Future Chips Newsletter

December 2010 Edition

This Newsletter updates the technical community on recent research within the Future Chips Constellation at Rensselaer Polytechnic Institute.

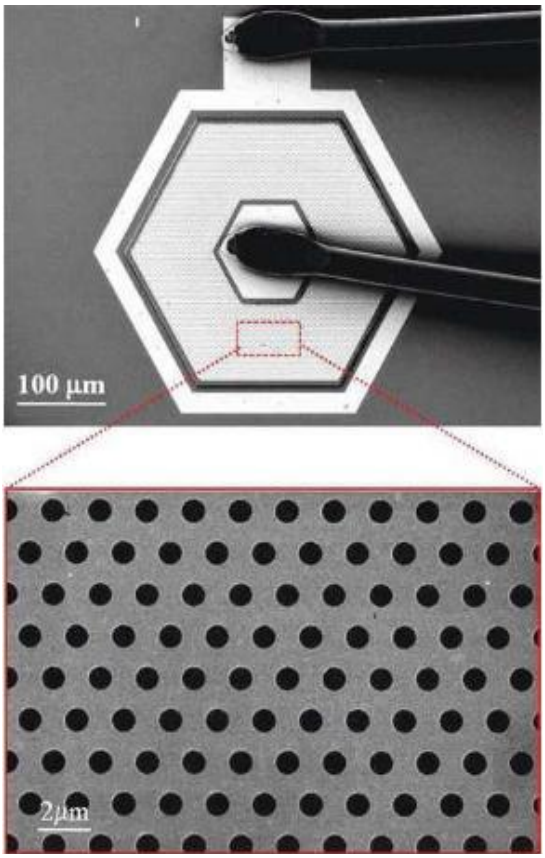
For additional information, please contact us at gina@ecse.rpi.edu.

Sincerely,
E. Fred Schubert
Shawn Y. Lin
Christian M. Wetzel

Nanotech Discovery Could Improve Infrared Satellite Imaging Technology

Researchers from Rensselaer have developed a new nanotechnology-based "microlens" that uses gold to boost the strength of infrared imaging and could led to a new generation of ultra powerful satellite cameras and night-vision devices.

By leveraging the unique properties of nanoscale gold to "squeeze" light into tiny holes in the surface of the device, the researchers have doubled the detectivity of a quantum dot-based infrared detector. With some refinements, the researchers expect this new technology should be able to enhance detectivity by up to 20 times.



Professor Shawn-Yu Lin has developed a new nano-technology-based "microlens" that uses gold to boost the strength of infrared imaging and could lead to a new generation of ultra-powerful satellite cameras and night-vision devices. The device, pictured above, leverages the unique properties of nanoscale gold to "squeeze" light into tiny holes in the surface of the infrared photodetector.

This study is the first in more than a decade to demonstrate success in enhancing the signal of an infrared detector without also increasing the noise, said project leader Shawn-Yu Lin, professor of physics and a member of the Future Chips Constellation and Smart Lighting Engineering Research Center.

Infrared detection is a big priority right now, as more effective infrared satellite imaging technology holds the potential to benefit everything from homeland security to monitoring climate change and deforestation," said Lin, who in 2008 created the work's darkest material as well as a coating for solar panels than absorbs 99.9 percent of light from nearly all angles.

New Records at International Workshop of Nitride Semiconductors

Energy efficiency -- in solid-state lighting, power conversion, and high frequency switching – those were the highlighted targets of the 2010 International Workshop on Nitride semiconductors (IWN2010) (Sept 18-24 in Tampa FL). The biannual workshop on the materials physics foundations of wide bandgap group-III nitrides set a new attendance record at 800 registrees.

Jim Speck of UC Santa Barbara gave the plenary talk on Progress in Nonpolar and Semipolar GaN-based Materials and Devices. Other hot topics presented in front of the full audience were Ultraviolet Laser Diodes (Yoshida, Hamamatsu), UV Lamps (Adivarahan), Theory of Light Loss Mechanisms (Van de Walle), GaN Transistors from Terahertz to Kilovolts (Palacios), Insulated Gate Field Effect Transistors (Shur), High-temperature Transistors (Kuzuhara), Quantum Cascade Devices (Monroy), Nanocolumn Growth (Calleja), Indium Nitride-based Devices (Nanishi), Bulk Gallium Nitride Materials (Paskova), and Bulk

After Montreux (Switzerland 2008), Kyoto (Japan, 2006) and Pittsburgh (2004) this is the second time the workshop was held in the United States since Professor Isamu Akasaki first initiated the series in Nagoya, Japan in the year 2000.

This year's event was co-chaired by the Wellfleet Constellation member Christian Wetzel and Asif Khan at University of South Carolina. Georgia Tech's Alan Doolittle with Hiroshi Amano (Meijo U) and Andreas Hangleiter (TU Braunschweig) chaired a large and international program committee for the best possible program. Out of 719 abstracts they selected 385 oral and 239 poster presentations. Major attendances came from North America (305), Asia (255) and Europe (204). The newly developed cruise ship shoreline of Tampa and Historic Ybor City provided a scenic environment for the busy workshop.

A forthcoming article in Compound Semiconductor Magazine (Dec 2010) will in turn summarize the workshop. Look out for the next installation of the workshop in 2012 in Sapporo, Japan.

TAMPA

IWN2010

International Workshop on Nitride Semiconductors

Carrier leakage from the active light-emitting region contributes to the efficiency droop in GaInN light-emitting diodes

Researchers of the Future Chips Constellation at Rensselaer Polytechnic Institute have demonstrated that carrier leakage from the active region of GaInN/GaN light-emitting diodes (LEDs) plays an important role in the well-known phenomenon of “efficiency droop”. This phenomenon is the gradual decrease of LED efficiency as the injection current increases and has plagued the development of GaInN / GaN LEDs.

Efficiency droop is a major obstacle that needs to be solved for LEDs to penetrate into the general illumination market. The origin and solution of the efficiency droop have been under the spotlight of the technical community during the recent years. A team of the Constellation, in collaboration with Sandia National Laboratories and Samsung LED, demonstrated that experimental efficiency-versus- current curves of GaInN/GaN LEDs require a carrier leakage term, f(n), which can have second, third, and fourth-order contributions to the total recombination rate. It was found that higher-than-third-order terms of f(n) contribute significantly to the total recombination rate at injection current densities that are typical for solid-state lighting applications [1]. The findings are indicative of electron leakage out of the active region of GaInN LEDs.

Results of the study were recently published by *Applied Physics Letters*.

[1] Qi Dai, Qifeng Shan, Jing Wang, Sameer Chhajed, Jaehee Cho, E. Fred Schubert, Mary H. Crawford, Daniel D. Koleske, Min-Ho Kim, and Yongjo Park, *Applied Physics Letters* **97**, 133507 (September 2010)