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.):** India
Organization legal name: Bubbles & Cafe Inc	
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):**

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 TRL: TRL 3-4, focused on exploring alternative materials and methods for synthesizing quantum dots.
Ending TRL: TRL 6-7, demonstrating feasibility of new materials and methods in a laboratory setting.
Starting MRL: MRL 1-2, focused on laboratory research and development.
Ending MRL: MRL 3-4, demonstrating feasibility of scaled-up production process for quantum dots.

- **Describe how the project utilizes the conditions of a space-based laboratory or environment:** A space-based laboratory or environment can benefit the project to explore alternative quantum dot synthesis methods. Microgravity enables the study of gravity's effects on quantum dot growth, eliminates settling of particles, and enhances uniform synthesis. Extreme space conditions like vacuum, temperature, and radiation aid in studying quantum dot stability and performance. Extended access to advanced analytical instruments allows for detailed characterization of quantum dots. Overall, a space-based laboratory optimizes quantum dot synthesis for a wider range of applications.

- **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. Exploring sustainable and efficient methods for synthesizing quantum dots in a microgravity environment can lead to the development of a new market for in-space production. This outcome can establish the feasibility of in-space quantum dot synthesis, reducing environmental impact and cost-effectiveness, and enabling space-based technologies such as advanced sensors and communications systems. The project could advance the understanding of quantum dot properties in a microgravity environment and have significant implications for space exploration and settlement. Ultimately, this research can create new commercial offerings and business models that leverage in-space production's benefits, including reduced launch costs, improved product quality, and environmental impact reduction.

Concept of Operations:

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

In-orbit requirements for project on quantum dot synthesis:

- Space-based laboratory or platform with necessary hardware, software, and infrastructure
- Safety measures to prevent hazards associated with quantum dot synthesis
- Access to resources like power, water, and air filtration systems

Experimental setup for project on quantum dot synthesis:

- Synthesis of quantum dots using alternative materials and methods in microgravity
- Specialized equipment like a reactor vessel or microfluidic chamber
- Monitoring of synthesis process using advanced imaging and spectroscopic techniques
- Collection and analysis of synthesized quantum dots using various analytical techniques
- Safe disposal of waste generated during experiments

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Complexity: R C A S
IP Portal Needed: Y N

Operations Lead: _____
Science Lead: _____

Overall, the project would involve conducting quantum dot synthesis experiments in a space-based laboratory or environment, using alternative materials and methods, with appropriate safety measures and advanced analytical techniques to optimize the process and improve the properties of the quantum dots. The in-orbit requirements and experimental setup would be crucial for the successful implementation of the project.

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

    1. Space-based laboratory or platform: Equipped with necessary infrastructure for experiments, such as power, air filtration, and waste disposal facilities.
    2. Microgravity environment: Created using appropriate hardware and software for quantum dot synthesis.
    3. Reactor vessel or microfluidic chamber: Required for synthesis process with precursors and alternative materials.
    4. Advanced imaging and spectroscopic equipment: Used for monitoring and evaluating quantum dot properties.
    5. Safety equipment: Necessary for handling hazards associated with synthesis, such as toxicity and flammability.
    6. Waste disposal facilities: Needed for proper disposal of generated waste.
    7. Communication equipment: Allows real-time communication with ground-based researchers and facilities. Overall, specific hardware and facilities required for the project would depend on the experimental setup and available space-based laboratory or platform, but generally include the above-listed items to support quantum dot synthesis in space.

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

Logistical support requirements:

- Transportation of equipment, materials, and personnel to the space-based laboratory or platform.
- Deployment, maintenance, and operation of the laboratory or platform during the experiments.

Payload return requirements:

- Return of synthesized quantum dots and samples to Earth for analysis.
- Safely returning personnel to Earth.
- Retrieval of the laboratory or platform, if necessary.

To meet these requirements, specialized launch vehicles and spacecraft, such as Falcon 9 or Soyuz, would be used for transportation and payload return. Overall, the project involves logistical support and payload return for the space-based laboratory or platform.

- **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**. I am still working with IPs, I can send the documentation soon.
- **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.)** No successive experiments are planned at this time.

Benefits/Business Case: 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

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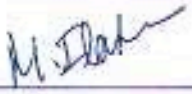
commercialize the resulting product and/or application can be a startup or an established company in the quantum dot industry. The commercialization efforts can be funded through various sources, such as venture capital, government grants, and strategic partnerships with industry players. Overall, this 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 but the offeror is working on fundraising for the project.
- **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?** Yes, the offeror has intent to commercialize project outcomes. During the course of this project, resources, experience and expertise will be gained

Item	Description	Amount ($K)
1	Project Costs	1,000,000
2	Implementation Partner (Mission Integration & Operations) Costs	500,000
3	**Total Project Funding Required (1 + 2)**	1,500,000
FUNDING SOURCES		
4	Funds Provided by PI's Organization	0
5	Funds Requested from CASIS (5a + 5b)	1,000,000
5a	Project Funding Requested from CASIS	500,000
5b	Implementation Partner (Mission Integration & Operations) Funding Requested from CASIS	500,000
6	Funds Provided by Other Sources	0
7	In-Kind Contributions	700,000
8	**Total from All Funding Sources (must equal Item 3)**	

Signature: 

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