environmental conditions).**

The project to explore alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable could potentially benefit from conducting experiments in a space-based laboratory or environment.

Microgravity is a unique feature of space-based environments that can be utilized in this project. Microgravity can provide an opportunity to study the effects of gravity on the growth and properties of quantum dots. The absence of gravity can also help to eliminate the settling and sedimentation of particles, which can interfere with the growth and formation of quantum dots. This can lead to more uniform and precise quantum dot synthesis, which can enhance the properties of the quantum dots.

Moreover, space-based environments can also provide extreme environmental conditions such as high vacuum, extreme temperatures, and radiation exposure. These conditions can be used to study the stability and performance of the newly synthesized quantum dots in extreme environments, which can be useful for various applications such as space exploration, aerospace, and defense.

Additionally, space-based environments can provide extended access to high-quality and advanced analytical instruments, which can help in characterizing the quantum dots in detail. These instruments can include advanced imaging techniques, high-resolution spectroscopy, and other analytical methods that are not easily accessible on Earth.

Overall, the use of a space-based laboratory or environment can help to optimize the synthesis of quantum dots and improve their properties, enabling them to be used in a wider range of applications, including space-based technologies.

- **Describe how the project's outcome will further technology development in in-space production and ultimately lead to a commercial offering.**

The project's outcome of exploring alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable in a space-based laboratory or environment can have significant implications for technology development in in-space production and ultimately lead to a commercial offering. Here are some potential ways in which the project's outcome could contribute to the development of in-space production:

1. Developing a more sustainable and efficient process for quantum dot synthesis: The project's outcome could lead to the development of a more sustainable and efficient process for synthesizing quantum dots using alternative materials and methods in a microgravity environment. This could potentially reduce the environmental impact of quantum dot production and make it more cost-effective.
2. Demonstrating the feasibility of in-space quantum dot synthesis: The project's outcome could demonstrate the feasibility of in-space quantum dot synthesis, which could lead to the development of other in-space production capabilities. This could have significant implications for space exploration and settlement by enabling the production of materials, components, and products in space without relying on resupply missions from Earth
3. Advancing the understanding of quantum dot properties in a microgravity environment: The project's outcome could provide new insights into the properties of quantum dots synthesized in a microgravity environment. This could potentially lead to the development of new applications for quantum dots in space-based technologies, such as advanced sensors, communications systems, and photovoltaics.

4. Establishing a new market for in-space production: The project's outcome could establish a new market for in-space production of quantum dots and other materials. This could lead to the development of new commercial offerings and business models that leverage the unique benefits of in-space production, such as reduced launch costs, improved product quality, and reduced environmental impact.

Overall, the project's outcome of exploring alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable in a space-based laboratory or environment could have significant implications for the development of in-space production and ultimately lead to new commercial offerings and business opportunities.

Concept of Operations:

- **Provide a basic description of the project's in-orbit requirements and experimental setup.**

The project to explore alternative materials and methods for synthesizing quantum dots that are less toxic and more sustainable would require specific in-orbit requirements and experimental setup to conduct experiments in a space-based laboratory or environment.

In-orbit requirements:

- The project would require a space-based laboratory or platform equipped with the necessary hardware, software, and infrastructure to conduct experiments related to quantum dot synthesis.
- The laboratory should be equipped with the required safety measures to prevent any hazards associated with quantum dot synthesis, such as toxicity and flammability.
- The laboratory should have access to resources such as power, water, and air filtration systems to support the experiments.

Experimental setup:

- The experimental setup would involve synthesizing quantum dots using alternative materials and methods in a microgravity environment.
- The laboratory would require specialized equipment such as a reactor vessel or a microfluidic chamber to carry out the synthesis process.
- The reactor vessel or microfluidic chamber would be filled with the necessary precursors and alternative materials to form the quantum dots.
- The synthesis process would be monitored using advanced imaging and spectroscopic techniques to study the growth and properties of the quantum dots.
- The synthesized quantum dots would be collected and analyzed using various analytical techniques to evaluate their optical and electronic properties.
- The laboratory should also have a facility to dispose of the waste generated during the experiments safely.

Overall, the in-orbit requirements and experimental setup for this project would involve synthesizing quantum dots using alternative materials and methods in a microgravity environment, which can be monitored using advanced analytical techniques to optimize the synthesis process and improve the properties of the quantum dots.

- **Describe any specific hardware or in-orbit facilities necessary to support this project, if known.**

While specific hardware or in-orbit facilities required for this project would depend on the specific details of the experimental setup, there are some general facilities and hardware that could be necessary to support the project:

1. Space-based laboratory or platform: The project would require a space-based laboratory or platform equipped with the necessary infrastructure, including power, air filtration systems, and waste disposal facilities, to support the experiments.
2. Microgravity environment: The laboratory or platform should be equipped with the necessary hardware and software to create a microgravity environment for the synthesis of quantum dots.
3. Reactor vessel or microfluidic chamber: The project would require a reactor vessel or microfluidic chamber to carry out the synthesis process, filled with the necessary precursors and alternative materials to form the quantum dots.
4. Advanced imaging and spectroscopic equipment: The laboratory or platform should be equipped with advanced imaging and spectroscopic equipment to monitor the synthesis process and evaluate the optical and electronic properties of the synthesized quantum dots.
5. Safety equipment: The laboratory or platform should be equipped with necessary safety equipment to handle the hazards associated with the synthesis of quantum dots, such as toxicity and flammability.
6. Waste disposal facilities: The laboratory or platform should have the facility to dispose of the waste generated during the experiments safely.
7. Communication equipment: The laboratory or platform should be equipped with communication equipment to allow for real-time communication with ground-based researchers and facilities.

Overall, the specific hardware or in-orbit facilities required for this project would depend on the specific details of the experimental setup and the specific space-based laboratory or platform available for the experiments. However, the facilities and equipment listed above are generally necessary to support the synthesis and evaluation of quantum dots in a space-based laboratory or environment.

- **Define the logistical support and payload return requirements.**

The logistical support and payload return requirements for this project involve the transportation of the necessary equipment, materials, and personnel to the space-based laboratory or platform and the return of the payload to Earth for further analysis and evaluation.

Logistical support requirements:

- Transportation of the necessary equipment, materials, and personnel to the space-based laboratory or platform.

- Deployment of the laboratory or platform in the desired orbit and orientation for the experiments.
- Maintenance and operation of the laboratory or platform during the experiments, including monitoring the experiments, handling the waste generated, and conducting any necessary repairs or maintenance.

Payload return requirements:

- Return of the synthesized quantum dots and any other equipment, materials, and samples collected during the experiments to Earth for further analysis and evaluation.
- Safely returning any personnel involved in the project to Earth.
- Retrieval of the laboratory or platform, if necessary.

To accomplish these logistical support and payload return requirements, the project would require the use of specialized launch vehicles, such as a Falcon 9 or a Delta IV Heavy, capable of delivering the laboratory or platform to the desired orbit. It would also require the use of specialized spacecraft and landing systems, such as a Dragon capsule or a Soyuz spacecraft, to return the payload and personnel safely to Earth.
Overall, the logistical support and payload return requirements for this project involve the transportation of the necessary equipment and personnel to the space-based laboratory or platform and the safe return of the payload to Earth for further analysis and evaluation.

- Identify any preliminary discussions the offeror has had with an Implementation Partner, including evidence that the Implementation Partner can meet the proposed technical and schedule requirements.
- If known, provide an in-orbit operations timeframe (i.e., desired launch date and flight duration).
- Offerors anticipating the requirement for iterative microgravity studies are encouraged to generally describe those successive experiments, noting whether they could be completed within one flight or whether they would require multiple flights. (Note: Only one flight project at a time will be funded.)

Benefits/Business Case: Provide a paragraph that describes why this proposed project is important. Describe how this research in low Earth orbit will lead to a disruptive product or service, who will use that product, and best estimates of how much revenue realistically will be generated from it, or as a result of it, and in what timeframe. Identify the organization that will commercialize the resulting product and/or application, and describe how the commercialization efforts will be funded.

This proposed project is important because it addresses the need for sustainable and efficient methods of producing quantum dots, which have a wide range of applications in electronics, solar cells, and medical imaging. By exploring alternative materials and methods for synthesizing quantum dots in a space-based laboratory or environment, this project has the potential to lead to a disruptive product or service that can revolutionize the way we produce and use quantum dots. The resulting product can be used by a variety of industries, including electronics, aerospace, and healthcare. Realistically, the revenue generated from this product will depend on various factors, such as the demand for the product, the production costs, and the level of competition in the market. However, it is estimated that the market for quantum dots will reach $4.6 billion by 2025, indicating a significant potential for revenue generation. The organization that will commercialize the resulting product and/or application can be a startup or an established company in the quantum dot industry. The commercialization efforts can be funded through various sources, such as venture capital, government grants, and strategic partnerships with industry players. Overall, this project has the potential to create a disruptive product that can generate significant revenue and bring new opportunities to the quantum dot industry.

Budget and Funding Sources:

Budget Narrative:

- If the project is receiving funds from an external source, identify the organization and funding amount. Currently there are no funds from external sources.
- Does the offeror require support from the ISS National Lab to identify potential investors or to obtain additional funding?
  Yes.
- Does the offeror or any funding partners have the intent, resources, or experience to develop and/or commercialize project outcomes?

  Not known at this time.

Item	Description	Amount ($K)
1	Project Costs	
2	Implementation Partner (Mission Integration & Operations) Costs	
3	**Total Project Funding Required (1 + 2)**	
FUNDING SOURCES		
4	Funds Provided by PI’s Organization	0
5	Funds Requested from CASIS (5a + 5b)	

5a	Project Funding Requested from CASIS	
5b	Implementation Partner (Mission Integration & Operations) Funding Requested from CASIS	
6	Funds Provided by Other Sources	0
7	In-Kind Contributions	
8	**Total from All Funding Sources (must equal Item 3)**	

Signature: ______________________________

Prepared By: ______________________________

Title: ___________________________________

Date: ___________________________________

Guidelines and Helpful Links (Do not include this page in the Concept Summary submission)

All offerors must complete and submit for review a Step 1: Concept Summary form. The purpose of Step 1 is to evaluate an offeror's concept for operational feasibility; scientific, technological, and economic/business merit; compliance with the CASIS Cooperative Agreement; and alignment with the scope of the solicitation. Concept summaries must use the template provided in this document, and all sections must be completed. As funding is limited for this research announcement, the level of funding requested will be a factor in concept approval.

Offerors are strongly encouraged to begin now during Step 1: Concept Summary preparation to identify and consult with an Implementation Partner—organizations that work with the ISS National Lab to provide services related to payload development. For more information, see the Instructions to Offerors for this research announcement.

The U.S. General Services Administration (GSA) has officially transitioned the System for Award Management (SAM.gov) to no longer use data universal numbering system (DUNS) numbers from Dun & Bradstreet (D&B) and instead use government-issued Unique Entity IDs. GSA implemented the change effective April 4, 2022. The new ID can be found on the offeror's SAM.gov profile.

It can take several weeks or longer to apply for and receive a Commercial and Government Entity (CAGE) Code. If an offeror is unable to obtain this code in time for submission of the concept summary, indicate the date one was applied for on the concept summary form. To obtain a CAGE code, go to https://cage.dla.mil/request or apply to the System for Award Management Registration at https://sam.gov/content/home. Before one can register with SAM or obtain a CAGE code, he or she will need to first obtain a Unique Entity ID.

Concerning the "In-Kind Contribution" line item in the budget table, this value should include the estimated value of any facilities, hardware, or support services provided by the offeror's institution to support the project.

Useful Links:

ISS National Lab Project Overviews: www.issnationallab.org/projects

ISS National Lab Implementation Partner Database: www.issnationallab.org/implementation-partners

NASA's Export Control Program: www.nasa.gov/oiir/export-control

NASA Designated Countries: www.nasa.gov/oiir/export-control

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