2003 Summary of Engineering Research

A Report of Activities During 2002

This pdf is part of the larger *2003 Summary of Engineering Research,* available on the Web at www.engr.uiuc.edu/research and on CD-ROM. The *Summary of Engineering Research* represents the extensive engineering research program conducted in 2002 at the University of Illinois at Urbana-Champaign.

Detailed statistics about research in the College of Engineering are included in the *Directory of Engineering and Engineering Technology Programs and Research,* published by the American Society for Engineering Education, Washington, D.C.

How to Use The *Summary of Engineering Research:* Research projects are listed by title, followed by the names of the investigators and the sponsoring agencies. Projects are sorted by major topic areas. Project descriptions are brief. Additional information on each project may be obtained from the investigator in charge (denoted by an asterisk). Mailing addresses are provided on the introductory page.

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COLLEGE OF ENGINEERING
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Micro and Nanotechnology Laboratory

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The Micro and Nanotechnology Laboratory, a multidisciplinary research facility in the College of Engineering, houses advanced equipment to support research in photonics, microelectronics, nanotechnology, and biotechnology. The research activities that are facilitated by the laboratory can be divided into four areas:

- Optoelectronics and Photonic Systems
- Microelectronics for Wireless Communications
- Microelectromechanical Systems
- Nanobiosystems

The research programs of the Optoelectronics and Photonic Systems area are focused on the conceptualization, design, fabrication, and testing of microelectronic and optoelectronic devices, circuits, components, and systems for lightwave communications and optical interconnects.

The activities of the Microelectronics for Wireless Communications area include the design and fabrication of state-of-the-art, low-power RF and microwave monolithic integrated circuits (MMICs) and GHz analog-to-digital converters for advanced wireless communication systems and advanced digital radar systems.

The above two research areas are supported in the laboratory with extensive development of growth, characterization, and processing technologies for a broad range of III-V semiconductor materials, quantum wells, superlattices, and nanostructures. The III-V materials include compounds and alloys with bandgaps appropriate for UV detectors, visible emitters, near- and mid-infrared sources (LEDs, side-emitting lasers, and VCSELs), detectors, FETs, and HBTs.

The Microelectromechanical Systems (MEMS) area focuses on the development of micromachining methods for a variety of materials, such as silicon, gallium arsenide, and polymers, to enable applications in many interdisciplinary areas, including wireless communications, optoelectronics, and biomedical engineering.

The Nanobiosystems area focuses on utilizing the various technologies developed in materials, nanofabrication, devices, and MEMS to study and solve biological issues. Examples of research activities being carried out include biomolecular flow patterns in nanoscale channels, integration of lasers onto biochips for real-time fluorescence study of bioreactions, and implantation of active devices in cells to study cellular biochemistry.

The Micro and Nanotechnology Laboratory is one of the nation's largest and most sophisticated university-based facilities for semiconductor, nanotechnology, and biotechnology research. It contains more than 8,000 square feet of class 100 and class 1000 clean-room laboratory and state-of-the-art, ultra-high-speed optical and electrical device and circuit measurements. The laboratory has in the past housed various centers, including the Engineering Research Center for Compound Semiconductor Microelectronics (funded by the National Science Foundation) and the Center for Optoelectronic Science and Technology (funded by the Defense Advanced Research Projects Agency). It currently houses the DARPA-funded Center for Bio-Optoelectronic Sensors and Systems. The laboratory is a User Facility that is available for use by university and industrial personnel from across the nation.

Faculty associated with the Micro and Nanotechnology Laboratory are listed below.

Biotechnology Center
H. Lewin

Department of Chemical and Biomolecular Engineering
P. Kenis
D. Leckband
C. Zukoski

Department of Chemistry
P. Bohn
J. Moore

Department of Electrical and Computer Engineering
I. Adesida
J. Bernard
S. Bishop
S. Boppart
K. Y. Cheng
K. Choquette
S. L. Chuang
J. Coleman
G. Eden
M. Feng
C. Gardner
K. Hess
N. Holonyak, Jr.
K. C. Hsieh
K. Kim
M. Kushner
J. P. Leburton
C. Liu
J. Lyding
G. Papen
U. Ravaioli
E. Rosenbaum
J. Schutt-Aine
G. Timp
J. Tucker
A. Webb
B. Wheeler

Department of General Engineering
N. Aluru

Department of Materials Science and Engineering
J. Abelson
L. Allen
P. Braun
J. Weaver
G. Wong

Department of Mechanical and Industrial Engineering
T. Saif
M. Shannon
L. Phinney

Department of Nuclear, Plasma, and Radiological Engineering
G. Miley

Department of Physics
I. Bezryadin
D. Van Harlingen
A. Yazdani

Faculty and Their Interests

Ilesanmi Adesida
Electronic and transport properties of ultra-low dimensional semiconductor structures; advanced processing methods for electronic devices; high-speed optoelectronic devices and integrated circuits; radiation effects

Keh-Yung Cheng
Molecular beam epitaxy technology, optoelectronic integrated circuits, high speed devices, *in situ* fabrication of nanostructures, quantum wire lasers, vertical cavity surface emitting lasers, Sb-based IR detectors and electronic devices

Kent Choquette
Vertical cavity surface emitting lasers (VCSELs), micro- and nano-cavity lasers, optoelectronic devices, selective oxidation of compound semiconductors, hybrid heterogenous integration, nano-processing fabrication, photonic crystal materials, Si-based optoelectronics

James J. Coleman
Semiconductor lasers, optoelectronics, epitaxial growth

Milton Feng
High-speed devices and ICs for wireless and optoelectronics (optoelectronic IC), monolithic microwave and millimeter-wave IC, digital IC, high field transport properties, RF-MEMS for wireless communications, advanced Si-CMOS device physics

Nick Holonyak, Jr.
Semiconductors, semiconductor device physics, semiconductor crystal growth and junction formation, diffused Si devices, SCRs, TRIACs, double injection, luminescence, light emitting diodes (LEDs), heterojunctions, lasers, tunnel diodes, compound semiconductors, quantum well heterostructures, superlattices, quantum well lasers, impurity-induced layer disordering, Al-based III-V native oxides and their use in heterostructures devices

Kuang C. Hsieh
Semiconductor materials/devices processing and characterization

Chang Liu
MEMS, microsensors, microintegrated fluidics systems, MEMS for nanotechnology, wireless interface for sensors, sensitive skin

Gregory Timp
Fabrication, development, and characterization of the performance of silicon MOS nanotransistors to discover the fundamental limitations of the silicon MOSFET; atomic physics and light pressure forces on single atoms for lithography applications; mesoscopic and nanostructure physics, including measurement of the low temperature transport characteristics of high electron mobility transistors that resemble electron waveguides Hopping (thermally-assisted tunneling) conductivity of localized electrons in a two dimensional impurity band formed in the inversion layer of a silicon metal-oxide-semiconductor field effect transistor (MOSFET); the effect of superlattices on lattice-dynamical properties of graphite intercolation compounds using Raman scattering, extremely high field magnetoresistors, Schubinkov-deHaas effect (using high resolution microscopy), high resolution x-ray scattering; nanometer-scale lithography to probe biological function

Advanced Processing and Circuits

AlGan/GaN HFET Fabrication and Characterization
I. Adesida,* V. Kumar, A. Kuliev
Triquint Corporation

Conducted in the Micro and Nanotechnology Laboratory

This project involves a collaboration with Triquint Corporation on the fabrication of AlGaN/GaN HFETs. Technologies for the fabrication of the HFETs will be developed.

Gallium Nitride Optoelectronics
I. Adesida,* L. Zhou
Defense Advanced Research Projects Agency, DAAD19-99-1-0011

Conducted in the Micro and Nanotechnology Laboratory

This project focuses on experimental issues for the fabrication of novel optoelectronic devices and circuits in gallium nitride and related materials. UV detectors, field effect transistors, and heterojunction bipolar transistors will be investigated. Methods for integrating these devices will also be explored.

Porous GaN: Production, Characterization, and Applications
I. Adesida,* P. Bohn,* X. Li,* S. Kim
U.S. Office of Naval Research, N00014-01-1

Conducted in the Micro and Nanotechnology Laboratory

This program involves the generation and characterization of porous GaN and SiC for applications in growth of high quality epitaxial layers. Matrices with dimensions down to 50 nm are to be achieved for the porous materials.

Processing of Gallium Nitride and Related Compounds
I. Adesida,* L. Zhou, F. Khan
ATMI/Air Force

Conducted in the Micro and Nanotechnology Laboratory

This program consists of the development of viable processing methods for gallium nitride and related compounds. A systematic study of etching techniques, ohmic contact formation, and other metallizations will be conducted and applied to devices.

Resonant Enhanced Modulators
I. Adesida,* S. Rommel
Air Force; Sarnoff Corporation

Conducted in the Micro and Nanotechnology Laboratory

This is a collaborative program with Sarnoff Corporation on resonant enhanced modulators in InP-based heterostructures. Waveguides with coupling rings are to be fabricated and characterized in InP-heterostructures. High precision patterning using inductively coupled plasma reactive ion etching and electron beam lithography will be used in fabricating the modulators.

Silicon Heterojunction Terabit Electronics
I. Adesida,* J. Tucker,* K. Ismail,* C. Faulkner, W. Lu, W. Lanford
Defense Advanced Research Projects Agency, N66001-97-1-8906

Conducted in the Micro and Nanotechnology Laboratory

This is an exploratory research project on advancing the performance of silicon-based field effect transistors. The utilization of shallow metal silicide Schottky source/drain and the use of strained Si/SiGe materials are two of the pathways being explored to realize ultrasmall (~ 25 nm) channel silicon-based heterojunction electronics capable of low power and terabit operation. This is a collaborative effort with IBM Corp. and Yale University.

*Denotes principal investigator.

Silicon-Germanium Modulation-doped Field Effect Transistors
I. Adesida,* K. Ismail*
National Science Foundation, ECS 97-10418

Conducted in the Micro and Nanotechnology Laboratory

This collaborative program with IBM Corp. is intended to significantly advance the growth and fabrication technologies for SiGe/Si modulation-doped field effect transistors (MODFETs) needed for low-power, high-speed microwave and digital applications. Specific goals are to study the physics of short gate-length p-type, n-type, and complementary MODFETs and to demonstrate simple circuits.

Ultra-High-Power GaN Power Amplifier at X-Band
I. Adesida,* W. Lu, D. Selvanathan
Air Force; TRW Corporation

Conducted in the Micro and Nanotechnology Laboratory

This collaborative project with TRW Corporation is to fabricate an ultra-high-power GaN-based HFET amplifier on SiC at X-Band. Various processing techniques for GaN will be developed as part of this project.

Electromagnetic Communication and Electronics Packaging

Design and Fabrication of MEMS Probe Station
J. Schutt-Ainé,* C. Liu, D. Lambalot
University of Illinois Research Board

Recent advances in microelectronics have led to considerable reduction in size of components in integrated circuits (ICs). Typical VLSI circuits have dimensions in the submicron range and feature size that can be as low as 0.25 microns. This reduction is a result of several requirements for higher density and shorter interconnection delays. Future state-of-the-art microprocessors will accommodate more than a million transistors in an area of a few hundred squared millimeters. Along with these trends, several issues related to signal integrity and testing have moved to the forefront. With submicron dimensions, interconnect resistance has become a major bottleneck in circuit performance, leading to signal degradation and delays. In addition, measurement and testing in submicron geometries, which allows for determining the performance of the structure, is a challenging task. Nowadays, the methods employed consist of fabricating special-purpose test vehicles for evaluation, which often require expensive mask processes and complex de-embedding schemes. This investigation proposes to implement a nondestructive testing methodology for submicron integrated circuits using the recent advances in microelectromechanical systems (MEMS). More specifically, we intend to fabricate and test a microprobe structure that will permit the high-frequency characterization of submicron interconnects and devices in integrated circuits.

High Frequency Devices

38-GHz Ion Implantation GaAs MESFET Technology Transfer Program
M. Feng,* J. Middleton, S. K. Hsia
Northrop Grumman Corp.; M/A-Com/Amp

Conducted in the Micro and Nanotechnology Laboratory

This project is aimed at the technology transfer of the University of Illinois 0.25 µm gate GaAs MESFET for 24-GHz and 38-GHz MMICs for LNA and VCO to M/A-Com. for low-cost production.

50-GHz Ion Implanted GaAs MESFET
M. Feng,* H. Hsia, Z. Tang, D. Beecher
TriQuint Semiconductor

Conducted in the Micro and Nanotechnology Laboratory

This program is to study the 50 GHz to 100 GHz ion implanted GaAs MESFET for millimeter-wave integrated circuit application.

50-GHz Ion-implanted Enhanced/Depletion/Power GaAs MESFETs
M. Feng,* H. Hsia, D. Becher, Z. Tang, J. J. Hwang, S. Shen
Network Device Inc.

Conducted in the Micro and Nanotechnology Laboratory

This project is to develop enhancement mode, depletion mode, and power mode (E/D/P) GaAs MESFETs operated at 50 GHz.

*Denotes principal investigator.

50-GHz Self-Aligned Gate MESFETs
M. Feng,* D. Becher, D. Caruth
Vitesse Semiconductor Corp.

Conducted in the Micro and Nanotechnology Laboratory

We have investigate Vitesse self-aligned gate MESFET for the analog applications in term of noise gain and power. We have compare performance with the University of Illinois re-aligned gate FET with Vitesse and to understand device improvement issues.

ADC Circuit Design on a Sigma-Delta Modulator
M. Feng,* M. Heins, D. Barlage
U.S. Army Research Office, DAAH04-96-0218
(Intel Fellowship)

Conducted in the Micro and Nanotechnology Laboratory

This project is aimed at design of 3 Gbit/s for an 8-bit ADC. Our first goal is to design the subcircuits library of comparator, sample, and hold circuit and OA design of an ADC.

AlGaAs/GaAs HBT Modeling
M. Feng,* P. Mares, M. Hein
Rockwell Microelectronics, Inc.

Conducted in the Micro and Nanotechnology Laboratory

This project aims to establish a useful SPICE model for HBT integrated circuits application. Our approach is based on 45-MHz to 50-GHz bias-dependent microwave data collection on an HBT device using HP-ICCAP. Temperature-dependent microwave data collection will be included in the model.

CAD Design Tools for an Integrated Millimeter-Wave Wireless Communication Microsystem
M. Feng,* S. C. Shen, J. J. Hwang, M. Heins
Defense Advanced Research Projects Agency, F30602-97-2-0328

In collaboration with C. Liu. Conducted in the Micro and Nanotechnology Laboratory.

We are developing CAD capabilities for a gigahertz wireless communication and distribution microsystems. We are also developing scalable MMIC modules with integrated MEMS components.

Development Materials for GaN-based Minority-Carrier Power Electronic Devices for Advanced DoD Systems
M. Feng,* J. Lai, K. Price
Defense Advanced Research Projects Agency, GaN Power Program (under UTA team-Prof. Russel Dupuis)

Conducted in the Micro and Nanotechnology Laboratory

This program is to study material interface of heterjunction, minority carrier transport property in GaN HBT system, since HBT provides high linearity and high efficiency power amplification.

Digital Radar Receiver
M. Feng,* J. Fendrich
Mayo Foundation; Defense Advanced Research Projects Agency

Conducted in the Micro and Nanotechnology Laboratory

This project performs the design and fabrication of an RF front end (400-700 MHz) fully tunable receiver system. We are working closely with the Mayo Foundation MIT-Lincoln Lab and Defense Advanced Research Projects Agency to build two brassboard RF receiver front ends for digital radar applications.

Direct Ion Implantation GaAs MESFETs
M. Feng,* H. Hsia, Z. Tang, D. Becher, S. Shen
GaAstronics Co.

Conducted in the Micro and Nanotechnology Laboratory

This project is to develop low-cost ion-implanted GaAs MESFETs for 5.8-GHz MMICs.

GaAs- and InP-based HBT Reliability
M. Feng,* D. Barlage, M. Heins
U.S. Army Research Office, DAAH04-94-0369

Conducted in the Micro and Nanotechnology Laboratory

This project is to set up an HBT reliability test. HBT reliability has become a major issue because of heterostructure interface and fast diffuse p-type impurities in both InP- and GaAs-based HBTs. We will test HBT devices from Rockwell, Hughes, and TRW for the basic failure mechanism.

*Denotes principal investigator.

GaN HBT Technology
M. Feng,* J. J. Huang
U.S. Navy, UTA 99-0302

Conducted in the Micro and Nanotechnology Laboratory

GaN has great potential to be a power source in millimeter wave ICs and high-speed electronics due to its large breakdown voltage and higher saturation velocity.
In collaborate with Prof. Dupuis at the University of Texas at Austin, we have fabricated GaN HBT with beta >100. There are many problems to be solved in terms of current and power efficiency issues at millimeter wave frequency.

High-Frequency Measurement Project on High-Tc Superconductor
M. Feng,* J. Fendrich, H. S. K. Hsia
National Science Foundation, DMR 89-20539

In conjunction with the Science and Technology Center for Superconductivity. Conducted in the Micro and Nanotechnology Laboratory.

This project has contributed to the study of BKBO and YBCO film characterization at microwave and terahertz frequencies. A parallel-plate resonator (10 GHz) was built to characterize sheet resistance in the microwave frequency. A noncontact coherent time-domain spectroscopy (THz) was used to characterize real and imaginary parts of conductivity. An on-wafer cryogenic microwave probing technique (1-40 GHz, 15-300K) is employed to establish patterned film scattering parameter. This work also aims to develop engineering model parameters using a GHz on-wafer probe technique.

Hybrid and Monolithic OEIC Receivers
M. Feng*
Defense Advanced Research Projects Agency, Center for Optoelectronics Science and Technology

Conducted in the Micro and Nanotechnology Laboratory

This project is aimed at hybrid integration of a PIN/GaAs transimpedance amplifier at 20 GHz operation. The monolithic IC is involved in design and fabrication of 4-channel OEIC receivers using GaAs MESFET technology.

InGaAs/InP BiFET for ADC Applications
M. Feng,* D. W. Seo, H. Hsia, Z. Tang
Defense Advanced Research Projects Agency, N66001-97-C-8618

Conducted in the Micro and Nanotechnology Laboratory

We have developed a 200-GHz InGaAs/InP HFET and integrated it with a 200-GHz HBT. Using this technology, we will construct a fifth-order Sigma-Delta ADC for a 16-bit and 3 FDR > 100 dbc.

InGaP HBT for ADC Applications
M. Feng,* D. W. Seo, J. Mu, M. Heins
Defense Advanced Research Projects Agency, N66001-96-C-8615

Conducted in the Micro and Nanotechnology Laboratory

We are developing an InGaP HBT device model (thermal and electrical model) for implantation into MDS and HSPICs. The second-order Sigma-Delta ADCs with 5 Gbits and 8-bit resolution has been designed, simulated, and fabricated.

Intelligent Vehicle Highway System Chip Sets (II) (IVHS)
M. Feng,* H. Hsia
Northrop Grumman Corp.

Conducted in the Micro and Nanotechnology Laboratory

This project is a follow-up of the TRP/DARPA contract based on the success of the University of Illinois 24-GHz and 38-GHz GaAs MESFET MMIC for LNA and VCO. The new contract is aimed at low-cost implementation of a 0.1 µm gate GaAs MESFET and MMIC by direct ion implantation for 77-GHz LNA and VCO collision avoidance radar.

Intelligent Vehicle Highway System Chip Sets (IVHS)
M. Feng,* P. Apostolakis, J. Middleton
Northrop Grumman Corp.

Conducted in the Micro and Nanotechnology Laboratory

This project is a joint development effort between the University of Illinois and Northrop Grumman Corp. on millimeter-wave IC chip sets for IVHS. We will design transmitter, receiver, mixer, and oscillator millimeter-wave ICs using co-planar technology. The mask and fabrication will use University of Illinois ion implanted, super-low-noise GaAs MESFETs, and a monolithic IC process.

*Denotes principal investigator.

Mechanically Conformal and Electronically Reconfigurable Aperture (RECAP) Using Low-Voltage MEMS and Flexible Membrane for Space-based Radar Applications
M. Feng,* J. Bernhard,* E. Michielssen,* C. Liu,* S. C. Shen, D. Becher
Defense Advanced Research Projects Agency, F33615-99-C-1519

Conducted in the Micro and Nanotechnology Laboratory

We will integrate wide-band reconfigurable aperture arrays with wide-band T/R functions on a flexible/rollable substrate in the 2-20 GHz range. We will investigate three reconfigurable arrays approaches (cavity-backed slot arrays, log periodic array, and coil-based spiral array) and develop a low-voltage MEMS switch suitable for integration on a flexible substrate.

Millimeter Wave Technology HBT and HFET
M. Feng*
Sumitomo Chemical America, Inc.

Conducted in the Micro and Nanotechnology Laboratory

We will design and fabricate MOCVD-grown, doped channel HFETs and InGaP and AlGaAs HBTs. We will characterize these devices and optimize their performance for 24- to 77-GHz applications.

Millimeter-Wave ICs and Packages
M. Feng*
Georgia Institute of Technology, NSF Package Research Center

Conducted in the Micro and Nanotechnology Laboratory

This project is to develop 38-GHz and 77-GHz coplanar MMICs for flip chip packages.

MOCVD HEMT Technology
M. Feng,* Z. Tang
Sumitomo Chemical America, Inc.

Conducted in the Micro and Nanotechnology Laboratory

We will investigate the performance of MOCVD grown P-HEMT and HEMT technology and its performance comparison between MESFETs and MBE-grown HEMTs.

Modeling of Flip Chip Interconnects for RF/Wireless
M. Feng,* J. Schutt-Aine
Georgia Institute of Technology, NSF ERC Package Research Center, SBC GIT E21-N50-G5

Conducted in the Micro and Nanotechnology Laboratory

The next generation of wireless personal communication links and wireless LAN and WAN will be focused in the millimeter wave range due to wide bandwidths and less interference effects. This work is to develop a low-cost solution of millimeter-wave MMICs flip chip technology. This work will provide the design, simulation, and process of MMICs operating at 38 GHz for a real application in point-to-point communication links. The Georgia Tech PRC will provide the flip chip package technology.

Monolithic Millimeter-Wave Integrated Circuits Technology
M. Feng*
Northrop Grumman Corp.

Conducted in the Micro and Nanotechnology Laboratory

This project is a joint effort with Northrop Grumman Corp. for developing 0.25 µm gate and 0.1 µm gate GaAs FET-based technology for the application in monolithic millimeter wave ICs (MMWICs). Based on the high-frequency device characterization, an equivalent circuit model will be generated. This model will then be used for MMWIC design. The fabrication of the MMWICs will be demonstrated.

Noise Characterization of Self-Aligned Gate GaAs MESFETs
M. Feng*
ITT Corp.

Conducted in the Micro and Nanotechnology Laboratory

This project aims to reduce the minimum noise figure on the direct ion-implanted self-aligned GaAs MESFETs based on the design of experiments in terms of dose and gate overlay.

*Denotes principal investigator.

Novel Giga Sampling Analog-to-Digital Conversion for Direct Digital Receiver
M. Feng,* D. W. Seo
National Science Foundation, ECS-9979341

Conducted in the Micro and Nanotechnology Laboratory

We proposed novel GHz ADC architecture, the folding and interpolation-based 15-bit subrange A/D converter, will reduce the transistor count by one-third and the area by 60%. The subrange ADC requires a very precise and wide-band track and hold amplifier to maximize input bandwidth to great than 2 GHz and converter resolution to greater than 15 bits.

Optical Correlation Spectroscopy Using Reconfigurable Diffraction Grating
M. Feng,* Q. He, K. F. Chen, J. J. Huang
Defense Advanced Research Projects Agency Center (DARPA) BOSS Program, MDA972-00-1-0020

Under Defense Advanced Research Projects Agency Center for Bio-Optical Sensor System. In collaboration with K. Y. Cheng. Conducted in the Micro and Nanotechnology Laboratory.

Sponsored by DARPA, the goal of this program is to develop a nano spectrometer for biological and chemical agents detection. Our group is to design and fabricate re-configurable grating using novel MEMS switch. It is capable of detecting 3-10 um wavelength.

Technology for Efficient, Agile Mixed Signal Microsystems
M. Feng,* R. Chan, K. F. Chen, W. G. Ho
Defense Advanced Research Projects Agency, TEAM Program

Under BAE Systems and collaboration with Greg Timp. Conducted in the Micro and Nanotechnology Laboratory.

The goal is to develop silicon RF CMOS with Ft and Fmax > 400GHz with 20 nm gate. The RF mixed signal circuits will be developed based the fastest RF CMOS technology.

Technology for Frequency Agile Digitally Synthesized Transmitter
M. Feng,* J. Lai, M. Hafez, M. Hampson, D. Chan, B. Chu-Kung
Defense Advanced Research Projects Agency TFAST Program

Under BAE Systems and Vitesse Semiconductor. Conducted in the Micro and Nanotechnology Laboratory.

The goal is to develop InP DHBT with Ft and Fmax > 500 GHz with sub-micron scaling of emitter size down to 0.1 micron. The technology is also required to demonstrate Flip-Flop speed over 200 GHz. A VLSI InP technology of over 10,000 transistor level of mixed signal Direct Digital Synthesizer (DDS) will be developed.

VCSEL and Smart Pixels for VLSI Photonics
M. Feng,* N. Holonyak, Jr., K. Y. Cheng, K. C. Hsia
Defense Advanced Research Projects Agency, DAAG55-98-1-0303

Conducted in the Micro and Nanotechnology Laboratory

This project is to develop oxide confined VCSELs at 85 nm and 1330 nm, as well as smart pixels for VSLI photonics.

Wavefunction Engineering of Individual Donors for Si-Based Quantum Computers
M. Feng,* R. Chan, C. Chuang
Defense Advanced Research Projects Agency, Quantum Computer Program, DAAD19-01-1-0324

In collaboration with John Tucker. Conducted in the Micro and Nanotechnology Laboratory.

The goal is to place individual phosphorus donors into silicon with atomic precision, demonstrate electronic control over wavefunction overlap, and characterize the spin singlet and triplet states of the two-electron system on couple donor pairs.

YBCO Superconducting Transmission Line Characterization
M. Feng,* J. Fendrich
Superconductor Technology Inc.

Conducted in the Micro and Nanotechnology Laboratory

This project studies the design rule of MCM using a superconductor as an interconnect line. Loss and phase delay are compared between gold and the superconductor line. Bit-error-rate and crosstalk will also be examined.

*Denotes principal investigator.

Optoelectronics

Fundamental Research on Infrared Photodetectors
S. L. Chuang,* Y. C. Chang,* K. Y. Cheng (Physics),* P. D. Coleman, R. Dupuis* (UT Austin), M. Feng,* N. Holonyak, Jr., H. C. Hsieh,* J. White*(MRL)
Army Research Office, Multidisciplinary Research Program of the University Research Initiative

This is a multidisciplinary university research initiative (MURI) program on the fundamental issues of infrared detection. We will focus on the following: investigation of HgCdTe defects using first-principles theory together with optical and electrical characterization, which includes nanotechnology characterization of both III-V and II-VI materials using the near-field scanning optical microscope (NSOM) and the transmission electron microscope (TEM); type II antimony-based quantum-cascade photodetectors; and quantum-dot infrared photodetectors (QDIPs) for high sensitivity normal incidence detection. We will also collaborate closely with industry and government laboratories.

High-Speed Wavelength-Agile Optical Network
S. L. Chuang,* I. Adesida,* K. Choquette,* S. Lumetta,* M. Medard* (MIT)
National Science Foundation

We propose to explore the architecture and device development issues necessary to develop optical Local Area Networks (LANs) that are ready to interface with optical metropolitan area networks (MANs). Our goal is to develop a clear plan for integration of multiwavelength LANs and MANs in order to improve the degree to which the benefits of high bandwidth in the MANs are delivered to end users on the LANs. Our tasks include the following: quantitatively evaluate the impact of wavelength conversion on network reliability and study the design of all-optical access architectures that leverage high-speed wavelength conversion and add/drop channel capabilities; design and fabricate tunable laser sources and wavelength converters using composite resonator vertical cavity lasers; design and fabricate a novel semiconductor-based wavelength converter capable of format-transparent and ultrafast wavelength conversion; and design and fabricate add/drop filters and photodetectors.

Power and Energy Systems

Fully Integrated Switch-Mode Power Supplies
P. L. Chapman,* C. Liu
Grainger Center for Electric Machines and Electromechanics

A typical switch-mode dc power supply involves several integrated circuits and discrete passive components. By moving all the circuitry to a single integrated circuit, the circuit is reduced in size and potentially cost. Power management and distribution within a chip are better enabled. Several versions of a step-up dc-dc converter have been demonstrated. Newer versions will take advantage of MEMS technology to improve the quality of the passive components and reduce the space occupied by the chip.

Semiconductor Lasers

1065 and 1040 nm DBR Laser Diodes
J. J. Coleman*
HRL Laboratories

Conducted in the Micro and Nanotechnology Laboratory

Narrow linewidth, tunable semiconductor lasers are of interest to a variety of applications, including fiber optic communication systems, optical generation of microwave radiation, remote optical sensing, and molecular spectroscopy. Various configurations of tunable lasers have been analyzed, and a two- or three-section distributed feedback (DFB) or distributed Bragg reflector (DBR) laser is often the choice. The goal of these programs is to develop narrow linewidth, single longitudinal mode, strained layer InGaAs DBR laser diodes operating near 1065 and 1040 nm for remote sensing applications.

Development of Advanced Laser Diode Sources for Remote-Sensing Applications
J. J. Coleman,* G. C. Papen*
National Aeronautics and Space Administration, NAG 1-1861

Conducted in the Micro and Nanotechnology Laboratory

Several outstanding technical issues for narrowband systems, such as water vapor DIAL lidars, must be resolved before solid-state, laser-based remote-sensing systems have widespread use. One issue is the development of cw local oscillators (LOs) based on

*Denotes principal investigator.

semiconductor laser diode technology for use as injection seeders, which has not been fully realized because of the severe linewidth, tunability, and stability requirements of narrowband systems. This project will develop novel semiconductor devices specifically for use as tunable LO sources for narrowband water vapor DIAL systems operating in the 940 nm region. Researchers will focus on a novel ridge-waveguide, distributed-Bragg-reflector laser, which has significant performance improvements for optical remote-sensing applications relative to conventional Fabry-Perot or distributed-feedback lasers.

EOSS+ Laser Diode Substrate
J. J. Coleman*
Northrop Grumman Corp.

Conducted in the Micro and Nanotechnology Laboratory

The electro-optic test station known as the EOSS+ is designed to support the testing of laser platforms at 1.064 mm through the use of a laser diode source. The characteristics of this diode, such as center wavelength and peak power, are determined by the capabilities of the test receiver and the design of the EOSS+ unit itself. The purpose of this program is to provide for the fabrication of a custom-built diode grown from a novel substrate designed to meet specification.

High Brightness Laser Diodes
J. J. Coleman*
Nuvonyx, Inc.

Conducted in the Micro and Nanotechnology Laboratory

The objective of this program is to address several issues related to the MOCVD growth and characterization of InGaAs-GaAs strained layer lasers in the range of 920 nm to 1080 nm for high brightness applications. This approach will be to develop a real index guided laser with integrated beam expanders and other active and passive optics formed by selective area epitaxy. Present narrow stripe semiconductor lasers are generally limited to less than 200 mW of fundamental mode output power, because of the narrow aperture. If the beam can be expanded while retaining fundamental mode operation, then the operating power can be correspondingly increased.

Narrow Linewidth, Multiple Wavelength, Simultaneous-Emission Laser Diodes for Remote Optical Sensing and Other Applications
J. J. Coleman*
National Science Foundation, ECS 9900258

Conducted in the Micro and Nanotechnology Laboratory

The proposal describes a program to develop multiwavelength, simultaneous-emission lasers based on a ridge-waveguide distributed Bragg reflector semiconductor laser. The specific example of an application that defines the need of such lasers is the differential absorption, remote optical sensing of water vapor. A multiwavelength source with closely spaced narrow laser lines would be useful to obtain the detailed absorption profile without having to turn the laser on and off the absorption peak as is practiced currently. This program is designed to study and develop a simple multiple wavelength source suitable for these kinds of applications.

Semiconductor Laser Transmitters for Integrated Optical Interconnects
J. J. Coleman*
National Science Foundation, ECD 89-43166

Conducted in the Micro and Nanotechnology Laboratory

This program involves development of semiconductor lasers suitable for use in integrated optoelectronics. There are a number of key technical issues to be addressed in this program, including the development of etched facet structures, distributed feedback and distributed Bragg reflector grating structures, monolithic space division multiplexing arrays designed for fiber coupling, selective epitaxy for wavelength division multiplexing arrays and for multielement integration, master oscillator-power amplifier (MOPA) configurations, frequency stabilization, and distributed Bragg pulse shaper high-speed parallel-to-serial packet encoders.

Naturally Nanostructured Epitaxial Semiconductors
J. M. Gibson,* D. G. Cahill, J. E. Greene, A. M. Zangwill, J. J. Coleman
National Science Foundation, DMR 9705440

Conducted in the Coordinated Science Laboratory

This FRG/GOALI proposal addresses basic materials science and engineering issues in a collaborative program between the University of Illinois and Hewlett-Packard Laboratories to understand fundamental phenomena and interactions associated with naturally nanostructured

*Denotes principal investigator.

epitaxial semiconductors. Goals of the project are to obtain semiconductor epitaxial nanostructures smaller than feasible via lithography and to examine their applications to novel devices. Strain-induced self-organization and kinetically driven pattern formation are two approaches being taken to achieve naturally nanostructured materials.

Semiconductors

Photoluminescence Studies of Semiconductor Nanostructures and Rare Earth-doped Semiconductor Materials
S. G. Bishop,* I. Adesida, J. J. Coleman, J. O. White
University of Illinois

Conducted in the Micro and Nanotechnology Laboratory

This research program applies photoluminescence (PL), photoluminescence excitation spectroscopy, time resolved PL, and PL imaging to the characterization of defects and impurities in bulk and epitaxial semiconductor materials, and the composition, doping, thickness, interfaces, uniformity, and quantum confinement effects in semiconductor nanostructures. Rare earth-doped semiconducting glasses and rare earth implanted GaN are being developed as sources of near- and mid-IR radiation. Excitation of the intra-4f shell emission from rare earth dopants (e.g. Er^{3+}, Pr^{3+}, Dy^{3+}) in chalcogenide glasses by broad band optical absorption in the Urbach edge of the host glass is under investigation as a novel optical pumping mechanism.

Bio-Optoelectronics Sensor Systems Center
K. Y. Cheng,* S. L. Chuang,* M. Feng,* N. Holonyak, Jr.,* K. C. Hsieh,* Z. P. Liang*
Defense Advanced Research Projects Agency, MDA 972-00-1-0020

Conducted in the Micro and Nanotechnology Laboratory

The goal of this center program is the development of integrated optoelectronic technologies, including materials, devices, integrated interferometers, optical microelectromechanical system (MEMS) spectrometers, and heterogeneous integration, that are critical to the realization of integrated and reconfigurable biological and biochemical sensor systems. Microspectrometer and interferometer-waveguide based optoelectronic biosensor systems will be developed to improve the size, cost, sensitivity, and signature resolution of the fieldable sensors for detecting biological and chemical entities in the environment in real-time through on-chip optical measurements.

GaAs-based Metal-Oxide-Semiconductor Structures
K. Y. Cheng,* K. C. Hsieh*
Agere Systems

Conducted in the Micro and Nanotechnology Laboratory

The goal of this research program is to develop oxide deposition techniques for the fabrication of GaAs-based metal-oxide-semiconductor field effect transistors (MOSFETs). Various oxides, including SiO_2, Al_2O_3, Ga_2O_3, and $Gd_3Ga_5O_{12}$ are deposited on GaAs in an ultrahigh vacuum system at Bell Laboratories to form MOS structures. Researchers will characterize their structural, optical, and chemical properties through transmission electron microscopy, photoluminescence spectroscopy, and Auger electron spectroscopy, respectively, to improve the oxide deposition process.

Ultra-High-Speed Heterojunction Bipolar Transistors
K. Y. Cheng*
Semiconductor Research Corporation, SRC-2001-NJ-946

Conducted in the Micro and Nanotechnology Laboratory

The goal of this research is to develop viable techniques that allow demonstration of Inp-based HBTs with fT>400GHz for insertion into the ultra-high-speed (>100 GHz) circuits.

VCSEL and Smart Pixel Research for VLSI Photonic Systems
K. Y. Cheng,* N. Holonyak, Jr.,* M. Feng,* K. C. Hsieh*
Defense Advanced Research Projects Agency, DAAG55-98-1-0303

Conducted in the Micro and Nanotechnology Laboratory

The purpose of this research is to develop technology related to VLSI photonic systems. The scope of the program ranges from basic materials research, to the fabrication of large-scale integrated circuits, to advanced technologies for the integration of systems in heterogeneous materials. Goals of the project include the design, growth, fabrication, and testing of III-V semiconductor vertical cavity surface-emitting lasers; the development of smart pixels, circuits for the detection of optical signals, intelligent routing of the information, and re-emission of optical signals; and the development of techniques for the integration of heterogeneous materials.

*Denotes principal investigator.

Nanometer-Scale Vertical Cavity Lasers
K. D. Choquette*
University of Illinois

Conducted in the Micro and Nanotechnology Laboratory

The development of ultracompact photonic light sources will be important for next generation applications in data communication, optical interconnects, and biological sensing. This program will develop extremely small volume vertical cavity surface emitting lasers (VCSELs) by incorporating photonic band gap structures within the laser active region. The objective of implementing strong transverse optical confinement is to establish single optical mode cavities with significantly reduced threshold operation. In addition, the artificially structured photonic gap may enable novel coupling schemes for coherent two-dimensional VCSEL arrays.

Spatially Multiplexed VCSEL/Receiver Optical Interconnect
Kent D. Choquette*
University of Illinois

Conducted in the Micro and Nanotechnology Laboratory

For high data rate transmission, spatial multiplexing of many optical channels will enable multiterabit/sec optical interconnects. The foundation of such a system will rely on two-dimensional arrays of transmitters and receivers, with a means of interconnection. This program will establish a spatially multiplexed interconnect testbed and characterize the performance of the system components. Arrays of 8x8 individually addressable vertical cavity lasers (VCSELs) with driver chips and matching arrays of metal/semiconductor/metal photodetectors monolithically integrated with MESFET amplifiers will be examined. A guided wave optical interconnect will be pursued utilizing an optical fiber image guide.

Materials Research for High-Performance Optoelectronic Devices Employing III-V Compound Semiconductor Native Oxide Layers
N. Holonyak, Jr.,* J. Miller
National Science Foundation, DMR-9612283; University of Texas-Austin

Conducted in the Micro and Nanotechnology Laboratory

The primary thrust of this program is the growth and characterization of heteroepitaxial materials employing native oxide layers. A variety of optoelectronic structures are being grown by MOCVD including AlGaAs/GaAs, InAlP/GaAs, and InAlP/InGaP double heterostructures. Currently under investigation are the minority carrier lifetime in the active regions, the interface recombination velocity between the active and oxide regions, and the effect of various oxidation conditions upon interface abruptness and impurity distributions. The results of this research will enable further advances in VCSEL (laser), field-effect transistor (MOSFET), and other technologies utilizing native oxide layers.

Surface Engineering for Compliant Epitaxy
K. C. Hsieh,* K. Y. Cheng,* I. Adesida
Defense Advanced Research Projects Agency, F49620-98-1-0496

Conducted in the Micro and Nanotechnology Laboratory

The goal of this research is to realize dislocation-free and stress-relaxed lattice mismatched epitaxy growth of different compound semiconductors on various substrates across the whole wafer or on selected areas for device integration applications. Our immediate goals include fundamental understanding of the growth conditions related to the formation of strained-modulated and defect-absorbing templates and the development of techniques to fully control the formation of strain-absorbing and deformable growth templates with an emphasis on processing simplicity and system integrability. InP-based optoelectronic and microwave devices will be integrated selectively on surface-engineered GaAs substrates.

Wafer Bonding for Advanced Optoelectronic Devices
K. C. Hsieh,* K. Y. Cheng
Defense Advanced Research Projects Agency, MDA 972-00-1-0020

Conducted in the Micro and Nanotechnology Laboratory

The goal of this research is to develop wafer-bonding technologies for hybrid integrating mismatched device structures for advanced optoelectronic integrated circuits. The potential applications include fabricating high-performance visible LEDs, vertical-cavity-surface-emitting lasers, resonant-cavity photodetectors, 2-D and 3-D photonic crystals, and high-performance semi-insulating wafer substrates. Our current efforts are focused on developing high-efficient wafer-bonding strategy and fundamental understanding of the hybrid interface properties, including interface microstructures, electrical and optical characteristics, interface strain/stress and adhesion properties, and so forth. The long-term goals will include developing chip-scale photonic/electronic integration methodologies for high-density 3-D architectures.

*Denotes principal investigator.

Biologically Inspired Artificial Haircell Sensors
C. Liu,* D. Jones, F. Delcomyn
Air Force Office of Scientific Research, F49620-01-1-0496

Conducted in the Micro and Nanotechnology Laboratory

This work is aimed at developing artificial haircell sensors that are inspired by biological haircell sensors. This work is focus on studying the fundamental principles of neurological responses of haircells and to develop micromachined devices that mimic the performance of biological entities.

CAD Design Tools for Millimeter Wave Wireless Communication Microsystems
C. Liu,* M. Feng, S. Kang, E. Michielssen, J. Schutt-Ainé
Defense Advanced Research Projects Agency, Composite-CAD Program, F30602-97-0328

Conducted in the Micro and Nanotechnology Laboratory

A mixed technology computer-aided design system is being developed for the cost effective design of wireless communication modules that will ultimately enable networked distributed MEMS. The module, operating at millimeter wave frequencies, will allow direct interface between MEMS transducers and the free-space electromagnetic radiation. MEMS components offer unique advantages for RF circuits. As an example, micromechanical switches exhibit lower insertion loss and higher isolation compared with conventional electronics switching components. MEMS fabrication technology for silicon and composed semiconductor materials is being studied in order to realize mechanical RF switches as well as high-gain antennas to validate results of the E-M simulation.

Efficient Computational Prototyping of Mixed Technology Microfluidic Components and Systems
C. Liu*
Defense Advanced Research Projects Agency

Conducted in the Micro and Nanotechnology Laboratory

The objective is to develop microfluid components (including pumps and valves), materials (including polymeric MEMS and biodegradable materials), and applications (including drug delivery systems). Microfluid circuits are on the scale of micrometer to millimeter; they are used to transport biological and chemical materials.

Integrated Biomimetic Sensors Using Artificial Hair Cells
C. Liu,* F. Delcomyn
National Aeronautics and Space Administration, NAG 5-8781

Conducted in the Micro and Nanotechnology Laboratory

The main focus of this work is to develop prototype micromachined artificial haircell (AHC) sensors that can be used as modular building blocks for a variety of sensors for sensing acceleration, flow rate, and tactile information.

Integrated Capillary Microelectrode Arrays for Studies of Olfactory Response Patterns in the Insect Brain
C. Liu*
Defense Advanced Research Projects Agency, Controlled Biological Systems Program

Conducted in the Micro and Nanotechnology Laboratory

This project aims to develop the first arrayed capillary microelectrodes using integrated microfabrication technology and to demonstrate the enhanced capabilities for monitoring neurological behavior of insect olfactory systems.

Integrated Sensing: Biomimetic Sensors for Autonomous Underwater Vehicles
C. Liu,* G. Karniadakis, C. Chryssostomidis
National Science Foundatioin, ECS 02-25S19

Conducted in the Micro and Nanotechnology Laboratory

A team of researchers from the University of Illinois and the MIT Ocean Engineering Department join efforts in developing artificial lateral line sensors for Autonomous Underwater Vehicles (AUV) that are useful for underwater exploration, warfare, and security. The lateral line sensor is a basic flow sensor for nearly all species of fish and many amphibian animals. We will develop micromachined underwater flow sensors with artificial haircells, shear stress sensors based on thermal transfer, and pressure sensors. Such sensors will be developed on a flexible substrate suitable for underwater applications.

*Denotes principal investigator.

Integrated Sensitive Skin with Advanced Data Architecture
C. Liu,* N. Shanbhag, D. Jones
National Science Foundation, IIS 00-80639

Conducted in the Micro and Nanotechnology Laboratory

An interdisciplinary team of researchers will develop microfabricated, multiple modality sensor skin with advanced data structure and signal processing algorithms. A flexible sensor skin that imitates biological tactile sensors faces important challenges in terms of microfabrication, materials, density of sensors, and accompanying circuits. Prof. Liu and students will develop advanced multimodal sensors with self-configuration capabilities. Prof. Shanbhag is developing energy efficient signal processors while Prof. Jones is interested in developing signal processing algorithms that are biologically inspired.

Mechanically Conformal and Electronically Reconfigurable Aperture (RECAP) Using Low-Voltage MEMS and Flexible Membrane for Space-based Radar Applications
C. Liu*
Defense Advanced Research Projects Agency

Conducted in the Micro and Nanotechnology Laboratory

The objective is to develop micromachined antennas with reconfigurible wavelength and directionality using micromachined switches. We are currently developing micromachining processes based on polymeric materials to realize three-dimensional RF MEMS.

CAREER: Biologically-Inspired Integrated Sensors for Robotics Applications
C. Liu*
National Science Foundation, IIS 99-84954 CAR

Conducted in the Micro and Nanotechnology Laboratory

This CAREER award is aimed at imitating biological haircell sensors that are widely used in the biological world. The research is focused on developing micromachined artificial haircell sensors for flow sensor applications.

Research Experience for Undergraduates (REU)
C. Liu*
National Science Foundation, IIS 99-84954 REU

Conducted in the Micro and Nanotechnology Laboratory

This grant provides undergraduate students with opportunities to conduct advanced research projects in C. Liu's research group.

Nanoscale Science and Engineering Center (NSEC): Center for Integrated Nanopatterning and Detection Technologies
C. Mirkin (Northwestern University), C. Liu, S. Sligar, G. Shartz, M. Ratman, M. Hersam, and others
National Science Foundation, SBC NW 0830-520-N602

Conducted in the Micro and Nanotechnology Laboratory

This is an NSEC center project in which more than 20 faculty members located at Northwestern University, the University of Illinois, the University of Chicago, and others are participating. The central objective of this center is to develop intergrated anopatterning technologies. The major thrusts in this project are nanopatterning techniques, optical chemical sensors, and microfluid platforms for biological detection. The C. Liu group works in the first and third areas.

Parallel, Ultrafast Sub-100 Nanometer Dip-Pen Nanolithography
C. Mirkin, (Northwestern Univ.) C. Liu*
Defense Advanced Research Projects Agency, Army NW 0650-300F245

Conducted in the Micro and Nanotechnology Laboratory

The Dip Pen Nanolithography (DPN) method is uniquely capable of directly patterning chemicals onto substrates with sub-100 nm spatial resolution. It is a powerful technique for depositing materials for surface chemistry. However, the DPN method typically relies on single probes and is serial in nature. In this work, we develop highly parallel arrayed DPN probes using micromachining techniques. Both passive and active probes are being developed. The active probes can be lifted individually. The actuation is based on thermal bimetallic bending or piezoelectric bending.

*Denotes principal investigator.

Solid State Devices

Luminescence and Laser Studies in III-V Semiconductors
N. Holonyak, Jr.,* J. Wierer, D. Kellogg
National Science Foundation, ECS 82-00517

Conducted in the Micro and Nanotechnology Laboratory in conjunction with the Department of Physics

Heterojunctions in $Al_xGa_{1-x}As$-GaAs and related materials are being examined. Quantum size effects have been observed and have led to single and multiple active layer quantum-well diode light emitters and lasers. Stimulated emission, absorption, disorder, alloy clustering, carrier scattering, phonon processes, tunneling effects, and impurity diffusion in these structures are being studied. Impurity-induced disordering and Al-bearing native oxides are being studied and used to form stripe-geometry lasers and more complicated array structures. Quantum well lasers have been operated in an external grating cavity in an extended wavelength range. Newer forms of quantum-well lasers have been realized, including native-oxide-defined lasers and waveguides.

Quantum-Well Heterostructures
N. Holonyak, Jr.,* J. Wierer, D. Kellogg
National Science Foundation, DMR 89-20538

Conducted in the Micro and Nanotechnology Laboratory in cooperation with the Department of Physics and the Materials Research Laboratory

The fundamental properties of III-V heterostructures grown by vapor phase epitaxy are being studied. On quantum-well MOCVD AlGaAs-GaAs heterostructures, laser operation 400 meV above E_g(GaAs) has been observed, the first cw 300 K laser operation has been achieved, laser operation on phonon-sidebands below the confined-particle states has been observed, and alloy disorder and clustering in quantum-well heterostructures have been identified. Impurity-induced disordering of quantum-well heterostructures and Al-bearing native oxides, that is, the native oxide of $Al_xGa_{1-x}As$ formed at 400° to 500°C with $H_2O + N_2$, are being examined via TEM and photoluminescence studies. This project is the first (1977) to realize p-n quantum-well lasers and to coin the name “QW lasers.”

Thin Films and Charged Particles

Epitaxial Growth and Characterization of GaN-based Nitride Semiconductors Using Plasma-assisted Molecular Beam Epitaxy for Development of High-Speed, High-Power Heterostructure Electronic Devices
K. Kim,* I. Adesida,* S. J. Hong, T. Day, C. W. Park
ETRI Electronics, Inc.

The dual objectives of this work are to grow and characterize device-quality heterostructure GaN-based films and use them to develop high-speed, high-power electronic devices. The materials growth is achieved using a plasma-assisted molecular beam epitaxy system designed and fabricated at the University of Illinois. The plasma source is capable of producing contamination-free nitrogen plasmas. The films are characterized using a variety of microanalysis techniques including RHEED, XRD, SEM, TEM, AFM, PL, CL, SIMS, and Hall measurement.

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Pickrell, G. W. **Compliant epitaxy of III-V compound semiconductors for optoelectronic device applications.** Ph.D. thesis, K. Y. Cheng, advisor (2002).

Awards and Honors

Ilesanmi Adesida
Scientific Member, Bohmische Physical Society
Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Engineering Council Advisors List for Outstanding Advising, University of Illinois, 1993, 1999
Oakley-Kunde Award for Excellence in Undergraduate Education, University of Illinois, 1994
Best Paper Award, Micro- and Nano-Engineering Conference, 1996
Distinguished Lecturer, IEEE Electronic Device Society, 1977-1999
University Scholar, University of Illinois, 1997, 1999
Associate Member, Center for Advanced Study, 2000-2001

Keh-Yung Cheng
Andersen Consulting Award for Excellence in Advising, University of Illinois College of Engineering, 1994
Engineering Council Advisors List for Outstanding Advising, University of Illinois, 1995, 1997, 1998
Fellow, Institute of Electrical and Electronics Engineers (IEEE), 2001

Kent Choquette
Senior Member, Institute of Electrical and Electronics Engineers (IEEE)/Laser and Electro-Optical Society
Distinguished Lecturer, IEEE/Laser and Electro-Optical Society, 2000-2001

James J. Coleman
Fellow, American Association for the Advancement of Science
Fellow, American Physical Society
Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Fellow, Optical Society of America
IEEE LEOS William Streifer Scientific Achievement Award
Distinguished Lecturer, IEEE, 1997-1998, 1998-1999
Franklin Woeltge Professorship, University of Illinois Electrical and Computer Engineering Department, 2002

Milton Feng
Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Fellow, Optical Society of America
Ford Aerospace Corporate Technology Award, 1988
Beckman Research Award, University of Illinois, 1993
Engineering Council Advisors List for Outstanding Advising, University of Illinois, 1995, 1996, 1998
Best Paper Award, IEEE/International Electronic Manufacturing Technology Symposium, 1995
David Sarnoff Award, Technical Field Award, Institute of Electrical and Electronics Engineers, 1997
Associate Member, University of Illinois Center for Advanced Study, 1998
Outstanding Research Award, Dr. Pan Wen Yuan Foundation, Taiwan, 2000
Nick Holonyak, Jr. Professorship, University of Illinois, 2000-2005

Nick Holonyak, Jr.
Fellow of American Association Advance Science
Member, National Academy of Engineering
Member, National Academy of Sciences
Fellow, American Academy of Arts and Sciences
Life Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Fellow, Optical Society of America
Fellow, American Physical Society
Member, Center for Advanced Study, University of Illinois
Cordiner Award, General Electric Co., 1962
Morris N. Liebmann Award, IEEE, 1973
John Scott Medal, City of Philadelphia, 1975
First GaAs Symposium Award with Welker Medal, 1976
Jack A. Morton Award, IEEE, 1981
Solid-State Science and Technology Award, Electrochemical Society, 1983
Sigma Xi Monie A. Ferst Award, 1988
Edison Medal, IEEE, 1989
National Medal of Science, 1990
Charles H. Townes Award, Optical Society of America, 1992

Honorary Doctor of Science, Northwestern University, 1992
Honorary Member, Ioffe Physical-Technical Institute, St. Petersburg, Russia, 1992
Award for the Industrial Application of Science, National Academy of Sciences, 1993
American Electronics Association 50th Anniversary Award, “Inventing America’s Future,” 1993
Centennial Medal, American Society for Engineering Education, 1993
John Bardeen Chair Professor of Electrical and Computer Engineering and of Physics, University of Illinois,1993-
Honorary Doctor of Engineering, Notre Dame University, 1994
National Medal of Technology, 2002

Chang Liu

Academician, Academia Sinica, 1998
Faculty Early Career Development Program (CAREER) Award, National Science Foundation, National Science Foundation, 2000