Research at Government Laboratories and Universities: A News Update

From May 2011 *High Frequency Electronics*

Raytheon to Fund New UCLA Center for Public Safety Network Systems

Raytheon Company (www.raytheon.com) has entered into a letter of intent with the University of California, Los Angeles (UCLA—www.ucla.edu) for a strategic relationship with the Henry Samueli School of Engineering and Applied Science that will establish the UCLA Center for Public Safety Network Systems. To lay the foundation for the new center, Raytheon has committed to initially contribute $1 million during three years to the UCLA Institute for Technology Advancement (ITA) of the School of Engineering and Applied Science to conduct research in the areas of public safety networks.

The mission of the UCLA-ITA Public Safety Network Systems Center is to bring together academia, industry and public safety agencies to provide technical leadership, a collaborative forum for research, as well to establish standards for public safety networks. The center will operate to benefit the public safety agencies and guide the public safety community in the evolution of technologies and standards. Any public or private organization that meets the membership requirements to be established by UCLA will be welcome to join the center.

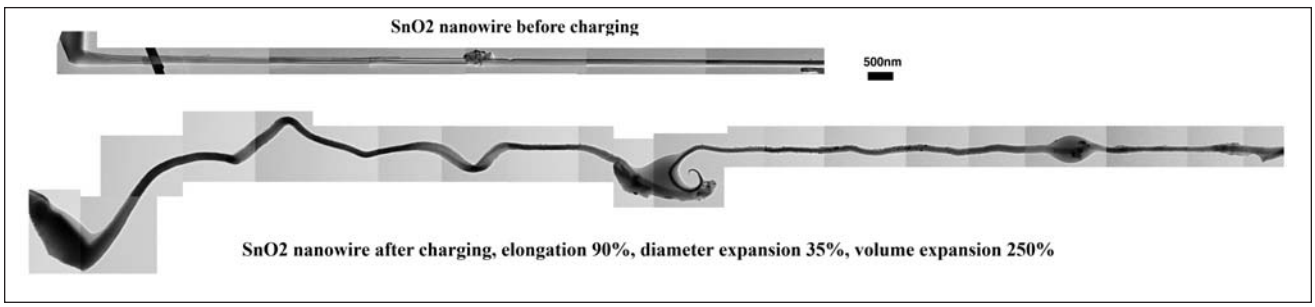
World's Smallest Battery Created at CINT Nanotechnology Center

A benchtop version of the world's smallest battery—its anode a single nanowire one seven-thousandth the thickness of a human hair—has been created by a team led by Sandia National Laboratories researcher Jianyu Huang.

To better study the anode's characteristics, the tiny rechargeable, lithium-based battery was formed inside a transmission electron microscope (TEM) at the Center for Integrated Nanotechnologies (CINT), a Department of Energy research facility jointly operated by Sandia and Los Alamos national laboratories.

Because nanowire-based materials in lithium ion batteries offer the potential for significant improvements in power and energy density over bulk electrodes, more stringent investigations of their operating properties should improve new generations of plug-in hybrid electric vehicles, laptops and cell phones. Huang noted, "To improve performance, we wanted to understand LIBs from the bottom up, and we thought in-situ TEM could bring new insights to the problem."

The tiny battery created by Huang and co-workers consists of a single tin oxide nanowire anode 100 nanometers in diameter and 10 micrometers long, a bulk lithium cobalt oxide cathode three millimeters long, and an ionic liquid electrolyte. The device offers the ability to directly observe change in atomic structure during charging and discharging of the individual "trees." An unexpected find was that the tin oxide nanowire rod nearly doubles in length during charging—far more than its diameter increases—a fact that could help avoid short circuits (see image below). The common belief has been that batteries swell across their diameter, not longitudinally. The electronic noise level generated from the researchers' measurement system was too high to read electrical currents, but a current level of a picoampere was estimated as the nanowire was charged to a potential of about 3.5 volts.



The Medusa twist: a formerly unobserved increase in length and twist of the anode in a nanobattery. (Courtesy DOE Center for Integrated Nanotechnologies)

MIT Lincoln Laboratory Receives Five R&D 100 Awards

Five Lincoln Laboratory (www.ll.mit.edu) technologies were named 2010 recipients of R&D 100 Awards. These awards are given annually by *R&D Magazine*, an internationally respected journal providing news and technical articles to research scientists and engineers. Instituted in 1963, these awards recognize the 100 most technologically significant innovations introduced during the previous year. Recipients of R&D 100 Awards are chosen from hundreds of nominations by an independent panel of evaluators and the editors of the magazine. The following innovations are the five winning Lincoln Laboratory technologies:

- *Geiger-Mode Avalanche Photodiode Detector Focal-Plane Arrays*—a two-dimensional array of ultrasensitive solid-state photodetectors, each of which can measure the arrival time of single photons
- *Subwavelength-Separated Superconducting Nanowire Single-Photon Detector Arrays*—a component in an optical detection system that enables broadband single-photon detection with high efficiency and low noise at rates exceeding one billion photons per second
- *Digital-Pixel Focal-Plane Array*—a complementary metal-oxide semiconductor readout-integrated circuit for infrared imaging. Fast on-chip processing provides an extreme dynamic range from a minimally sized package.
- *Runway Status Lights*—a system integrating data from airport surveillance sources to control in-pavement lights that directly alert pilots to potential runway incursions
- *Miniaturized Four-Channel Receiver*— the smallest, least-power-demanding receiver that can detect frequencies over a six-octave range

High-Performance Wireless Telemetry Link

John H. Glenn Research Center (www.nasa.gov/centers/glenn/) has developed a method for wireless telemetry used in the monitoring of rotating machinery such as turbines. Prior technology for machinery data acquisition used slip rings, FM radio communication, or non-real-time digital communication.

This innovation extends the amount of information conveyed from a rotating machine to a data acquisition system while keeping the development time short and keeping the rotating electronics simple, compact, stable, and rugged. The data are all real time. The product of the number of channels, times the bit resolution, times the update rate, gives a data rate higher than available by older methods.

The telemetry system consists of a data-receiving rack that supplies magnetically coupled power to a rotating instrument amplifier ring in the machine being monitored. The ring digitizes the data and magnetically couples the data back to the rack, where it is made available. The transformer is generally a ring positioned around the axis of rotation with one side of the transformer free to rotate and the other side held stationary. The windings are laid in the ring; this gives the data immunity to any rotation that may occur.

A medium-frequency sine-wave power source in a rack supplies power through a cable to a rotating ring transformer that passes the power on to a rotating set of electronics. An alternative method would be to use two symmetrical coils. Since the two coils are rotationally symmetrical, rotation does not influence the magnetic coupling from the primary to the secondary. With the sec-

NASA'S Hubble Celebrates 21st Anniversary

To celebrate the 21st anniversary of the Hubble Space Telescope's deployment into space, astronomers at the Space Telescope Science Institute pointed Hubble's eye at an especially photogenic pair of interacting galaxies called Arp 273. The new image is featured on the cover of this issue of *High Frequency Electronics*, and is available at www.nasa.gov/hubble. Hubble was launched April 24, 1990, aboard Discovery's STS-31 mission. Hubble discoveries revolutionized nearly all areas of current astronomical research from planetary science to cosmology.

The newly released Hubble image shows a large spiral galaxy, known as UGC 1810, with a disk that is distorted into a rose-like shape by the gravitational tidal pull of the companion galaxy below it, known as UGC 1813. A swath of blue jewel-like points across the top is the combined light from clusters of intensely bright and hot young blue stars. These massive stars glow fiercely in ultraviolet light. The smaller, nearly edge-on companion shows distinct signs of intense star formation at its nucleus, perhaps triggered by the encounter with the companion galaxy. Arp 273 lies in the constellation Andromeda and is roughly 300 million light-years away from Earth. The image shows a tenuous tidal bridge of material between the two galaxies that are separated from each other by tens of thousands of light-years.

ondary coil electrostatically shielded, environmental noise pickup is intrinsically low. Since the transformer is air-core, the uncompressed bandwidth can be high — 50 MHz, 200 MHz, or higher.

Rice University Unveils State-of-the-Art Physics Research Facility

Officials from Rice University (www.rice.edu) and the U.S. Department of Commerce today dedicated Brockman Hall for Physics, a state-of-the-art research facility that is the new home for fundamental and applied physics research at Rice. The 111,000-square-foot, four-story building was partially funded by $11.1 million in federal stimulus funding from the National Institute of Standards and Technology (NIST—www.nist.gov). Brockman Hall will support research in atomic, molecular and optical physics; biophysics; condensed matter physics; nanoengineering and photonics.

Silver-Diamond Composite Offers Cooling Capabilities for Electronics

Researchers at the Georgia Tech Research Institute (GTRI—www.gtri.gatech.edu) are developing a solid composite material to help cool small, powerful micro-

Photo credit: Georgia Tech / GTRI

electronics used in defense systems. The material, composed of silver and diamond, promises an exceptional degree of thermal conductivity compared to materials currently used for this application. The research is focused on producing a silver-diamond thermal shim of unprecedented thinness—250 microns or less. The ratio of silver to diamond in the material can be tailored to allow the shim to be bonded with low thermal-expansion stress to high-power wide-bandgap semiconductors planned for next generation phased-array radars.

Thermal shims are needed to pull heat from these high-power semiconductors and transfer it to heat-dissipating devices such as fins, fans or heat pipes. Since the semiconductors work in confined operating spaces, it is necessary that the shims be made from a material that packs high thermal conductivity into a tiny structure. Diamonds provide the bulk of thermal conductivity, while silver suspends the diamond particles within the composite and contributes to high thermal conductivity that is 25 percent better than copper.