Microsystems Monthly

NASA highlights in this issue!!!!!

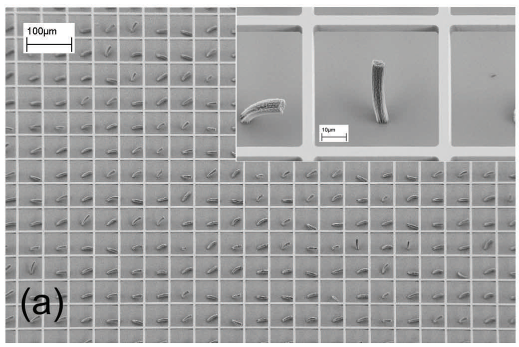
March 1, 2009
Volume 1, Issue 1

Mid-Atlantic MEMS Alliance Mission Statement:

To network expertise, capabilities, and research to facilitate the development of new applications and commercialization of miniaturization technologies.

NASA—Carbon nanotube electron gun for low-contamination, long-lifetime mass spectrometer

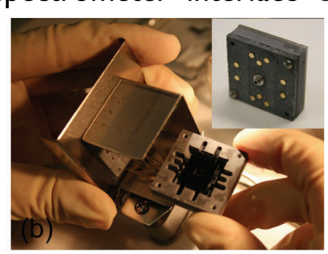
Stephanie Getty, with Todd King, Mary Li, Nick Costen, Larry Hess, and Paul Mahaffy, NASA GSFC



The team's approach employs microfabrication patterning, etching, and bonding techniques to integrate a patterned micron-scale CNT emitter array with a bonded grid-insulator stack. The CNTs can be grown under ideal conditions and subsequently aligned and mated to the extraction grid.

Owing to the low power and low voltage requirements, carbon nanotube (CNT) field emission electron sources are appealing for use in electron impact ionization mass spectrometry. For mission applications to the outer reaches of the Solar System, reliability and long lifetime are critically important. Stephanie and her team use only the cleanest, non-outgassing materials during fabrication of the electron gun. Using ultraclean materials will not only ensure a low background signal but will also help to reduce CNT degradation by sputtering and oxidation.

Recent efforts in the fabrication and characterization of a modular, ultra-clean CNT field emission electron gun reveal that the design is capable of producing microamps of current at the low voltages demanded by electron impact ionization mass spectrometry. With further characterization, the team expects improvements to emitter lifetime, background signal, and ionization efficiency, compared to previous prototypes. They will use their findings to guide future modifications to the mass spectrometer interface design for enhanced performance.



The integrated cathode-grid element has recently been packaged with a stack of silicon electrostatic lenses into a modular electron gun.

(The authors acknowledge support from NASA GSFC Internal Research and Development Program, NASA Astrobiology S &T Instrument Development Program.)

Welcome

Thank-you for reading this inaugural print edition of the Mid-Atlantic MEMS Alliance (MAMA) Newsletter. MAMA is a non-profit organization that has been in existence since the fall of 2000, when a group of Washington DC- area Universities, Government laboratories and companies banded together to increase the visibility and reach of research and development in Micro-mechanical-systems (MEMS). MAMA has hosted numerous symposia and workshops on different aspects of MEMS, including biomedical micro-devices, defense and homeland security applications, optical MEMS, and reliability. We have featured keynote speakers such as notable MEMS pioneers Steven Senturia, Roger Howe, and Ken Wise. We have also provided a venue for Universities, Government and industry to partner on miniaturization projects and to develop new approaches and ways of doing business.

Somewhere along the way, MEMS went mainstream! Currently, MEMS are so ubiquitous that many people don't even give them a second thought. If you ask a lay person how a digital projector works, they might tell you that there's a "chip" inside that reflects light onto the screen. Similarly, one might also attribute automobile roll detection or accident detection for airbag deployment to a "chip" under the hood. It doesn't occur to most people to wonder how it is that a "chip", by which of course we usually mean an integrated circuit, can measure information about its physical requirement or even interact with it (e.g. by shining light.) That, of course, is what MEMS is all about. Future applications for MEMS are staggering,, with some industry experts predicting a level of wireless sensor and transducer network integration that could revolutionize environmental monitoring,, bedside medical testing, and public health and food safety.

"MEMS are so ubiquitous that most people don't give them a second thought."

Meanwhile, as MEMS has grown up, it has also grown deep roots. It is no longer possible for most of us to do MEMS Research and Development in a bubble, separate from overlapping fields like Application Specific Integrated Circuit (ASIC) development, advanced packaging techniques, and accurate mechanical and multi-element modeling. Accordingly, MAMA has become over the years more about *Microsystems* and overall miniaturization than it is just about MEMS. You will notice that our mission statement includes the very general goal *"… to facilitate the development of new applications and the commercialization of miniaturization technologies."* At the same time, our membership reach has expanded and our members are no longer located just in the Baltimore/DC area, but come also from as far south as Virginia and as far north as Philadelphia and New Jersey.

It's an exciting time for our group, as we actively seek to expand our reach and mission. Specifically, over the next year MAMA will:

- Reach out to researchers and product developers who are interested in Microsystems technology and miniaturization, but do not necessarily consider themselves "MEMS Experts."
- Expand our commercial/industrial base

Mid– Atlantic MEMS Alliance Steering Committee Chair Brian Jamieson, Ph.D.

- Build on our successful "stone soup sessions," i.e. interactive panels trying to match industry needs with researchers' solutions
- Recruit several new members of our Steering Committee, including at least one from industry.
- Bring attention to the important role that Microsystems Technology can play in driving economic growth in the Mid-Atlantic region

We hope that you will enjoy this and future issues of our newsletter, and that you will consider all that you can gain from joining our dynamic organization.

Best Regards,

Brian Jamieson

Brian Jamieson
Mid-Atlantic MEMS Alliance Steering Committee Chair

Upcoming Events

MEMS Alliance Fall Symposium

MEMS, Nano and Microsystems in the Green Revolution …..This conference will feature explore the role that micro– and nano– technology will play a role in the development of “green” solutions to environmental and energy issues. A :”Stone Soup” problem solving session will link industry and government needs with technology solutions. There will be a poster session with a student award for best presentation. Washington DC November 30, 2009. www.mems-alliance.org

TRANSDUCERS 2009
2009 International Solid-State Sensors, Actuators and Microsystems Conference

The conference will feature four days of presentations and posters highlighting the latest and most technically advanced work in mechanical, optical, chemical, and biological devices and systems using micro- and nano-technology. Jun 21-25, 2009 Sheraton Denver Hotel Denver, CO. www.transducers09.org

PowerMEMS 2009

The 9th International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications.
Washington DC Dec 1-4, 2009 www.powermems.org.

SAMPE in Baltimore this YEAR!!!

http://www.sampe.org/events/Baltimore09ConferenceProgram.aspx

Local Interest

Collaborative Opportunity- Larry Hilliard of **NASA GSFC** is developing a space flight instrument concept called the Slow and Low UAS for Snow Hydrology (SLUSH) to measure the Snow Water Equivalent (SWE) for NASA Earth science missions. His instrument aims to significantly reduce the mass, volume and power of the overall system package by harnessing MEMS solutions for several critical components in his instrument system including a) RF frequency selective (1215 MHz to 37 GHz and intermediate bands) cross-connect switches, and b) Variable Delay Line (VDL) technology for a miniaturized azimuth (conical) scanning system and integrated feed network. He is actively seeking collaborators in this development effort. If you are interested in finding out more, please contact Larry at lawrence.m.hilliard@nasa.gov.

Georgetown University -----Professor Mak Paranjape reports: “We have recently purchased a new DRIE system, and are making it available to external users at deep discount :-) usage fees. Of course, great to get external users to make use of our lab/cleanroom/FESEM. Also he has two PhD students defending in April and looking for post doc positions; contact paran@physics.georgetown.edu

PROCUREMENT/PROPOSAL OPPORTUNITIES

ONR N00173-09-R-CB02, Advanced Electronic Warfare(EW), FedBizOpps/CBD 2 February 2009.

DHS HSHQDC-09-R-00045(D),) Procure and Deploy an Autonomous Biodetection System Called Gen 3 Biowatch, FedBizOpps/CBD 5 February 2009.

VACA VACA-2010-02, Ground Based Sensor, FedBizOpps/CBD 5 February 2009. Additional information is available online.

VACA VACA-2010-01, Ground Based RF Detection Demonstration, FedBizOpps/CBD 5 February 2009. Additional information is available online

OTHER RESEARCH OPPORTUNITIES.
AFMC R1997,AFRL Electromagnetics Technology Division , FedBizOpps/CBD 9 February 2009.

DARPA Microsystems Technology Office-Wide

Broad Agency Announcement **Document Type:** Presolicitation Notice
Solicitation Number: BAA09-25 **Posted Date:** February 17, 2009
http://www.darpa.mil/mto/solicitations/baa09-25/index.html

OF NOTE

Dr. Robert F. Leheny was named Acting Director DARPA February 20, 2009. He continues to serve as Deputy Director of DARPA, a position he has occupied since June 2, 2003.(Leheny is in an acting role….it has become Washington's favorite parlor game to guess Tony Tether's successor)

POSITION OPENINGS IN THE AREA

Post-Doctoral Research Associate Rutgers, The State University of New Jersey, Piscataway, NJ

Postdoctoral Research Student DOC/NIST/CNST/Nanofabrication Research Group, Gaithersburg, MD 20899-6203

Radar Systems Engineer—Northrup Grumman

http://careers.northropgrumman.com/ExternalHorizonsWeb/getQuery.do Drop - Radar Systems Engineer - in the keywords box. Choose MD as the state and Baltimore as the city.

JHUAPL Microelectronics Packaging / Assembly Engineer www.jhuapl.edu

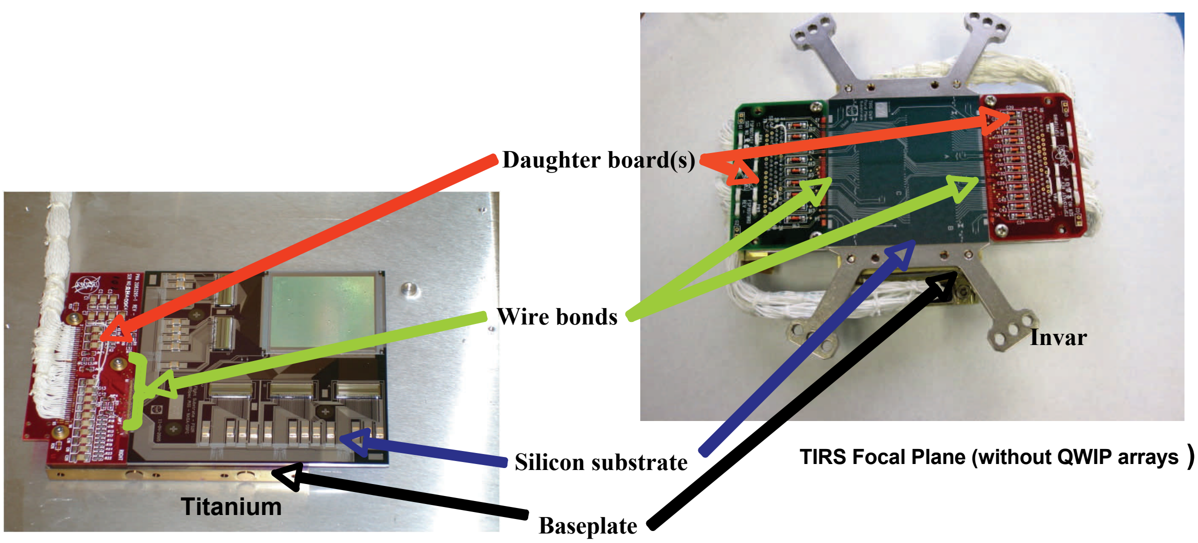
MEMS Business Development and Marketing Manager
MEMS and Nanotechnology Exchange

Microfabrication Engineer / Technician MEMS and Nanotechnology Exchange (Reston, Virginia) Phone: 703-262-5368 Fax: 703-262-5367 http://mems-exchange.org/

QWIP-Based Thermal Infrared Sensor for the Landsat Data Continuity Mission

M. Jhabvala[a], D. Reuter[a], K. Choi[b], C. Jhabvala[a] and M. Sundaram[c]

Advances continue to be made in the development and performance optimization of GaAs Quantum Well Infrared Photodetector (QWIP) focal plane arrays. The research and development cycle for these arrays has progressed at a remarkable rate and in the space of a few years megapixel arrays are readily available. In the 1990s and into this decade rapid development from single element QWIPs to 1K x 1K arrays occurred across a broad spectrum of the near to far infrared. With the concurrent development of large format silicon readout ICs it has been a relatively simple task for QWIP technology to keep pace. However, in order to be considered in a NASA mission a much more stringent technology readiness level must be demonstrated and for good reason. NASA avoids investing large sums of money and human resources on a risky technology for a space mission before it is verified on ground. For this reason QWIPs have not been considered for NASA earth or space science satellites. The low quantum efficiency of QWIP devices combined with the proven (although sometimes shaky) heritage of HgCdTe and InSb technologies have routinely disqualified QWIPs from being considered. However, the decision has recently made to add a Thermal Infrared Sensor (TIRS) instrument on the upcoming NASA-United States Geological Survey (USGS) Landsat Data Continuity Mission (LDCM) to the existing Operational Land Imager (OLI) instrument. The NASA Landsat program has been in existence since 1978 and in 1999 Landsat 7 was launched with a design lifetime of 5 years. The Landsat program and the data provided on a wide range of earth science parameters has not only been a national resource but is used throughout the world. Landsat has been an international resource and the LDCM will continue this legacy. The OLI is the prime instrument aboard LDCM and is designed to continue the spectral coverage of the earth that was available in the Landsat 7 mission. This spectral coverage ranges from 433 nm to 1.39 mm in discrete bands. The launch date for LDCM is late 2012. In order to provide a more comprehensive data set on a variety earth science parameters it was determined that thermal imagery in the 10.5-12.5 mm spectral range (divided into two discrete spectral bands) was essential.



Microshutter Assembly

Photograph of the JWST Microshutter Assembly (left) and the TIRS focal plane assembly.

We have consistently maintained that the applications for QWIP arrays are numerous ranging from military hardware to environmental monitoring to medical/commercial instrumentation. Some specific TIRS applications include: agricultural monitoring; cloud detection and analysis; mapping heat fluxes from cities; monitoring air quality; monitoring volcanic activity; monitoring the rain forests; biomass burning; industrial thermal pollution in the atmosphere, rivers and lakes; monitoring/tracking material transport in lakes and coastal regions; identifying insect breeding areas and applications that breeding areas and applications that will ultimately arise in the future as a result of global warming and climate change. The set of circumstances that simultaneously materialized present a unique opportunity for the advancement of QWIP technology insertion into the national space program. Space flight qualified instruments have been historically based on developed, field tested and often somewhat dated technology and for good reason. These instruments tend to be unique, very expensive, generally only have one chance to succeed and must be reliable for long periods of time in a sometimes hostile space environment. These instruments must survive the rigors of a launch including severe vibration, acoustic effects and often a shock event (such as the explosive removal of a protective cover). There is no room for chance or even the slightest error and this is after the fundamental technologies have been thoroughly proven.

QWIP FOCAL PLANE ASSEMBLY

The goal of this project is to deliver a fully space flight qualified QWIP-based focal plane thermal imaging instrument on a very aggressive schedule. This precludes any research and development that is not absolutely required to achieve this goal. Numerous groups have been developing QWIP technology for many years and in order to maximize our chances of developing this instrument to specification it is imperative that we utilize existing, verified technologies to meet the TIRS requirements. To that end, we designed a focal plane assembly based on a MEMS assembly that was developed for the James Webb Space Telescope (JWST) project-the Microshutter Assembly (MSA). This effort spanned almost a decade and resulted in a fully qualified assembly. Shown below in figure 1 is a side-by-side illustration of the MSA and TIRS focal plane. The QWIP arrays are yet to be affixed to the silicon substrate but the process will be similar to the process used for attaching the silicon integrated circuits to the MSA substrate. The main difference is the use of invar instead of titanium, which provides a much better CTE match to the silicon substrate than titanium. To further improve our chances of success we opted to pursue two parallel QWIP development paths. The Goddard Space Flight Center teamed with the US Army Research Laboratory (ARL) would design and fabricate a corrugated (C)-QWIP array. We also established a team consisting of QmagiQ, LLC with support from GSFC/ARL to develop a grating based QWIP array. By pursuing both approaches we are incorporating risk mitigation that is of essential importance to NASA missions. The driving parameters of the QWIP are the low dark current and high conversion efficiency (CE) across the spectral band. To further reduce our risk, we are implementing a temporary hybrid-mounting step into a Leadless Chip Carrier (LCC) package so that the QWIP detector can be fully tested, removed from the LCC and re-bonded onto the TIRS silicon substrate. The focal plane requires three precisely aligned arrays to be mounted on the silicon substrate. As the QWIP arrays are epoxied to the silicon substrate the value dramatically rises with each subsequent addition of a QWIP hybrid and once they are epoxied to the focal plane they cannot be removed without destroying the silicon substrate. The intermediate step of fully testing the QWIP HYBRID in an LCC gives us one last look at the hybrid before committing it to the silicon substrate. This is especially important for the second and third QWIP arrays since a failure in any one of the 3 arrays disqualifies the entire focal plane (and the other 2 QWIP arrays)--a situation we are determined to avoid. In addition to the Flight focal plane that is required for the TIRS instrument we are building two additional assemblies: a ”Pathfinder” and an Engineering Model (EM).

ACKNOWLEDGEMENTS: The authors would like to acknowledge the following individuals for their invaluable support to this NASA Landsat/TIRS project: Brent Mott, Anh La, Tom Hartman, Larry Hess, Audrey Ewin, Ron Hu, Nick Costen, Sam Moseley, Avery Miles, Carol Sappington, Laddawan Miko, Trang Nguyen, Tomoko Adachi, Peter Shu, Augustyn Waczynski, Jay Cho, Bing Guan, Phil Goodwin, Sherry Warner of NASA's Goddard Space Flight Center; Jason Sun of the Army Research Laboratory; Axel Reisinger, Rich Dennis, Kelly Patnaude, Doug Burrows, Robert Cook, Jason Bundas of QmagiQ, LLC and we would also like to express our appreciation to Indigo Corp. and Intelliepi, Corp. for their ongoing support. And, of course, the entire Microshutter Assembly team at Goddard.

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[b]*US Army Research Laboratory, 2800 Powder Mill Road, Adelphi, Maryland, 20783 USA*
[c]*QmagiQ, LLC, 22 Cotton Road, Unit H, Suite 180, Nashua, NH 03063 USA*

REFERENCES

1. See Landsat project description at: http://landsathandbook.gsfc.nasa.gov/handbook/handbook_htmls/chapter1/chapter1.html
2. M. Jhabvala, K.K. Choi, C. Monroy and A. La, *Infrared Physics and Technology* V50 pp 234-239, June , 2006.
3. M. Jhabvala, *Infrared Physics and Technology* V42 pp 363-376, July , 2000.
4. Core by Indigo Large-Format Readout Integrated Circuits.FLIR Systems, Santa Barbara, CA.
5. M. Jhabvala, et al. SPIE, Orlando, FL , March, 2008.
6. K. K. Choi, A. C. Goldberg, K. M. Leung, T. Tamir, M. Jhabvala, APS March Meeting, Austin, TX 2003.

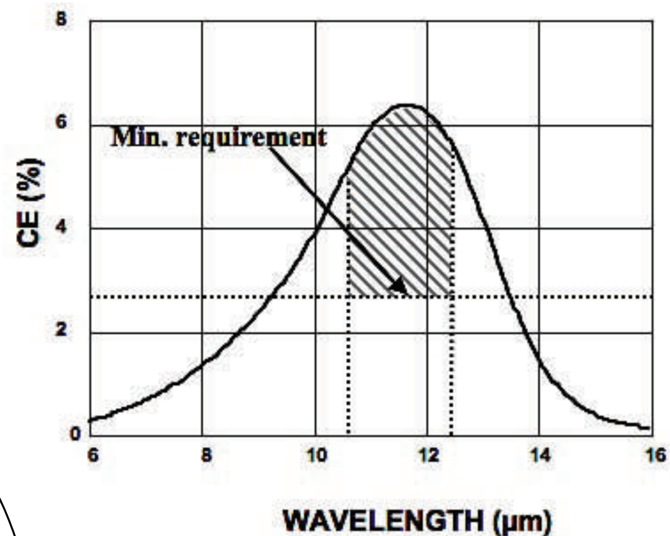
The MEMS Alliance
Mid Atlantic Area

WE'RE ON THE WEB:

WWW.MEMS-ALLIANCE.ORG

Universities, Government and Industry… working together to make Microsystems for the real world.

Designed spectral response and corresponding C-QWIP growth recipe.



30000 A	GaAs	1×10^{18} cm^{-3}	
50 A	AlGaAs (x = 0.17)	undoped	
60 A	GaAs	0.6×10^{18} cm^{-3}	x 60
700 A	AlGaAs (x = 0.17)	undoped	
60 A	GaAs	0.6×10^{18} cm^{-3}	
50 A	AlGaAs (x = 0.17)	undoped	
50000 A	GaAs	1×10^{18} cm^{-3}	
1000 A	AlGaAs (x = 0.3)	undoped	
2500 A	GaAs	undoped	
	GaAs	S.I. - SUBSTRATE	

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QWIPS

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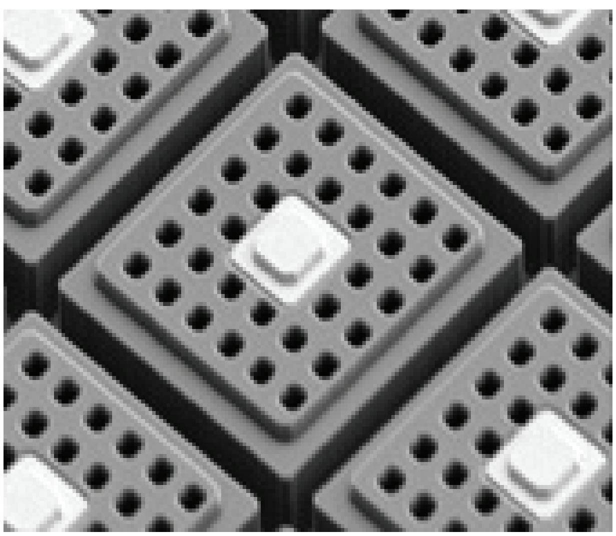
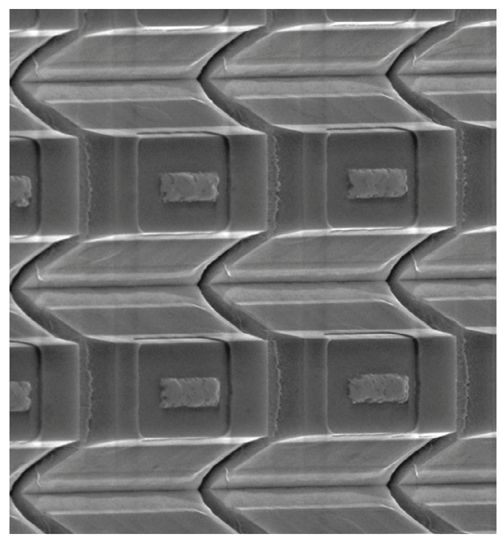
NASA





Photograph of the grating-based (left) and the corrugated QWIP pixels. Each has an indium bump on the top surface

MEMS Alliance member and best poster winner Stephan Koev receives UMD

University-wide Honor..story at

:http://www.ece.umd.edu/news/news_story.php?id=3710

NIST Technology Innovation Program: March 9 White Papers (first date)

The America COMPETES Act created a new Technology Innovation Program (TIP) at the National Institute of Standards and Technology (NIST). TIP was established "to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need.

TIP is aimed at speeding the development of high-risk, transformative research targeted to address key societal challenges. Funding could be provided to industry (small and medium-sized businesses), universities, and consortia for research on potentially revolutionary technologies for meeting critical national needs that present high technical risks-with commensurate high rewards if successful. The mechanism for this support would be cost-shared research grants, cooperative agreements, or contracts awarded on the basis of merit competitions.

NIST announced that, while it is accepting papers in any topic area of concern to the submitter, it is particularly interested in white papers that would help further refine several topic areas now under consideration, including:

* Civil Infrastructure-for example construction technologies or advanced materials for transportation or for water distribution and flood control;
* Complex networks and complex systems-for example new theory or mathematical tools to enable better understanding and control of the complex networks that have evolved for energy delivery, telecommunications, transportation and finance;
* Energy-technologies that address emerging alternative energy sources;
* Water-technologies that address growing needs for fresh water supplies and ensure the safety of water and food supplies from contamination;
* Manufacturing-for example, advanced manufacturing technologies that have shorter innovation cycles, more flexibility, and are rapidly reconfigurable;
* Nanomaterials and nanotechnology-for example technologies that enable the scale-up of nanomaterials and nanodevices from lab prototypes to commercial manufacturing;
* Personalized Medicine-for example, advances in proteomics and genomics that could enable doctors to select optimal drug treatments and dosages based on the patient's unique genetics, physiology, and metabolic processes; and
* Sustainable Chemistry-for example, novel, advanced process chemistries and technologies that are inherently safer and cleaner, while creating products /processes with attributes superior to conventional methods.

White papers can be submitted to meet several due dates, including: Jan. 15, 2009, March 9, 2009, May 11, 2009, and July 13, 2009. White papers may be mailed to: National Institute of Standards and Technology, Technology Innovation Program, 100 Bureau Drive, Stop 4750, Gaithersburg, MD 20899-4750, Attention: Critical National Needs Ideas, or may be emailed to tipwhitepaper@nist.gov <mailto:tipwhitepaper@nist.gov> .