On-Chip Nano-Plasmonics Blood-Based Assay Cartridge

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Team 9
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Contributors: Michaela Fennell, Michael DelSesto, Thavishka Gamage, Benjamin Benjadol

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Abstract

Nanoplasmonics is a ground breaking technology. If used in our day-to-day life, it can predict the onset of a disease without it even beginning to show its effects and the integrated AI software technology can suggest the medicines needed to be taken. In this way one can become more efficient. Material used in it is either gold or silver which makes it very costly for mass manufacturing. So it's not a regular product in our daily lives. To make it cheaper and to still keep it just as healthy for the body, different material alternatives were researched. The best combination found was Titanium Nitride (TiN) used with the dielectric Tellurium. TiN is already used for making artificial internal organs for transplants. When coupled with Tellurium it becomes a great conductor and hence can be used with sensors on board by monitoring the variations in pulse rate and blood glucose level.

Technology Merit and Work Plan

Current Human Vitals Technology

There are several solutions to help maintain a watchful eye on astronauts' general health and well being while they are in space. Currently, all monitoring is completed through wearable technologies, blood samples, ultrasounds, and mouth swabs. All of these listed technologies require bulky, heavy equipment, taking up extra space during the mission. Conversely, our chip device will help reduce all of that extra clutter but still serve the same purpose.

The Canadian Space Agency (CSA) currently uses a Bio-Monitor to track the astronauts vital signs. This wearable technology records and monitors pulse and the heart's electrical activity, blood pressure, breathing rate and volume, skin temperature, blood oxygen levels, and physical activity. This is currently implemented with a wireless shirt to be worn around the clock and it has adjustable areas to ensure all sensors are touching the skin to ensure accurate measures. The Bio-Monitor Shirt was sent into space in 2018.

The European Space Agency (ESA) has a similar wearable technology that completes relatively the same tasks. The Skinsuit 2.0 is a wearable technology tailored suit that provides extra support and forces to the body. This extra support and additional forces are nowhere near the amount of forces on the body as on Earth, but do help decrease the backaches upon return from their mission. Since most astronauts experience a good amount of back pain and a weakened spine, the suit mainly produces pressure around the spine. While this sounds like a complex and bulky suit, it is very flexible due to being composed of optical fibers. This suit measures swelling, elongation. Utilizing Tempus Pro, the data of the astronauts' vitals can be transmitted via satellite or a 4G phone network.

NASA uses a Wireless Physiological Monitor, LifeGuard. LifeGuard is a monitoring system, different from wearable technology like a suit, watch, or strap. This is a fanny-pack-like pouch with wires, pads, and electrodes to help monitor the astronauts vitas. LifeGuard was developed by the NASA Ames Astrobionics team and can wirelessly transmit the physical and vital data via bluetooth. An updated version of LifeGuard is currently in progress.

Pulse Rate Monitor

While in space, astronauts have to go through daily health screenings and are constantly monitored to ensure good health and well-being. Muscle atrophy, particularly in the heart, is a concern of those on the ground for those in space. Because the muscles are no longer working against gravity, their mass decreases and functions poorly relative to their original strength. At first glance, it appears convenient to require less work in order to complete basic tasks, but upon return to Earth's gravitational pull there are significant complications.

Previous studies have shown heart abnormality when the astronauts return to normal gravity. In this case, it is best to monitor the heart's health and to keep it strong during the astronaut's stay in space. Our team's technology is new and innovative- current monitoring technology includes wires, machines, watches, shirts, and further complicated devices. In order to decrease the amount of equipment brought to space and decrease the weight of the trip, we plan to implement a heart rate monitor in our chip to be placed just under the skin. This will also allow for health monitoring to be resting in the back of the mind for astronauts as it can be done remotely, and increases the amount of time they can spend on other important tasks and daily achievements.

This is a form of body modification, so there are risks to be expected. With current medical technologies we expect the procedure to be safe and to have minimal lasting effects based on the body modification community that currently exists.

Our chip will use an optical heart rate monitor as seen in the majority of current fitness trackers. Photoplethysmography, PPG, uses a green LED to measure the blood flow through your veins, hence the reason why it is most common in fitness tracking watches. This light then refracts from your blood flow and the refracted light captures the data in which can be processed and analyzed to be a heart rate. While it is most common to see Optical Monitors on watches and wristbands, it can also be used on your temple, earbud, or even anywhere near a vein. Our chip will include all the proper technology included in the optical heart rate monitors and can be best placed near a vein for the most accurate measurements.

Blood Glucose Testing

We first considered measuring blood glucose from urine but ran into several problems. Extra glucose in the bloodstream can be excreted into the urine, which we believed may create an opportunity for another biostat to be taken. Physicians often test the glucose levels in urine using a dipstick and colorpad technique to diagnose diabetes, pregnancy, and renal glycosuria (when kidneys mistakenly drop glucose into urine). Historically, in the 1970s, labs used three methods-- (1) hexokinase, (2) chemiluminescence, and (3) chemiluminescence with Somogyi precipitates-- to measure urine glucose. However, these methods needed large chambers and centrifuges. Urine glucose monitoring has advanced little since this era. In 1997, Paul Shoeh patented a device in which a chip made of a carbon layer, enzyme layer, and silver chloride reference layer oxidized and read ural glucose levels. This patent was sold to BioMedix Inc but expired in 2017 after the project was abandoned.

Our team pivoted to measure blood instead of urine. Uric acid in urine skews readings and waste products in urine are less reliable as in blood. Additionally, normal ranges of glucose in urine are from 0 to 15 mg/dL whereas normal ranges in the blood are 140 to 200 mg/dL. Regardless of the type of reading— whether blood or glucose— glucose input can affect readings so levels will be higher after a meal. It has also been found that readings will be higher after sleeping. An AI software system must be paired with the glucose monitor in order to understand fluctuations in readings. Software would be created to account for these variables and integrate the glucose data.

AI Integration and Software

AI software would be used to integrate all the biostatistics as statistics may be correlated to many other factors. Our technology would give a holistic view of an astronauts health by measuring blood glucose and pulse rate.

Additionally, our software would display this data in an easy to read graphical image. The complex data streams would be simplified into charts and graphs in order for mission control and astronauts to look over a summary of data. The original data could also be viewed if requested. The software would decide if levels were normal, higher than normal, lower than normal, or at extreme levels. The astronauts themselves would not need to see the multitude of data as the program would summarize trends for quick viewing.

Additional Potential Technologies

Recently, in August 2019, the FDA improved an implant which could help regulate blood pressure. In future versions of our product, we plan to consider adding a similar feature. The device, BAROSTIM NEO, senses changes in blood pressure and then sends electrical impulses to baroreceptors. Baroreceptors are the body's natural sensors of blood pressure. By alerting the body of abnormal blood pressure before the baroreceptors sense change, the body has extra time to compensate. Additional research and clinical trials would allow us to access if the baro-stimulating technology would be practical and useful for an aeronautical mission.

Potential Risks

Our primary risk is that the body rejects the material and chip in a particular condition. The materials pose a hazard as chemical risks— combustible liquid, compressed gas, or oxidizer that is explosive, flammable, unstable (reactive), or water-reactive— remain a possibility. Extensive testing would be needed before fielding this technology. Additionally, users could experience allergic contact dermatitis, a form of dermatitis/eczema caused by an allergic reaction to a material.

Several risks pertain to our infrastructure. Employee dropout poses a problem as team members that leave the mission for other opportunities. Additionally site accidents such as power outages, temporary site quarantine, local criminal activity, or site security breaches could should the project down.

Risk Mitigation

Our team must predict and marginalize cost in order to protect from unexpected expenses. A percentage of the mission budget will be set aside for hiring new employees if necessary. We hope to incentive employees with the following: encourage generosity and gratitude; offer flexible hours; pay attention to engagement; prioritize employee happiness; make opportunities for development and growth; innovative testing environment

To protect from hazardous material and other chemical risks we will employ hazardous materials labels (in accordance to OSHA), serve safety trainings, and administer personal protective equipment (PPE). We will ensure all waste containers must have the Hazardous Waste Accumulation label on the container. The label is to be filled out completely at the accumulation start date including physical state: hazardous and container contents. All team members will receive training on safety precautions when dealing with hazardous material and chemical risks. Lastly, all personnel will receive and work with safety equipment like HAZMAT suits, respiratory protection, gloves, boots, and eye protection. This will protect against hazardous physical-machinery/equipment injuries.

To ensure safety and security, the site will not be open to the public and the site will be only open to employees.

Resources/Material Needed

Biosensing finds its application in a wide range of areas. Nano-plasmonics is a breakthrough technology in this area. Expensive materials like gold and silver are used to ensure no poison risks when injected into the human body. This makes it difficult for commercialization and hence has failed to gain popularity. Our technology aims at revolutionizing this area and making it cheaper for nanoplasmonic-chip production.

Research shows that Titanium Nitride (TiN) has excellent conducting properties. It has been used to coat the inner surface of the ring vacuum chambers of the United States Spallation Neutron Source(6) so it has the potential to work really well in low temperature and low pressure conditions such as that of Space. This needs to be tested through experimental analysis. This can be used to make a nanoplasmonic chip which can be inserted into the bloodstream of the human body as it is already a material being used for internal organs transplant. "Resonance spectra of high refractive index dielectric cubes made of Te in air are studied using CST based numerical simulations”(4). We found out that Tellurium (Te) as a dielectric when coupled with Titanium Nitride works as an excellent sensor.

Project Management Approach

Team Leadership Structure

To overcome the fact that our team was spread among several different time zones, we created a team Slack channel to communicate. We had biweekly meetings, meeting one-on-one to complete tasks if necessary. Around the third week of the project we created and voted on leadership roles. These included a Chief Executive Officer (Osho Priya), Chief Operating Officer (Michae Fennell), Quality Assurance Officer (Michael Del Sesto), Records Officer (Tienna Matthews), and Technology Officer.

The CEO begins and guides all-team meetings, is the primary communication between Team 9 and Dann Garcia/NASA L’SPACE, visits meetings outside of their own to check in with other sub teams, works with Quality Assurance Officer to ensure that the team is producing content held to standards and acts as the conflict resolution point of contact. The COO helps CEO in various leadership duties if necessary, leads coordination of team strategy, checks in with individual team members to ensure inclusion, manages sub team development and operation, and reviews action items developed by records officers and ensures completion.

The Quality Assurance Officer ensures team aesthetics are preserved; reviews all documentation for grammatical errors; creates standards for team documents; ensures the visuals of all documents, proposals, quads, and others that leave the boundary of the team are quality and held to a high standard; submits documents. Additionally, Michael managed Google forms sent out to the team and the team’s Google Drive. The Records Officer schedules meetings for the all-team, records meeting minutes and action items, posts meeting minutes, and concludes meetings. The Technology Officer ensures that technological developments of the team are running smoothly, which includes but is not limited to team websites, team folders, team apps, slack, and team documents; creates space for records officers to post meeting notes; aids team members with technological needs; checks in with QAO to ensure the aesthetic of visual outputs.

Teaming and Workforce Development

Team 9.1: Tienna Matthews, Thavishka Gamage

Team 9.2: Michael Del Sesto, Benjamin Benjadol, Darren Chiu

Team 9.3: Osho Priya, Andrew Granger

Team 9.4: Kristin Komendowski, Michaela Fennell

The core members (students) will be working on the state of the art technology. The project will be tested using the chip in various conditions. This will require a time of approximately 6 months. The major milestones would be the following:

I. Testing Titanium Nitride.
II. Paring Titanium Nitride with Tellurium.
III. Conducting human trials.
IV. Implementation for improvement of design.
V. Testing of concept and/or process by drafting a version of an updated product.
VI. Buffer time, for better performance and better results.

Experimentation will be done for possible threats by students. Students will be provided funding and laboratory usage.

Conclusion

In conclusion, Nanoplasmonics is a ground breaking technology. It can be a cost effective technology moving forward by breaking walls within the healthcare industry. Coronavirus will and/or have changed the world permanently. Pushing all the artificial barriers to moving more of our lives online. In brief, the following device can be potentially beneficial for homo sapiens on earth: (1) those who are high risk causing a need for a health monitoring device at all times. (2) pre-k through 12 students. (3) Beneficial for doctors who see most of his or her patients virtually. More so within advance care settings. Potential benefits for astronauts within space: (1) real-time monitoring of the astronauts health. (2) no requirement of introduction of instruments within the astronauts body. (3) ability to allow the astronauts to become familiarized with more possible ground breaking areas within the space environment. Nanoplasmonics is a ground breaking technology. It can be a cost effective technology moving forward by breaking walls within the healthcare industry.

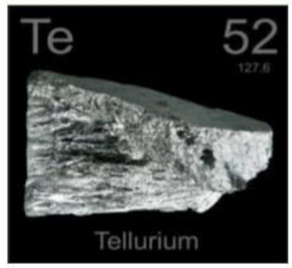
Appendix

Quad Chart

On-Chip Nano-Plasmonics Blood-Based Assay
PI: Tienna Matthews Team #9

Goal / Objective:

Titanium Nitride coupled with tellurium will cut down the cost of manufacturing the nanochip by 50-60% by creating an effective technology by replacing silver/gold from the technological on-chip, nano device in order to not only benefit astronauts in space but for those on earth as well creating quite an abundance for commercial use and/or purposes.



"Tellurium." *Pictures, Stories, and Facts about the Element Tellurium in the Periodic Table*, periodictable.com/Elements/052/index.html.

Team Overview

Innovators: Tienna Matthews, Osho Priya, Kristin Komendowski, Andrew Granger
Contributors: Michaela Fennell, Michael DelSesto, Thavishka Gamage, Benjamin Benjadol

Metrics/Key Performance Parameters

Gold Price Per Gram	*$61.46*
Silver Price Per Gram	*$0.08*
Titanium Nitride Price Per 100 Grams	*$8.00*
Tellurium Price Per Pound	*$14.00*

NPWEE Fall 2020

National Aeronautics and Space Administration	**Disclosure of Invention and New Technology (Including Software)**	Form Approved O.M.B. NO. 2700-0052	DATE 2020-10-22
		CONTRACTOR CASE NO.	

This is an important legal document. Carefully complete and forward to the Patent Representative (NASA in-house innovation) or New Technology Representative (contractor/grantee innovation) at NASA. Use of this report form by contractor/grantee is optional; however, an alternative format must at a minimum contain	NASA CASE NO. (OFFICIAL USE ONLY) NONE

the information required herein. NASA in-house disclosures should be read, understood and signed by a technically competent witness in the witness signature block at the end of this form. In completing each section, use whatever detail deemed appropriate fora "full and complete disclosure." Contractors/Grantees please refer to the New Technology or Patent Rights – Retention by the Contractor clauses. When necessary, attach additional documentation to provide a full, detailed description.

1. DESCRIPTIVE TITLE

On-Chip Nano-Plasmonics Blood-Based Assay Cartridge

2. INNOVATOR(S) *(For each innovator provide: Name, Title, Work Address, Work Phone Number, and Work E-mail Address. If multiple innovators, number each to match Box 5.)*

Tienna Matthews, , 5990 S Sterling Mall, Mesa, AZ, 85212, 3056190351, contact@tiennam.com
Osho Priya, , 5990 S Sterling Mall, Mesa, AZ, 85212, 9173312243, oshopriy@buffalo.edu
Kristin Komendowski, , 5990 S Sterling Mall, Mesa, AZ, 85212, 9173312243, komendowski.k@gmail.com
Andrew Granger, , 5990 S Sterling Mall, Mesa, AZ, 85212, 940 765 0724, andrew.granger@mavs.uta.edu

3. INNOVATOR'S EMPLOYER WHEN INNOVATION WAS MADE *(For each innovator provide: Name, Division and Address of Employer, Organizational Code/Mail Code, and Contract/Grant Number if applicable. If multiple innovators, number each to match Box 5.)*

Arizona State University, 5990 S Sterling Mall, Mesa, AZ, 85212, , 80NSSC19M0186
Arizona State University, 5990 S Sterling Mall, Mesa, AZ, 85212, , 80NSSC19M0186
Arizona State University, 5990 S Sterling Mall, Mesa, AZ, 85212, , 80NSSC19M0186
Arizona State University, 5990 S Sterling Mall, Mesa, AZ, 85212, , 80NSSC19M0186

4. PLACE OF PERFORMANCE *(Address(es) where innovation made)*

5990 S Sterling Mall, Mesa, AZ, 85212
5990 S Sterling Mall, Mesa, AZ, 85212
5990 S Sterling Mall, Mesa, AZ, 85212
5990 S Sterling Mall, Mesa, AZ, 85212

5. EMPLOYER STATUS *(choose one for each innovator)*	6. ORIGIN *(Check all that apply and provide all applicable numbers. If multiple Contracts/Grants, etc., list Contract/Grant Numbers in Box 3 with applicable employer information.)*
CU Innovator #1 *CU* Innovator #2 *CU* Innovator #3 *CU* Innovator #4	[] NASA In-house Org. Mail Code [] Grant/Cooperative Agreement No. [] Prime Contract No. Task No. Report No.
GE = Government *CU = College or University* *NP = Non-Profit Organization* *SB = Small Business Firm* *LE = Large Entity*	[] Subcontractor: Subcontract Tier [] Joint Effort (contract, subcontractor and/or grantee contributions(s), and NASA in-house contribution) [] Multiple Effort (multiple contractor, subcontractor and/or grantee contributions, no NASA in-house contribution) [] Other (e.g., Space Act Agreement, MOA) No.

7. NASA CONTRACTORING OFFICER'S TECHNICAL REPRESENTATIVE (COTR)	8. CONTRACTOR/GRANTEE NEW TECHNOLOGY REPRESENTATIVE (POC)
	/

9. BRIEF ABSTRACT *(A general description of the innovation which describes its capabilities, but does not reveal details that would enable duplication or imitation of the innovation.)*

Nanoplasmonics is a ground breaking technology. If used in our day-to-day life, it can predict the onset of a disease without it even beginning to show its effects and the integrated AI Software technology can suggest the medicines needed to be taken. In this way one can become more efficient. Material used in it is either gold or silver which makes it very costly for mass manufacturing. So it's not a regular product in our daily lives. To make it cheaper and to still keep it just as healthy for the body, different material alternatives were researched. The best combination found was Titanium Nitride (TiN) used with the dielectric Tellurium. TiN is already used for making artificial internal organs for transplants. When coupled with Tellurium it becomes a great conductor and hence can be used with sensors on board by monitoring the variations in pulse rate and blood glucose level.

SECTION I – DESCRIPTION OF THE PROBLEM OR OBJECTIVE THAT MOTIVATED THE INNOVATION'S DEVELOPMENT (Enter as appropriate: A. – General description of problem/objective; B. – Key or unique problem characteristics; C. – Prior art, i.e., prior techniques, methods, materials, or devices performing function of the innovation, or previous means for performing function of software; and D. – Disadvantages or limitation of prior art.)

Motivating innovation is an important concern in incentive problems. This section will focus on the most favorable incentive schemes that motivates innovation for long term success. An On-Chip Nano-plasmonics Based Urine Protein Assay Cartridge is a potential NASA commercial application. Which, in turn, can be easily integrated with existing astrobiological instrumentation. There is no known atmosphere in space to protect astronauts from UV radiation, gamma-rays, cosmic rays, and dangerous X-rays. A process of physiological change can weaken or damage an astronauts performance during long-term exposure to radiation causing significant loss of bone and muscle mass. Radiation is exposed to astronauts with resulting doses ranging from 50 to 2,000 mSv. Comparable to three chest x-rays is 1 mSv resulting in 150 to 6,000 chest x-rays. Over time these physiological effects can weaken or damage an astronauts' performance by denoting exercise that improves or is intended to improve the efficiency of the body's cardiovascular system in the absorbing and transporting of oxygen. Causing multiple health problems, one of the most significant being loss is bone and muscle mass. Creating a bio-technology/life support for better quality of health during long term manned missions is essential for an astronauts health. Creating a cost effective technology by replacing silver and gold from the technological device can not only benefit astronauts in space but those on earth as well creating quite an abundance for commercial use and/or purposes.

SECTION II – TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF INNOVATION DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE (Enter as appropriate; existing reports, if available, may form a part of the disclosure, and reference thereto can be made to complete this description: A. – Purpose and description of innovation/software; B. – Identification of component parts or steps, and explanation of mode of operation of innovation/software preferably referring to drawings, sketches, photographs, graphs, flow charts, and/or parts or ingredient lists illustrating the components; C. – Functional operation; D. – Alternate embodiments of the innovation/software; E. – Supportive theory; F. – Engineering specifications; G. – Peripheral equipment; and H. – Maintenance, reliability, safety factors.)

Use of titanium nitride coupled with dielectric tellurium instead of gold and silver metal in the nanochip will reduce the costs by 50%-60%.

Research shows that Titanium Nitride (TiN) has excellent conducting properties. It has been used to coat the inner surface of the ring vacuum chambers of the United States Spallation Neutron Source so it has the potential to work really well in low temperature and low pressure conditions such as that of Space. This needs to be tested through experimental analysis. This can be used to make a nanoplasmonic chip which can be inserted into the bloodstream of the human body as it is already a material being used for internal organs transplant. "Resonance spectra of high refractive index dielectric cubes made of Te in air are studied using CST based numerical simulations". We found out that Tellurium (Te) as a dielectric when coupled with Titanium Nitride works as an excellent sensor. The maintenance will be further determined through testing. Testing will show how the body will react to the chip and how often it may need to be checked up on.

SECTION III – UNIQUE OR NOVEL FEATURES OF THE INNOVATION AND THE RESULTS OR BENEFITS OF ITS APPLICATION (Enter as appropriate: A. – Novel or unique features; B. – Advantages of innovation software; C. – Development or new conceptual problems; D. – Test data and source of error; E. – Analysis of capabilities; and F. – For software, any re-use or re-engineering of existing code, use of shareware, or use of code owned by a non-federal entity.)

A. - Use of Titanium Nitride (TiN) and Tellurium instead of gold and silver for fabricating the chip lowers the cost of manufacturing.

B.- This will revolutionize the healthcare industry by making the nanochip available for mass production and accessible to the common man which can make each individual more efficient by reducing the number of times a person falls sick.

C.- On-Chip Nano-Plasmonics Blood-Based Assay Cartridge.

D.- It is to be tested on rats or mice. The data collected will form the test data. This can also be a source of error as human body does not always behave as the bodies that it is being tested upon.

SECTION IV – SPECULATION REGARDING POTENTIAL COMMERCIAL APPLICATIONS AND POINTS OF CONTACT (Including names of companies producing or using similar products.)

Technology developed for spaceflight applications by or in cooperation with NASA has often found its way into the commercial and public sphere. This technology is no exception. Bio-monitoring systems designed to monitor and maintain the health of astronauts require advances in materials in order for the system to be small and minimally invasive while still performing advanced monitoring. This technology, after being refined, proven safe, and mass production ready, could be used in monitoring the health of members of the general public, being able to identify diseases and conditions so that severe health problems can be prevented instead of treated after the fact. The advanced AI technologies used in the bio-monitoring product designed for astronauts can be used to continually improve early detection of health problems, increasing general public welfare. The NASA Technology Transfer Program (NASA Spinoffs) can assist in the propagation of this technology to commercial applications and the general public. Companies like Proteus Digital Health have already utilized microchip technologies to monitor people's health, for example, ensuring that elderly people are taking their medications. However, in the future, our technology could extend the uses of these small electronic devices to monitor people's health overall long term.

10. ADDITIONAL DOCUMENTATION *(Include copies or list below any pertinent documentation which aids in the understanding or application of the innovation (e.g., articles, contractor reports, engineering specs, assembly/manufacturing drawings, parts or ingredients list, operating manuals, test data, assembly/manufacturing procedures, etc.).)*

TITLE	PAGE	DATE
QuadChart.pdf		2020-10-22

11. DEGREE OF TECHNOLOGY SIGNIFICANCE *(Which best expresses the degree of technological significance of this innovation?)*

[X] Modification to Existing Technology [] Substantial Advancement in the Art [] Major Breakthrough

12. STATE OF DEVELOPMENT

[] Concept Only [X] Design [] Prototype [X] Modification [] Production Model [X] Used in Current World

13. PATENT STATUS (Prior patent on/or related to this innovation)

Patent Num:	Patent Issue Date:	App Serial Num:	App Serial Issue Date:

14. INDICATE THE DATE OR THE APPROXIMATE TIME PERIOD WHICH THIS INNOVATION WAS DEVELOPED *(i.e. conceived constructed, tested, etc.)*

Start: End:

15. PREVIOUS OR CONTEMPLATED PUBLICATION OR PUBLIC DISCLOSURE INCLUDING DATES *"(Provide as applicable: A. - Type of publication or disclosure, e.g. report, conference or seminar, oral presentation; B. - Disclosure by NASA or Contractor/Grantee; and C. - Title, volumne no., page no., and date of publication*

Report	NASA	An On-Chip Nano-plasmonics Based Urine Protein Assay Cartridge	2007-09-18

16. QUESTIONS FOR SOFTWARE ONLY

(a) Using non-NASA employees to beta-test the program? [ ]YES [ ]NO If Yes, done under a beta-test agreement? []YES []NO

(b) Modification of this program continued by civil servant and/or contractual agreement? []YES []NO

(c) Copyrighted registered? []YES []NO []UNKNOWN If Yes, then by whom? NASA

(d) Has the lastest version been distributed outside of NASA or contractor? []YES []NO []UNKNOWN

(e) Were prior version distributed outside of NASA or Contractor? []YES []NO [] UNKNOWN If Yes, supply NASA or contractor contact

(f) Contains or based on code not owned by U.S. Government or its contractors? []YES []NO []UNKNOWN
If Yes, name of code and codes' owner
Has a license for use been obtained? []YES []NO []UNKNOWN

17. DEVELOPMENT HISTORY

STAGE OF DEVELOPMENT	DATE (MM/YYYY)	LOCATION	IDENTIFY SUPPORTING WITNESSES (NASA in-house only)
a. First disclosure to others	/		
b. First sketch, drawing, logic chart or code	/		
c. First written description	/		
d. Completion of first model of full size device *(invention)* or beta version *(Software)*	/		
e. First successful operational test *(invention)* or alpha version *(Software)*	/		
f. Contribution of innovators *(if jointly developed, provide the contribution of each innovator)*			
g. Indicate any past, present, or contemplated government use of the innovation			

18. SIGNATURES OF INNOVATOR(S), WITNESS(ES), AND NASA APPROVAL

TYPED NAME AND SIGNATURE *(Innovator #1)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #2)*	DATE
TYPED NAME AND SIGNATURE *(Innovator #3)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #4)*	DATE
TYPED NAME AND SIGNATURE *(Innovator #5)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #6)*	DATE
NASA APPROVED	TYPED NAME	SIGNATURE	DATE

Note: This NTR has been generated through the internal system and is pending approval.

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