MITTIC Activity Description

MUREP Innovation and Tech Transfer Idea Competition (MITTIC) is a spinoff challenge established to develop new ideas for commercialization by seeking concept papers from multi-disciplinary student teams enrolled at a Minority Serving Institution (MSI).

Concept papers must be submitted online via http://go.nasa.gov/nasamittic and include all relevant documentation.

MITTIC Competition

1. Teams choose one NASA Intellectual Property (IP) from the provided list on page 6 and submit concept papers explaining the commercial viability of the proposed concept using MITTIC challenge guidelines. Teams are encouraged to partner with a NASA Small Business Company (SBC) before submitting paper.

2. Up to ten qualifying teams selected to participate in an online collaboration tool and are funded to travel to NASA Johnson Space Center (JSC) for an onsite immersion experience in January 2019. During the experience, all participants are REQUIRED to submit:
   - technical concept paper
   - explain their technical concept and business plan during a poster session
   - present an oral “lightning pitch” presentation to a panel of judges

The concept paper, poster session, and oral presentation will be reviewed and evaluated using a common rubric.

3. Winning team members receive travel funding for up to eight team members and one Principal Investigator (PI) to visit, tour, and present at NASA Ames Research Center (ARC) and various companies in Silicon Valley. This experience exposes team members to research facilities and laboratories, start-up companies, and the opportunity to discuss further development.

4. Up to 8 MITTIC participants receive a paid NASA Internship funded by Minority University Research and Education Project (MUREP) through the SBIR/STTR & Technology Transfer (TT) programs at any NASA center. All MITTIC participants can apply.

   NASA MUREP Internships Eligibility Requirements:
   - GPA – 3.0 at the time of application – There are no exceptions. Rounding of the GPA is not permissible.
   - Applicants must be U.S. citizens.
   - Accepted to or enrolled full-time in an accredited U.S. college or university. Must be a Minority Serving Institution (MSI).
   - 16 years of age or older.
   - Letter of recommendation to be submitted on your application to intern.nasa.gov.
MITTIC Eligibility Requirements

- Only one team per Minority Serving Institution (MSI) is allowed to submit a concept paper.
- Four primary team members are **required** to be currently enrolled in the proposing MSI.
- Supervising Principal Investigator (PI) is **required** to actively work for a MSI.
- Up to four primary team members and one PI are **required** to attend all onsite immersion experience events.
- Each team is **required** to provide a supporting letter of intent on school letterhead from an authorized official.
- Each team is encouraged to have a supporting letter of intent from a participating NASA Small Business Company (SBC).
- **All** team members must be a full-time undergraduate or graduate student enrolled in an accredited U.S. institution of higher learning (junior college, community college, college, university) at the time the proposal is submitted.
- **All** team members must be 16 or older before arrival to Houston, Johnson Space Center and Mt. View, Ames Research Center.
- **All** onsite NASA MITTIC participants are **required** to be U.S. Citizens.
- Teams may enlist the support of students of any classification, faculty members, professional consultants, etc. However, **only** four primary team members and one PI may participate in the onsite immersion experience at JSC or ARC.
MITTIC Challenge Guidelines

A. Format Requirements

MITTIC actively screens all concept papers and reserves the right to reject any paper that does not conform to following formatting requirements.

Page Limitations and Margins
Any page(s) going over the required page limit will be deleted and omitted from the review. The concept paper shall not exceed a total of 12 standard 8 1/2 x 11 inch (21.6 x 27.9 cm) pages. The cover sheet, concept paper summary, table of contents, and outreach plan are not included in the 12 page limit.

Type Size
No type size smaller than 10 point shall be used for text or tables, except as legends on reduced drawings. Concept papers prepared with smaller font sizes may be rejected without consideration.

Header/Footer Requirements
Header must include institution name and project title. Footer must include the page number. Margins can be used for header/footer information.

Each proposal submitted shall contain the following items in the order presented:

Cover Sheet (Page 1) (Does not count towards the 12-page limit.)
A. Team Name
B. Minority Serving Institution Name
C. NASA Intellectual Property (IP) Selected
D. Team Member Information (List ALL team member’s information below. A minimum of 4 core team members are REQUIRED to meet MITTIC eligibility requirements.)
   1. First and Last Name
   2. Email address
   3. Phone number
   4. Institution Attending
   5. Academic Year (Freshman, Sophomore, Junior, Senior, Graduate Level)
   6. Academic Major
E. Principal/Co-Principal Investigator (PI) Information (Lead PI is REQUIRED to meet MITTIC eligibility requirements.)
   1. First and Last Name
   2. Email address
   3. Phone Number
   4. Institution Employed By
F. NASA Small Business Information (Optional)
   1. NASA Small Business Company (SBC) Name
   2. NASA Small Business Company (SBC) registration number https://www.sbir.gov/registration
   3. First and last name of contact at NASA small business
   4. Email Address
   5. Phone Number
G. Team Logo (Optional)
**Concept Paper Summary (Page 2)** (Does not count towards the 10-page limit.)
(** Do not include proprietary information.)

A. Concept Paper Title
B. Technical Abstract (Limit 2000 characters, approximately 200 words)
C. Potential Commercial Application(s) (Limit 1500 characters, approximately 150 words)
D. Potential Non-NASA Commercial Application(s) (Limit 1500 characters, approximately 150 words)

**Concept Paper (Pages 3-14)**
(Do not include proprietary information.)

*Table of Contents for Concept Paper*
Part 1: Table of Contents
Part 2: Identification and Significance of the Innovation
Part 3: Technical Objectives
Part 4: Work Plan
Part 5: Institution Capabilities
Part 6: Facilities/Equipment/Budget
Part 7: Commercial Applications
Part 8: Technical References
Part 9: Outreach

**Part 1: Table of Contents**

The concept paper shall begin with a Table of Contents indicating the page numbers of each of the parts of the proposal.

**Part 2: Identification and Significance of the Proposed Innovation**

Describe:

1. The proposed cutting-edge spinoff concept.
2. The relevance and significance of the proposed innovation to an interest or need for commercialization.
3. How the innovation is new and ground-breaking.

**Part 3: Technical Objectives**

Define:

1. The aims and goals of the potential product.
2. Include a sketch, drawing, or photo of the concept. (CAD file(s) should be submitted as a .jpg or pdf file.)

**Part 4: Work Plan**

Develop:

1. Milestone chart with tasks and objectives of development of spinoff concept.
   
   *(Task descriptions, schedules, resource allocations, estimated task hours for each key personnel and planned accomplishments including project milestones shall be included.)*
Part 5: Institution Capabilities

Outline:
(1) MSIs capabilities to commercialize products.
(2) NASA Small Business partners capabilities to commercialize products.

Part 6: Facilities/Equipment/Budget

List:
(1) Facilities needed to produce your spinoff concept.
(2) Equipment needed to produce your spinoff concept.
(3) Proposed budget.

Part 7: Commercial Applications

Forecast:
(1) Potential and targeted application(s) of the proposed innovation relative to NASA needs, other Government agencies and commercial markets.
(2) Identify potential customers.
(3) Provide an initial commercialization strategy that addresses key technical, market and business factors for the successful development, demonstration and utilization of the innovation and associated products and services. Commercialization encompasses the transition of technology into products and services for NASA mission programs, other Government agencies, and non-Government markets.

Part 8: Technical References

Referenced works should be cited in text and in the “Bibliography”. Standard MLA format should be used.

Part 9: Outreach (Does not count toward the 12-page limit.)

Team's plan for disseminating the experience to the general public. Should include:
(1) Description of the team’s objectives and goals
(2) Activities planned
(3) Timeline
(4) Targeted audience (K-12 class or school groups, undergraduate research symposiums, university outreach to local schools, informal groups such as Boy/Girl Scouts, after school clubs, church groups)
(5) Estimated number of participants in each event
(6) Letters or agreements from institutions who have accepted your invitation to address their group
(7) Press and/or social media plan
B. NASA Intellectual Property (IP) Available

Choose one NASA IP listed below to create a spinoff product concept for commercialization. Be sure the concept is:

- Innovative – cutting-edge, ground-breaking
- Commercially Viable – ability to be successful in the commercial market
- Feasible – capability of being produced

Detailed IP information can be found in Appendix A.

- Abnormal Grain Growth Suppression in Aluminum Alloys
- Variable Power Handheld Laser Torch
- Compliant Electrode and Composite Materials for Piezoelectric Wind and Mechanical Energy Conversions
- Unmanned Aerial Systems (UAS) Traffic Management
- New Optics See More With Less
- Low-Cost Detection of Thin Film Stress during Fabrication
- Wind Event Warning System
- Oil-Free Turbomachinery Technologies

- Filtering Molecules with Nanotube Technology
- Self-Contained Device Isolates Biological Samples
- Nanosensor Array for Medical Devices
- Subcutaneous Structure Imager
- Real-Time Tracking System
- Portable Wireless Signal Booster
- Floating Ultrasonic System
- Multicolor Detectors for Ultrasensitive Long-wave Imaging Cameras
- Printable Chemical Nanosensor
- Lab-On-Chip Flow and Temperature Sensor
- Directional UAV Localization of Power Line Ultraviolet Corona
- Low Frequency Wideband Step Frequency Inverse Synthetic Aperture Radar

- Health, Medicine, and Biotechnology
- Communications
- Sensors
- Environment
Method of Selection and Evaluation Criteria

A. MITTIC Evaluation Process

Concept papers shall provide all information needed for complete evaluation. Evaluators do not seek additional information. NASA scientists and engineers evaluate concept papers. Also, qualified experts outside of NASA (including industry, academia, and other Government agencies) may assist in evaluations as required to determine merit.

B. MITTIC Evaluation Criteria

MITTIC intends to select concept papers that offer the most advantageous commercialization potential. MITTIC gives primary consideration to the innovation, commercial viability and feasibility of the concept and its benefit to NASA interests. Each concept paper is evaluated and scored on its own merits using the factors described below:

**Factor 1: Innovation (20% weighted value)**
- Cutting edge or ground-breaking spinoff concept
- Need for commercialization

**Factor 2: Commercially Viable (20% weighted value)**
- Ability to be profitable and successful in a commercial market

**Factor 3: Feasible (15% weighted value)**
- Concept has the capability to be produced
- Plan describes how the concept would be produced

**Factor 4: Effectiveness of the Proposed Work Plan (15% weighted value)**
- Comprehensive work plan
- Effective use of available resources
- Labor distribution
- Documents proposed schedule for meeting objectives
- Detailed plan to achieve each objective or task

**Factor 5: Price Reasonableness (15% weighted value)**
- Price reasonableness
- Budget included to prove cost efficiency

**Factor 6: Outreach (15% weighted value)**
- Diverse list of events and activities planned
- Include projected audience type and number of participants
- Detailed implementation plan

**Factor 7: Eligibility (Must meet all eligibility requirements or proposal will be rejected.)**
- Team must meet eligibility requirements
Manufacturing

Abnormal Grain Growth Suppression in Aluminum Alloys

A post-friction stir welding heat treatment procedure that reduces abnormal grain growth and restores optimum material properties in heat treatable aluminum alloys.

This innovation is a thermal processing methodology for retaining the fine-grained structure in aluminum alloys subjected to solid state welding and subsequent forming processes.

BENEFITS

- Enables friction stir welding to join aerospace components made from lightweight aluminum alloys, in particular Al-Li alloys.
- Suppresses abnormal grain growth known to occur in the weld region during post-weld heat treatment.
- Simple, low-cost processing step suitable for large components or structures.
THE TECHNOLOGY

Heat treatment of the deformed welds is desirable in order to restore the properties of the alloy negatively affected in the weld region. In these alloys, abnormal grain growth frequently occurs in friction stir welds during solution heat treatment, and is known to degrade key materials properties, such as strength, ductility and toughness. The innovation of inserting an intermediate annealing step covered here reduces abnormal grain growth during post-welding heat treatment, thereby allowing optimum mechanical properties. This is important where Al-Li alloys (and other heat treatable alloys) are friction stir welded followed by deformation processing and high performance, high reliability structural components are required for aerospace vehicles.

Applications

The technology has several potential applications:

- Manufacturing structural components for aerospace vehicles, cars, buses, trains, ships and submarines

Publications

Patent No: 9,060,952

Patent Pending

As Spin-Formed

As Solution-Treated

An Intermediate Annealing Step Reduces Abnormal Grain Growth. Image credit: NASA/Stephen J. Hales
Manufacturing

Variable Power Handheld Laser Torch
for Joining Processes

NASA’s Marshall Space Flight Center developed the handheld laser torch, designed for welding and brazing metals, to repair hard-to-reach Space Shuttle engine nozzles. It incorporates various manual controls and changing lenses to allow the operator to adjust the lasers power output in real time. The controls and lenses are designed to increase precision, portability, and maneuverability as compared to existing automated lasers and traditional welding techniques such as tungsten inert gas (TIG), metal inert gas (MIG), or gas-tungsten arc welding (GTAW) systems. Proximity sensors with automated shut-off switches also ensure a high level of safety for the user.

BENEFITS

- As compared to TIG or MIG welding, the NASA torch offers:
- Enhanced accuracy:
- Variable lenses allow the user to adjust power in real time, depending on circumstantial welding needs.
- Increased portability and maneuverability: Handheld form allows the user to braze in small or hard-to-reach places.
- Improved user safety: Added sensors and emergency switches boost user safety.
- Decreased heat affected zone. The laser applies heat to a very localized working area to prevent damage to the welding surface.

APPLICATIONS

Opportunities include

- Various welding applications where real-time laser variation may be needed due to spatial or accuracy constraints where traditional welding methods are cumbersome.
- Aerospace engine repair
- Medical hardware manufacturing
- Plastic mold and die restoration
- Jewelry manufacturing and repair

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**THE TECHNOLOGY**

Features of the handheld torches design include manual controls to modify the laser diameter and power output in real time. These features allow the user to adjust the laser depending on circumstantial needs, resulting in a torch that is well suited for in-field repairs of metals where space and time are constrained. The primary applications are likely to be in-field welding and brazing of damaged specialized equipment where traditional welding systems cannot easily access the welding area.

The laser technology is a variable power, continuous wave, handheld fiber laser torch for brazing metals with an increased precision and maneuverability. The laser hard ware and supply measures 24 inches in length, 15 inches wide, and 30 inches high, with a torch diameter of about 0.8 inches. This size is nearly half that of traditional welding systems, which increases the portability of the machine as well as the welder's maneuverability.

The current handheld torch replaces earlier versions of handheld torches that cost over $400,000 to produce, with a large footprint over 60. After numerous design improvements and the inclusion of a commercial off-the-shelf fiber laser, the third generation NASA torch has a much smaller footprint, with the handheld component being about 2.5 times larger than standard incinerators. The NASA handheld torch and system integration is estimated to cost between $600K and $700K.

NASA has used the handheld laser on Haynes 230 super alloy to improve localized repair procedures. Preliminary tests of the NASA handheld laser produced a consistent data set of yield strength (YS), ultimate tensile strength (UTS), and percent elongation (%EL) that are comparable to the results of current GTAW techniques.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Temp °F</th>
<th>YS (ksi)</th>
<th>UTS (ksi)</th>
<th>%EL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate 01</td>
<td>1</td>
<td>70</td>
<td>68</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>70</td>
<td>66</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1700</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>Plate 02</td>
<td>4</td>
<td>70</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>70</td>
<td>64</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1700</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td><em>GTAW 230 W Weld Metal</em></td>
<td></td>
<td>70</td>
<td>75.7</td>
<td>112.6</td>
</tr>
<tr>
<td></td>
<td>1500</td>
<td>21.2</td>
<td>22.7</td>
<td>24.5</td>
</tr>
</tbody>
</table>

Two sets of plates were welded, and six tensile specimens were evaluated and tested; comparable results to GTAW techniques are demonstrated. Weld specimen Plate 01 demonstrates full penetration of Haynes 230 super alloy using the handheld laser.

**PUBLICATIONS**

Patent No: 8,290,006
Compliant electrode and composite materials for piezoelectric wind and mechanical energy conversions

NASAs Piezoelectric Energy Harvesting Technology

Thin film, piezoelectric materials generate a small voltage whenever they are deformed, suggesting that they are suitable for tapping energy from freely available resources, such as the wind. Yet their low-energy production levels and lack of electrode durability have hampered development. NASA researchers have invented a system, method, and device for improving the performance and increasing the lifespan of small form factor, thin film electrode, piezoelectric devices capable of interacting with the wind to provide power to wearable devices and stretchable electronics.
THE TECHNOLOGY

The NASA researchers integrated two innovations into this unique piezoelectric device. First, they combined polyvinylidene fluoride (PVDF) with a metal oxide to improve conductance. Second, they designed a new carbon-electrode to improve durability (compliance) and reduce susceptibility to fatigue while retaining flexibility. Additionally, to integrate the carbon nanotube components, they used a polymer-to-polymer design that eliminates the need for adhesion layers. A prototype device generated 1 W power (at 15 mph wind) with a single layer of PVDF [4 inch by 12 inch and 50 um (micrometer) thick] sandwiched between two thin electrode films. A rectifier converts the AC signal into a DC signal and stores the charge in a capacitor. This electric power can be used for low power consuming devices, such as inaccessible sensors.

APPLICATIONS

The technology has several potential applications:

- Wearable electronics
- Wind energy harvesting
- Mechanical energy harvesting
- Sustainable energy

PUBLICATIONS

Patent No: 9,024,510

One of the applications of this technology is sustainable energy
Unmanned Aerial Systems (UAS) Traffic Management

Safe and efficient UAS operations

NASA has developed a traffic management system for Unmanned Aerial Systems (UASs) to maintain safe and efficient UAS operations. This novel technology enables the growth in civilian applications of UAS operations at lower altitudes by developing a UAS Traffic Management (UTM) system. There are a number of applications of UAS which include goods and services delivery in urban, difficult terrain and rural areas, imaging and surveillance for agricultural, and utility management. To enable significant commercial use of UAS within lower altitude airspace and airspace that does not interfere with regular National Airspace System (NAS) operations, a UTM system is required. UTM is essential to enable accelerated applications of UAS. UTM will accommodate and support all types of UAS operations ranging from disposable with minimalistic avionics capabilities to highly capable UASs.

BENEFITS

- UTM support geographically geo-fenced area on a continuous basis
- Economical means of delivery rather than road transport due to smaller size, quantity, and volume than trucks
- Very useful where road conditions are unsuitable for road transport
- UTM can be portable as-needed system or real-time continuous operation
- Support micro, small, and medium size UAS
- Reliability provides communication, navigation, and surveillance below 10,000 ft.
- Safe airspace operations by procedures and airspace design that keep UAS separated from other UAS and general aviation
- Provide congestion management, route planning and rerouting, conflict avoidance, collision avoidance, terrain avoidance, obstacle avoidance, severe weather and wind avoidance services as needed based on needs of UASs operation and capability
- Support departure from and arrival into any location that is deemed safe
- Support operations at remote regions, and urban areas

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Bringing NASA Technology Down to Earth

THE TECHNOLOGY

The UTM functions will include support for the strategic as well as tactical operations. These functions include airspace design where altitudes are assigned based on direction of flight, and geofencing design and updates based on the need to avoid sensitive areas (e.g., noise sensitive areas or high valued assets). It will provide surveillance of vehicles; weather and wind prediction, and integration with route and flow management; congestion management and constraint and obstacle management (e.g., terrain, tall natural and man-made structures). Other functions include demand and capacity imbalance management for crossing points, arrival and departure phases; separation assurance, collision avoidance and recovery, and emergency landing site selection and landing, if needed. It provides minimum requirements on UASs to operate at the lower altitudes as relates to communication, sensors, navigation, collision avoidance, and classification of UAS based on their performance characteristics in terms of weight, wake, ability to operate with certain types of wind and weather.

APPLICATIONS

The technology has several potential applications:
- Wildfire mapping
- Agriculture monitoring
- Disaster management
- Law enforcement
- Telecommunication
- Weather monitoring
- Aerial imaging and mapping
- Freight transport
- Delivery of goods and services, like medical service delivery
- Television news coverage, sporting events, movie making
- Oil and gas exploration

PUBLICATIONS

Patent Pending

National Aeronautics and Space Administration
Technology Partnerships Office
Ames Research Center
MS 207-3, Moffett Field, CA 94035
800-857-2246
ASCII.TechTransfer@mail.nasa.gov
http://technology.nasa.gov/

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research and secondary uses that benefit the economy, create jobs, and improve quality of life.

More Information

www.nasa.gov

NP-28922-149-HQ

AMD-112ZP1
TQP2-37
New Optics See More with Less

NASA offers companies an optical system that provides a unique panoramic perspective with a single camera.

NASA's Marshall Space Flight Center has developed a technology that combines a panoramic refracting optic (PRO) lens with a unique detection system to acquire a true 360-degree field of view. Although current imaging systems can acquire panoramic images, they must use up to five cameras to obtain the full field of view. MSFC's technology obtains its panoramic images from one vantage point.

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NASA Technology Transfer Program
Bringing NASA Technology Down to Earth

THE TECHNOLOGY

This technology emerged from NASA's advanced optics research for space applications. Unlike fish-eye lenses, which use refraction to produce a 180-degree image field, NASA Marshall Space Flight Center's panoramic reflecting optic lens uses both refraction and internal reflection to provide a unique annular (i.e., radial) 360-degree image field of view. The PRO lens can be shaped to view a small or large angular range of the entire region that surrounds the optical axis of the lens. The lenses production process involves simple lathing or injection molding of a glass or acrylic plastic. The simple manufacturing process enables low-cost production of MSFC's optical system.

The ability of the system to acquire the 360-degree imaging information from a single vantage point is an important feature for many applications. For example, a PRO-equipped camera mounted on top of a vehicle could simultaneously view the entire surrounding area, providing optical information without blind spots. This image information could be archived so that dynamic incidents could be accurately reconstructed. In security systems, a single inexpensive camera could monitor, detect, and record movement around a large physical area, such as a parking lot or building grounds.

APPLICATIONS

The technology has several potential applications:

- In combination with a standard camera, this technology offers a visual radar system for transportation equipment, security systems, and monitoring devices. The unique 360-degree field of view can benefit a variety of applications:
  - Security/surveillance
  - Collision detection and safety alerts
  - Driver assistance
  - Monitoring and detection

PUBLICATIONS

Patent No: 6,424,470, 6,580,567

More Information

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11/30/94

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research and secondary uses that benefit the economy, create jobs, and improve quality of life.
Optics

Low-Cost Detection of Thin Film Stress during Fabrication

In-situ Measurement Using Fiber Optic Probes

NASA’s Marshall Space Flight Center has developed a simple, cost-effective optical method for thin film stress measurements during growth and/or subsequent annealing processes. Stress arising in thin film fabrication presents production challenges for electronic devices, sensors, and optical coatings; it can lead to substrate distortion and deformation, impacting the performance of thin film products.

NASA’s technique measures in-situ stress using a simple, noncontact fiber optic probe in the thin film vacuum deposition chamber. This enables real-time monitoring of stress during the fabrication process and allows for efficient control of deposition process parameters. By modifying process parameters in real time during fabrication, thin film stress can be optimized or controlled, improving thin film product performance.

BENEFITS

- Low-cost, simple design - Uses inexpensive off-the-shelf fiber optic probes, reducing costs by an order of magnitude or more
- Real-time measurement - Provides immediate feedback via in situ probe, facilitating the efficient adjustment of deposition process parameters
- Easy to implement - Requires little or no modification to the existing vacuum chamber
- Versatile - Applies to a wide range of thin film and bulk material applications
- Sensitivity: Offers sensitivity of 0.05 N/m, comparable to existing techniques, such as the multibeam optical stress sensor (MOSS)
NASA Technology Transfer Program
Bringing NASA Technology Down to Earth

THE TECHNOLOGY

Traditional methods of determining film stress use ex-situ deflectionometry techniques and require significant and costly modifications to the vacuum chamber to allow optical access to the substrate. These techniques determine film stress by measuring the change in substrate curvature resulting from stress.

NASA’s method infers the stress-induced substrate curvature by measuring the out-of-plane displacement of a single point on the substrate using a fiber optic displacement sensor (Figure 1). The probe gains optical access to the substrate through a normal fiber optic feed-through common in vacuum systems. In turn, this simplification leads to a significant reduction in cost, complexity, and system requirements. It also eliminates interference effects. With a measurement sensitivity of 0.05 N/m, the method is compatible in sensitivity with MOSS and could potentially rival the sensitivity of the microcantilever technique. NASA’s method can be used to measure the stress during film growth for heated substrates, as well as the evolution of stress during thermal annealing processes. The technique can be used in a variety of thin film applications, with no limitation on substrate size or reflective characteristics of deposited films. The methodology has been proven with magnetron sputtering of chromium films, where it was used to adjust process gas pressure to achieve zero stress.

APPLICATIONS

The technology has several potential applications:
- Semiconductors - Electronic devices, solar cells, printed circuit boards
- Optics - Coatings
- Magnetics - Read/write heads
- Precision machining - Metrology of surfaces, surface plates

PUBLICATIONS

Patent Pending
Wind Event Warning System

High-energy Doppler LIDAR to protect wind turbines and aircraft from severe wind events

NASA Langley Research Center has developed a wind event warning technology providing a practical early warning system (5–10 minutes) for a severe change in the wind vector. Events such as gusts, shear, microbursts or thunderstorm outflows can be detected in time to prevent damage to wind turbines or help airports prevent damage to aircraft. Further, an alternative power source could be ramped up or down as needed to accommodate the power draw in the electrical grid.
The Wind Event Warning System (WEWS) is a high-energy Doppler LIDAR sensor that measures approaching changes of wind such as an oncoming variation of wind speed that will change the power output of a wind farm. Different from low-energy, the high-energy Doppler LIDAR has the energy to reach the long distances necessary to provide adequate warning time of a wind event. With the time provided by WEWS, the blades of a wind turbine could be feathered to prevent strong wind from damaging the turbine. In addition, airports could use WEWS to protect aircraft from sudden wind hazards.

Gust detection of more than 10-minute warning time is shown here from a prototype high-energy lidar. A mild gust of 6-m/s speed is imbedded in background wind of 2-m/s. A severe wind event would produce an even more pronounced signal. Image Credit: NASA/Grady Kooch
Materials and Coatings

Oil-Free Turbomachinery Technologies
Creating a revolution in aircraft propulsion

NASA’s Glenn Research Center has developed high-temperature solid lubricant materials suitable for foil gas bearings that enable the commercialization of a broad array of revolutionary Oil-Free gas turbines, compressors, blowers, motors, and other rotating machines that can operate from cryogenic to red-hot temperatures. These tribological (friction and wear) coatings and composite powder metallurgy material innovations have immediate and proven spinoff potential for high-temperature steam turbine control valves, exhaust gas recirculation (EGR) valves, articulating ducts and piping joints, and other industrial and aerospace applications.

BENEFITS

PS300 and PS400 solid lubricant coatings provide reduced friction and wear to any lightly loaded sliding mechanism operating from cryogenic to 650°C.

PS300 coated shafts operating against foil bearings have logged well over 100,000 start-stop cycles without wearing out resulting in a truly maintenance-free bearing.

NASA PS300 coatings and PM300 powder metallurgy materials and related technology are freely available in the marketplace from licensed vendors.

The constituents (ingredients) used in NASA PS/PM 300 and 400 materials are nontoxic and thermally and chemically stable. They are not water-soluble and have a low environmental impact.

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**THE TECHNOLOGY**

Oil-Free foil bearings require innovative approaches to solid lubrication for start-stop sliding contact that occurs before the gas lubricating film forms. The PS300 and PS400 coatings and their powder metallurgy cousins are composites from a unique combination of metals, ceramics, and solid lubricant additives. Plasma spray coating deposition is used to apply a thick (0.010 inch) layer onto a metal surface that is then ground and polished before use. During rubbing contact, the lubricant phases migrate to the surface forming a lubricious glaze that prevents wear and reduces friction. Powder metallurgy techniques are used to make freestanding self-lubricating components such as bushings and wear plates whenever a coating is not convenient or possible (e.g., inside small diameter parts). These materials are made from thermomechanically stable, nonmeltable, nonconductive constituents and typically include nickel, molybdenum, chrome oxide, silver, and lithium fluoride-calcium fluoride eutectic. Compositions can be easily tailored for specific applications. Operation of machinery using these tribomaterials has been proven over decades of use from subzeroing to over 550°C.

![PS400 cross-section control coating. The morphology is typical of plasma sprayed coatings and shows spall nature of constituent phases.](image)

**APPLICATIONS**

The technology has several potential applications:

- **PS300 coated shafts enable maintenance free, high-temperature Oil-Free microturbine electrical generators**
- **PS300 used to lubricate high-temperature steam control valve lift rods in power plants worldwide for well over a decade and PM300 bushings provide long-life service in heat-treatment furnace conveyor systems**
- **PS400 coating (simplified composition) has a lower cost and is more dimensionally stable than predecessor PS300. PS400 has been proven curable in over 20,000 hours of turbine engine operation**
- **PS300/400 has direct applications to any high-temperature sliding contact. Automotive exhaust components such as recirculation (EGR) valves and aircraft bleed air valves, high-temperature ducting, and pipe**

**PUBLICATIONS**

Patent No: 8,182,741, 8,377,373, 8,753,417

Also see US Patent 5,866,516
Health, Medicine and Biotechnology

Filtering Molecules with Nanotube Technology

Conceived to eliminate contaminants from water or other molecules

Innovators at NASA's Johnson Space Center have identified a method to create a filtration device to eliminate contaminants from water supplies. Originally developed to purify wastewater for reuse aboard the International Space Station, the innovation is applicable to numerous situations on Earth where there is a need to collect potable, medical-grade water from a contaminated water supply. The unique aspect of the technology is its use of acoustics rather than pressure to drive water through small-diameter carbon nanotubes. The invention requires less power than conventional filtration systems and is well-suited to a variety of water processing needs.

This NASA patent is available for your company to license, mature the technology and develop into a commercial product. NASA does not manufacture products for commercial sale.

BENEFITS

- Produces clean water by eliminating contaminants
- Requires less power than conventional filtration systems
- Does not depend on gravity for water to flow through the system
- Potentially scalable to a large bank of integrated filters

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THE TECHNOLOGY

This water filtration innovation is an acoustically driven molecular sieve embedded with small-diameter carbon nanotubes. First, water enters the device and contacts the filter matrix, which can be made of polymer, ceramic, or metallic compounds. Carbon nanotubes within the matrix allow only water molecules to pass through, leaving behind any larger molecules and contaminants. The unique aspect of the technology is its use of acoustics to help drive water through the filter.

An oscillator circuit attached to the filter matrix propagates acoustic vibration, further causing water molecules to de-bond and move through the filter. This use of acoustics also eliminates dependence on gravity (and thus filter orientation) to move water through the device. When water exiting the system diminishes to a pre-determined set point, a cleaning cycle is triggered to clear the sediment from the inlet of the filter, re-establishing the standard system flow rate. Unlike other filtration systems, flushing of the filter system is not required. The combination of acoustics and small diameter carbon nanotubes in this innovation make it an effective and efficient means of producing contaminant-free, clean water.

APPLICATIONS

The technology has several potential applications:

- Medical facilities
- Laboratories
- Distilleries
- Ultrapure Water Filtration: Semiconductor Fabrication Facility
- Desalination plants
- Wastewater treatment facilities
- Consumer markets

PUBLICATIONS

Patent No: 6343003, 7935258

Existing water filtration technologies are generally plagued by limited performance, high energy consumption, and high costs. Ultrapure water can be produced through this acoustically driven water filtration system.

More Information

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MHD-64001, MHD-64190-1
MHD-TOPS-55

26 | Page
Health, Medicine and Biotechnology

Self-Contained Device Isolates Biological Samples

Pipette-free technology enables DNA/RNA isolation/analysis outside of the laboratory using a self-contained device.

JSC is looking to interested parties to license and commercialize this patented technology. Innovators at NASA’s Johnson Space Center (JSC) developed a patented self-contained device for isolating deoxyribonucleic acid (DNA), ribonucleic acid (RNA), proteins, and cells without using pipettes or centrifuges. Composed of reagents, functionalized membranes, and multi-way valves and pumps, this novel fluidic system enables automation of highly accurate real-time polymerase chain reaction (PCR) technology to isolate genetic material from organisms and microorganisms for molecular analysis. The device is self-enclosed and leak-proof, so users are protected from chemically hazardous reagents. Developed to enable molecular diagnostics aboard the International Space Station (ISS), this easy-to-use analysis tool can be fully automated and programmed, extending laboratory isolation protocols to numerous applications in health care, forensics, and field biology.

BENEFITS

- Compact and portable: DNA/RNA isolation kits (10 x 10 x 2 in)
- Self-contained: Requires no auxiliary equipment to isolate desired targets
- Safe: Does not require hazardous chemicals for PCR analysis
- Effective: Offers sensitivities similar to standard isolation methods

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THE TECHNOLOGY

JSC's technology provides hazard-free, microgravity-compatible hardware for DNA/RNA isolation. It also allows PCR analysis to be used outside the lab in environments where pipetting is difficult and/or where hazardous chemicals must be confined to an enclosed container, such as military settings and remote clinical operations.

This self-contained device for isolating DNA/RNA, proteins, and cells is a component system that includes syringes and pistons, membranes of different capacities, reagents, four-way valves, and small pumps. The pre-filled reagents are the same as those used in conventional PCR laboratory isolation analysis. The DNA and RNA isolation kits are novel and process small sample amounts using a self-enclosed and pipette-free technique. Multiple kits can be stacked to allow several samples to be processed simultaneously. The system can be used in conjunction with existing analysis modules, such as commercially available DNA instruments. The process can be fully automated and programmed and can potentially be applied to other biological processes. The JSC innovation will permit the extension of laboratory isolation protocols to many applications.

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APPLICATIONS

The technology has several potential applications:
- Remote clinical operations
- Arctic operations
- Forensic investigations
- Agribusiness
- Space vehicles

PUBLICATIONS

Patent No: 8,069,056; 9,017,621

More Information

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NP-201202-014492

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MSFC-2013-I, MSFC-2013-1
MSFC TOPS-42
Health, Medicine and Biotechnology

Nanosensor Array for Medical Diagnoses
A low-power, and compact nanosensor array chip

NASA has developed an innovative approach to improve the quality and convenience of medical diagnosis, and data transmission for immediate therapy. The new technology uses a network of nanochemical sensors on a silicon chip combined with a monitoring system composed of humidity, temperature, and pressure/flow sensors for real-time chemical and physical properties measurement of human breath for non-invasive and low-cost medical diagnosis. No such technology exists in the market today. Although many research activities are ongoing, NASA's technology is readily available for this application. With a detection range of parts per million (ppm) to parts per billion (ppb) this technology, called a nanosensor array chip, provides a highly-sensitive, low-power, and compact tool for in-situ and real-time analysis. It changes the way and time decisions are made to help both patient and medical care provider to minimize their cost, optimize resources, reduce risk, and cut the amount of time needed for conducting a response.

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THE TECHNOLOGY

Many diseases are accompanied by characteristic odors. Their recognition can provide diagnostic clues, guide the laboratory evaluation, and affect the choice of immediate therapy. The study of the chemical composition of human breath using gas chromatography mass spectrometry (GC/MS) has shown a correlation between the volatile compounds and the occurrence of certain illnesses. The presence of those specific compounds can provide an indication of physiological malfunction and support the diagnosis of diseases. This condition requires an analytical tool with very high sensitivity for its measurement. A number of volatile compounds, so called biomarkers, are found in breath samples, normally at low parts per billion (ppb) levels. For example, the acetone in the exhaled breath from human with other biomarkers can indicate Type I diabetes. Usually, the concentration of the volatile compounds in human breath is very low and the background relative humidity is high, almost 100%. NASA's invention utilizes an array of chemical sensors combined with humidity, temperature, and pressure for real-time breath measurement to correlate the chemical information in the breath with the state and functioning of different human organs. This tool provides a non-invasive method for fast and accurate diagnosis at the medical point of care or at home. The sensor chip includes multisensors for a comprehensive measurement of chemical composition, temperature, humidity, and pressure/flow rate. The sensor data collected from this chip can be wired or wirelessly transmitted to a computer terminal at the doctor's desk or hospital monitoring center. The sensor chip can be connected directly or via Universal serial bus (USB) to a cell phone for data transmission over a long distance and receive an instruction from a doctor's office for an immediate therapy.

APPLICATIONS

The technology has several potential applications:

- Medical diagnosis
- Nanotechnology
- Health monitoring
- Homeland security
- Biomedicine
- Aerospace

PUBLICATIONS

Patent Pending
Health, Medicine and Biotechnology

Subcutaneous Structure Imager

Uses near-infrared imaging to improve health providers’ ability to locate veins in patients

Scientists at NASA’s Glenn Research Center have successfully developed a novel subcutaneous structure imager for locating veins in challenging patient populations, such as juvenile, elderly, dark-skinned, or obese patients. Spurred initially by the needs of pediatric sickle-cell anemia patients in Africa, Glenn’s groundbreaking system includes a camera-processor-display apparatus and uses an innovative image-processing method to provide two- or three-dimensional, high-contrast visualization of veins or other vasculature structures. In addition to assisting practitioners to find veins in challenging populations, this system can also help novice healthcare workers locate veins for procedures such as needle insertion or excision. Compared to other state-of-the-art solutions, the imager is inexpensive, compact, and very portable, so it can be used in remote third-world areas, emergency response situations, or military battlefields.

BENEFITS

- Inexpensive: Uses commercially available electronic and optical components and requires minimal operator training
- Portable: Takes up little space and is self-contained
- Robust: Utilizes durable system components that are easily serviced or replaced
- Battery powered: Does not require an external power supply, so the imager can be used in emergency or other non-hospital environments
- Fast: Displays images in real-time and in easily interpretable form
- Versatile: Can provide 2D or 3D images

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THE TECHNOLOGY

Current subcutaneous vessel imagers use large, multiple, and often separate assemblies with complicated optics to image subcutaneous structures as two-dimensional maps on a wide monitor, or as maps extracted by a computer and focused onto the skin by a video projection. The scattering of infrared light that takes place during this process produces images that are shadowy and distorted. By contrast, Glenn's innovative approach offers a relatively compact and inexpensive alternative to the conventional setup, while also producing clearer images that can be rendered in either two or three dimensions. Glenn's device uses off-the-shelf near-infrared technology that is not affected by melanin content and can also operate in dark environments.

In Glenn's novel subcutaneous imager, a camera is configured to generate a video frame. Connected to the camera is a processor that receives the signal for the video frame and adjusts the thresholds for darkness and whiteness. The result is that the vein (or other subcutaneous structure) will show very dark, while other surrounding features (which would register as gray) become darker due to the heightened contrast between thresholds. With no interval of complex algorithms required, the image is presented in real-time on a display, yielding immediate results. Glenn's advanced technology also allows the operator to achieve increased depth perception through the synchronization of a pair of imaging devices. Additionally, the novel use of a virtual-reality headset affords a three-dimensional view of the field, thereby improving the visualization of veins. In short, Glenn's researchers have produced an inexpensive, lightweight, high-utility device for locating and identifying subcutaneous structures in patients.

APPLICATIONS

The technology has several potential applications.

- Biomedical: Facilitate vein access for challenging patient populations, in emergency situations, aboard aircraft, and in areas with fewer skilled practitioners
- Diagnosis: Diagnose conditions currently treated with ultrasound techniques, such as stenosis of leg veins, pre-screening to determine whether a costly MRI is needed
- Screening: Provide rapid non-invasive initial screening for sub-surface lesions such as cancers and venous malformations

PUBLICATIONS

Patent Pending

More Information

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NP-2511-04-2681792

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LCW 10340-1
LCW TCF-62
Communications

Real-Time Tracking System
Pinpointing emergency and military personnel in remote environments

A real-time locating system (RTLS) developed at the Johnson Space Center uses ultra-wideband (UWB) radio frequency (RF) signals for tracking and reporting the position of transmitter-equipped people and objects. The technology has 100 to 1,000 times finer granularity than conventional narrowband RF RTLS systems and achieves a tracking resolution of less than 1 percent of the range (tested up to 3,500 feet). The technology has a number of commercial applications including long-range tracking of emergency, military, and mining personnel in limited access or hostile environments where global positioning systems are not reliable. This method combines the advantages of accurate Time Difference of Arrival (TDOA) information achieved using UWB technology with the geometric advantages of two-cluster tracking to provide accurate location information at long ranges.

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THE TECHNOLOGY

The innovation builds upon conventional UWB hardware by incorporating tracking methodology and algorithms in addition to external amplifiers for signal boost. The tracking methodology is a triangulation calculation consisting of Angle of Arrival (AOA) and Time Difference of Arrival (TDOA) using a cross-correlation peak detection method. By directly estimating TDOA information from UWB pulses, the method achieves a high temporal resolution (on the order of picoseconds) needed to measure AOA with extreme precision. The system uses a PC to synchronize and process data in real-time from two receivers, or clusters, to display the position of the transmitter-equipped person or object. The interface software enables the PC to access the two data sets simultaneously through separate sockets. In the data collection process, data segments from each receiver are interleaved with those from the other receiver in chronological order of collection. Within the PC, the data segments are stored in a separate buffer, therefore, the contents of the buffers are representations of the same UWB pulse waveform arriving at the two receivers at approximately the same time. This data synchronization provides the separate and simultaneous collection of waveform data that the tracking algorithm requires for accurate real-time tracking.

APPLICATIONS

The technology has several potential applications:

- Aerospace rovers, robots and astronauts on exploratory missions
- Emergency workers in limited access areas where GPS is not reliable
- Military personnel and equipment on battlefields and in other hostile environments
- Mining industry to locate and communicate with underground personnel
- Oil companies for use in drilling operations
- High-value inventory tracking industry

PUBLICATIONS

Patent No: 8116350
Communications

Portable Wireless Signal Booster

Increases signal strength for commercial wireless products

Innovators at NASA Johnson Space Center have invented a portable communications signal booster that is currently available for licensing. Originally designed to improve communications for lunar missions, this lightweight, portable device can boost incoming signals to improve local reception for cell phones, laptops, satellite and Wi-Fi internet receivers without the need for power plugs, cables or batteries. This portable signal booster can be configured as an umbrella or window shade for easy deployment and compact storage. This technology has the flexibility to be designed in different shapes and sizes to offer variations in booster strength and degree of directional focus.

UPDATE: This Technology has an exclusive license. If you are interested in a sub license on this technology, please contact the NASA Johnson Space Center License Manager using the contact information below. NASA does not manufacture products for commercial sale.

BENEFITS

- High performance - 7-15 dB gain increase
- Cable free - requires no physical connection to wireless devices
- Free of power plugs and batteries
- Compact, portable and lightweight
- Easy to set up, easy to store
- Simple, low-cost manufacturing

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THE TECHNOLOGY

Communications are of paramount importance in conducting space missions, and an antenna's signal strength is vital to the success of any mission. All antennas have a limited range. NASA needed a mobile signal booster that could be placed as needed to supplement any weak spots encountered by an astronaut crew at the site once a baseline system was deployed. Like all space hardware, the booster needed to be durable, compact and lightweight.

This innovation successfully integrates the classic Fresnel Ring model into a conductive fabric structure. The result is an ultra-light, deployable device that acts as a lens to significantly enhance the realizable gain of an antenna. A Fresnel Ring design on the booster is specially shaped to cancel specific phases of the radiated signal. This makes other more desirable parts of the signal more prominent.

Different variations of shapes of the booster can be offered. A round, medium-size unit could expect to increase signal gain in all directions by about 7 dB. A larger, elliptical-shaped unit could expect to increase signal gain in a focused direction by up to 15 dB.

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APPLICATIONS

The technology has several potential applications:

- Consumer: boost dead zones at home and work
- First responders: wireless communications systems for field emergency & rescue workers
- Recreation: enhance hunting, camping and other remote/experience adventures
- Networking: support RFID/wireless sensor networks
- Industry: remote work

PUBLICATIONS

Patent No: 8394514

Results of the gains with no signal booster ring (in blue) and with signal booster (red)
Sensors

Floating Ultrasonic System

Nondestructive inspection of surfaces without an external liquid couplant

NASA’s Langley Research Center has developed a Floating Ultrasonic System for improved nondestructive testing. Most ultrasonic scanners require an external liquid coupling agent (e.g., water, gel, oil) to make a good contact between the probe and the surface being scanned. However, some surfaces are sensitive to moisture and/or contamination created by these agents. NASA created the Floating Ultrasonic System to address this issue. NASA’s technology is based on a momentary-touching scheme where a vibrating probe comes in contact with the structure for fractions of a second while performing measurements, giving the probe the appearance of floating across a surface. The design allows for the easy movement of the probe over surfaces being inspected without the use of a liquid couplant between the probe and the surface. Initial test results have also shown NASA’s system to have comparable performance to liquid-couplant-based, ultrasonic scanners.

BENEFITS

- No external liquid couplant needed - does not require liquid or gel coupling materials between the probe and surface being scanned
- Multipoint scanning in the XY plane - does not have limitations with freedom of movement
- Improved inspection - permits easier and faster movement of the probe across the test surface (due to reduced friction)
- Versatile - can be used to scan a variety of materials, including composites and metals
- In situ - will allow for in-place inspection of surfaces and will significantly simplify inspection, especially for vertical or overhead surfaces
- Cost competitive - is anticipated to be comparable in cost to other ultrasound techniques

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THE TECHNOLOGY

NASA’s Floating Utrasonic System includes a transducer assembly with a flexible membrane tip made of nitride rubber. A small amount of gel couplant is layered between the transducer and the inside of the membrane. The gel is fully contained inside the probe and does not come into contact with surfaces being inspected. The transducer assembly is mounted to a voice-coil motor that acts as an actuator. Electrical current sent to motor moves the transducer up and down over the surface being inspected. The vibrating, or floating, transducer design provides two critical functions. First, it applies a small force that enables coupling of the ultrasonic energy from the transducer to the surface being inspected. Second, it facilitates movement of the transducer across the surface. A diagram of NASA’s Floating Utrasonic System is presented in Figure 1(a). NASA has constructed a bench-top unit that has undergone successful testing. Figure 1(b) shows ultrasonic C-scan images of a composite plate using both NASA’s Floating Utrasonic System and a traditional water-tank-based scanning system. NASA’s system provides comparable results, but unlike the water-tank system, it allows for inspection without the use of an external liquid couplant. NASA researchers are working on additional refinements to the technology, including improving resolution, and plan to develop it into a handheld device. The technology will be used for the in-situ inspection of composite aerospace parts that are undergoing fatigue testing.

FIGURE 1 - (a) Diagram of NASA’s Floating Utrasonic System, (b) C-scan images of a composite part - NASA’s Floating Utrasonic System (unfocused transducer at 6MHz) on left vs. traditional water tank scan (focused transducer at 10MHz) on right

APPLICATIONS

The technology has several potential applications:
- Aerospace - inspecting manufactured or in-service aerospace parts
- Aviation - inspecting structural health of vehicles
- Automotive - assessing durability and damage tolerance of metallic or composites parts
- Medical - imaging soft tissues such as internal organs and muscles
- Oil and gas - inspecting pipelines and other distribution/storage infrastructure

PUBLICATIONS

Patent No. 8,354,205
Sensors

Multicolor detectors for ultrasensitive long-wave imaging cameras

Increases mapping speed and pixel count over state-of-the-art far-infrared sensors

NASA Goddard Space Flight Center has developed ultrasensitive, long-wavelength sensors that increase mapping speed by a factor of ten through simultaneous multicolor terahertz (THz) imaging. Current sensors image each wavelength separately, limiting mapping speeds. On a moving airplane, fast mapping speed is critical for obtaining good spectral data, because of changing atmospheric conditions during flight and the relatively short flight duration. This design also eliminates the need for bulky filters in the focal plane offering a low-loss, high efficiency detector that can be calibrated.

BENEFITS

- Increases mapping speed by a factor of 10
- Simplifies image calibration
- No moving parts for improved reliability

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THE TECHNOLOGY
This technology addresses the need for Terahertz imaging which is necessary for next generation instruments. The detector involves two innovations: a quasiparticle (QO) filter arrangement that enables a compact multicolor spectrum at the focal plane, and a THz antenna readout by up to three bolometers. This innovation achieves high efficiency by greatly reducing high, frequency-dependent microstrip losses, and pixel compactness is achieved by eliminating the need for bulky filters in the focal plane. The zeptobolometer is a small TES bolometer, on the scale of a few microns, which can be readily coupled through an impedance-matching resistor to a metal or dielectric antenna. The bolometer is voltage-biased in its superconducting transition, allowing the use of superconducting RF multiplexers to read out large arrays. The antenna is geometrically tapped at three locations so as to efficiently couple radiation of three distinct wavelengths to the individual TESs.

APPLICATIONS
The technology has several potential applications:
- Short range optical communication in the THz band
- Thermal Imaging

PUBLICATIONS
Patent No: 8912494

More Information
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GSC-18502-1
GSC-17035-151
Printable chemical nanosensor

An integrated nanosensor printed on a daughter board using 3-D printing techniques.

NASA Goddard Space Flight Center has developed a printable nanosensor and leads using 3-D printing techniques on a silicon daughter board that can be connected to a self-contained pre-amp PCB. The sensor contains a graphene sensor array (a printed CNT or MoS2 could also work) and a PCB with pre-amplifier circuit connected to the daughter board with mechanical clips, and also wire bonded together. The sensor dimensions are typically from microns to 100s of microns. This innovation increases the sensitivity of gas sensors, enabling detection of ppb level concentration (and possibly single molecules).

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THE TECHNOLOGY

These sensors use field effect transistors based on 2-dimensional materials to sense the surface potential of a graphene channel exposed to an analyte. When analyte molecules adsorb onto the sensor surface, they act as electron donors or acceptors, inducing a local change in electrical resistance in graphene. This effect is very pronounced in 2-D materials due to high surface area, high electrical conductivity (in the case of graphene), and inherent low noise, making it possible to detect the changes in resistance. Different gases have different effects on the resistivity. The selectivity among target gases can be improved further through functionalization of the 2-D materials. The sensors are microfabricated on a suitable substrate as arrays. Different sensors on the array can have different functional groups targeting different analytes.

APPLICATIONS

The technology has several potential applications:

- Planetary science
- Earth science
- Contamination control
- Habophysics

PUBLICATIONS

Patent Pending
Sensors

Lab-On-Chip Flow and Temperature Sensor

Provides accurate and real time measure of flow rates and temperature in next generation microfluidic instruments.

NASA Goddard Space Flight Center has developed a sensor for micro analytical systems that measures, in real time, the flow rate and temperature of the liquid being sampled. Current sensors divert the liquid to separate temperature and flow sensors, which can result in fluid leakage and the need for a larger initial sample. This design eliminates that diversion. The system sensors will be able to measure flow rates in the nano-liter per minute range, and temperatures from greater than 150o C down to below -80o C.

BENEFITS

- Measures flow and temperature of fluids being analyzed in micro analytical systems
- Small enough to be used in lab-on-chip applications
- Novel design reduces fluid leakage and the amount of sample required

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THE TECHNOLOGY

The sensors in this system will be encased in Silicon Nitride (SiN) to electrically isolate them from the fluid flow and will be suspended in the middle of the channel to maximize their sensitivity and response time. The temperature sensors are utilized as part of the flow sensor design. The temperature sensor in front (before) of the heater will give the initial temperature reading for the fluid. The sensor behind (following) the heater will measure how much heat the heater was able to inject into the fluid. By knowing the thermal conductance and the heat capacity of the fluid, in addition to the power into the resistor and the change in temperature, the flow rate of the fluid can be calculated.

The sensors will be fabricated on a silicon (Si) wafer that has a micro channel etched into it. A sacrificial layer will be deposited on to the Si wafer to back fill the channels, this will provide a planar surface to fabricate the sensors.

APPLICATIONS

The technology has several potential applications:

- Microfluidics
- Microbiology
- PCR Sampling for Point of Care Applications

PUBLICATIONS

Patent Pending
Directional UAV Localization of Power Line Ultraviolet Corona
Improved method of detecting power line faults

NASA’s Langley Research Center has developed a novel system that uses an ultra-violet camera to detect, inspect, and analyze a corona discharge. This discharge signifies a power line fault, making the technology ideal for use in power line inspections. When coupled to a drone, the technology offers the ability to remotely monitor power lines in a cost-effective way. Adding GPS technology results in precise location of power line faults.
THE TECHNOLOGY

This technology comprises a novel system of detecting, inspecting and analyzing a corona discharge using an ultra-violet camera. It is useful for a number of potential applications, most notably, power line fault detection. The most novel feature is that it uses UV instead of IR which has been problematical for corona discharge detection because there is too much interference from other sources. UV detection offers images that isolate the location of the corona discharge with far greater precision.

When coupled to a drone, the technology offers the ability to remotely monitor power lines in a cost effective way. Image credit: Pixabay/LoggoWiggler
Environment

Low Frequency Wideband Step Frequency Inverse Synthetic Aperture Radar

A high-bandwidth, high-resolution ISAR technology for studying subsurface structures.

NASA Goddard Space Flight Center has developed a compact, lightweight, low frequency wideband Inverse Synthetic Aperture Radar (ISAR) and associated post-processing software. The software processes data received by the ISAR radar to extract down- and cross-range images of the target object. This ISAR system enables scientists and geologists to image 3D interior structure of a solid object to a depth of up to tens of meters. The system also features wide bandwidth, providing higher resolution than previous technologies such as conventional pulse ground penetrating radar (GPR) for analysis of thin layer pavements and geological subsurface structures.

BENEFITS

- Higher bandwidth compared to single pulse systems
- Higher resolution
- Higher signal-to-noise ratio
- Less expensive
- Compact and lightweight

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THE TECHNOLOGY

This technology is a low frequency (25–100 MHz) wide band (75 MHz) subsurface imaging ISAR. Use of low frequencies allows the electromagnetic energy to penetrate to a greater depth, enabling observation of the interior of a solid object to a higher resolution than can be achieved with alternate technologies. Higher bandwidth has been used in earlier ISAR systems; however, these require expensive high bandwidth RF components, and also higher speed data processing units. The new ISAR system uses a novel step frequency technique which eliminates both these requirements. The step frequency approach keeps the local bandwidth very small, enabling data processing at much lower speed. And by stepping through the frequencies, the ISAR achieves much higher overall bandwidth and consequently very high range resolution.

APPLICATIONS

The technology has several potential applications:

- Ground penetrating radars (thin layer pavements and geological subsurface structures)
- Study of the interior of asteroids, comets, and other small Near Earth Objects
- Characterization of the 3D structure of the lunar regolith

PUBLICATIONS

Patent No: 6136961