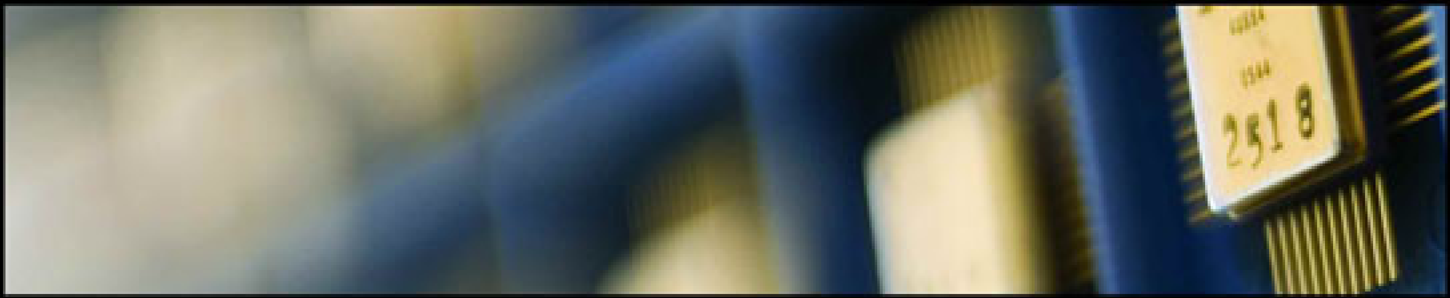
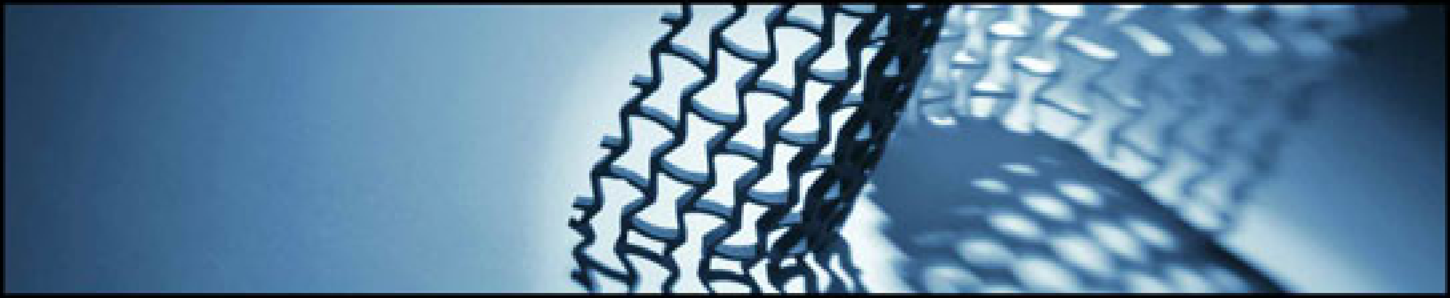
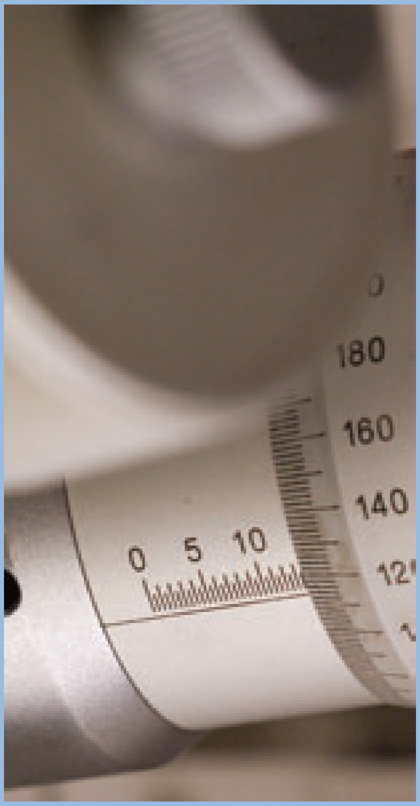


HRL LABORATORIES, LLC

2005 ANNUAL REPORT



TECHNOLOGIES CREATING OPPORTUNITIES



2005

CONTENTS

HRL LABORATORIES

VISION

To enhance our position as a world-class R&D Lab and become:

- Increasingly valued by our LLC Members, customers, and employees
- Increasingly respected by our peers in the scientific community

ANNUAL REPORT

MISSION

To create sustained competitive advantages for our LLC Members and customers by:

- Developing innovative technical solutions that:
  - Solve important, technically challenging national and global problems
  - Create significant value for our customers
- We will accomplish this by
  - Attracting and maintaining world-class technical talent and leadership
  - Serving the needs of our government customers
  - Working together to accelerate transfer of technology solutions

Welcome

to this, the 2005 Annual Report for HRL Laboratories, LLC, a world-class industrial research laboratory with an outstanding legacy and an even brighter future. HRL is owned jointly by the Boeing Corporation and the General Motors Corporation, our LLC Members. We continue to provide leading edge R&D services to our parent companies and to both government and commercial customers.

HRL's mission is to provide sustained competitive advantages for our LLC Members and customers by developing innovative technology-based solutions. We solve important and technically challenging problems and, by working closely with our customers, ensure that our technologies are smoothly integrated. Our unique joint ownership model allows our parent companies to find synergies and leverage the resources of both our LLC Members and our other customers.

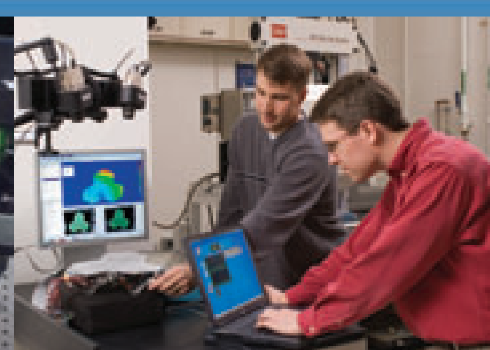
Dr. Conilee Kirkpatrick
Vice-President

We made very significant progress in many of our traditional technology areas this year and we started several new and exciting programs. In 2005, we set performance records in digital and analog microelectronics, photonics, infrared detector materials, MEMS, antennas, energy technologies, quantum electronics, and other areas. We also had many significant accomplishments in emerging areas such as cognitive computing, nanowires and nanotubes, active structural materials and, bio- and bio-inspired materials and systems. Our proprietary developments in nanotechnology and bio-inspired technologies are particularly exciting.

People are HRL's most important resource, and we continually strive to upgrade our staff through effective hiring and first-rate professional management and training practices. Approximately 95 percent of our technical staff have an advanced degree with more than 70 percent holding a Ph.D. Recognizing an increasing need to strategically focus our technologies, we have created a new Program Development organization, to better match our technologies to key market needs. We have also expanded our staff and management training programs in order to provide career growth for our staff and to better serve the needs of our customers. These programs include a disciplined process to guide our investment in and marketing of our newest ideas and technologies.

We continue to work with a variety of government and commercial customers. Our base of governmental work has broadened with the addition of several small, but very important, new programs from new customers. We have also expanded the size and scope of our commercial work. In particular, we are finding very significant market demand for many of our millimeter wave electronic products and we have become the supplier of

Technologies Creating Opportunities



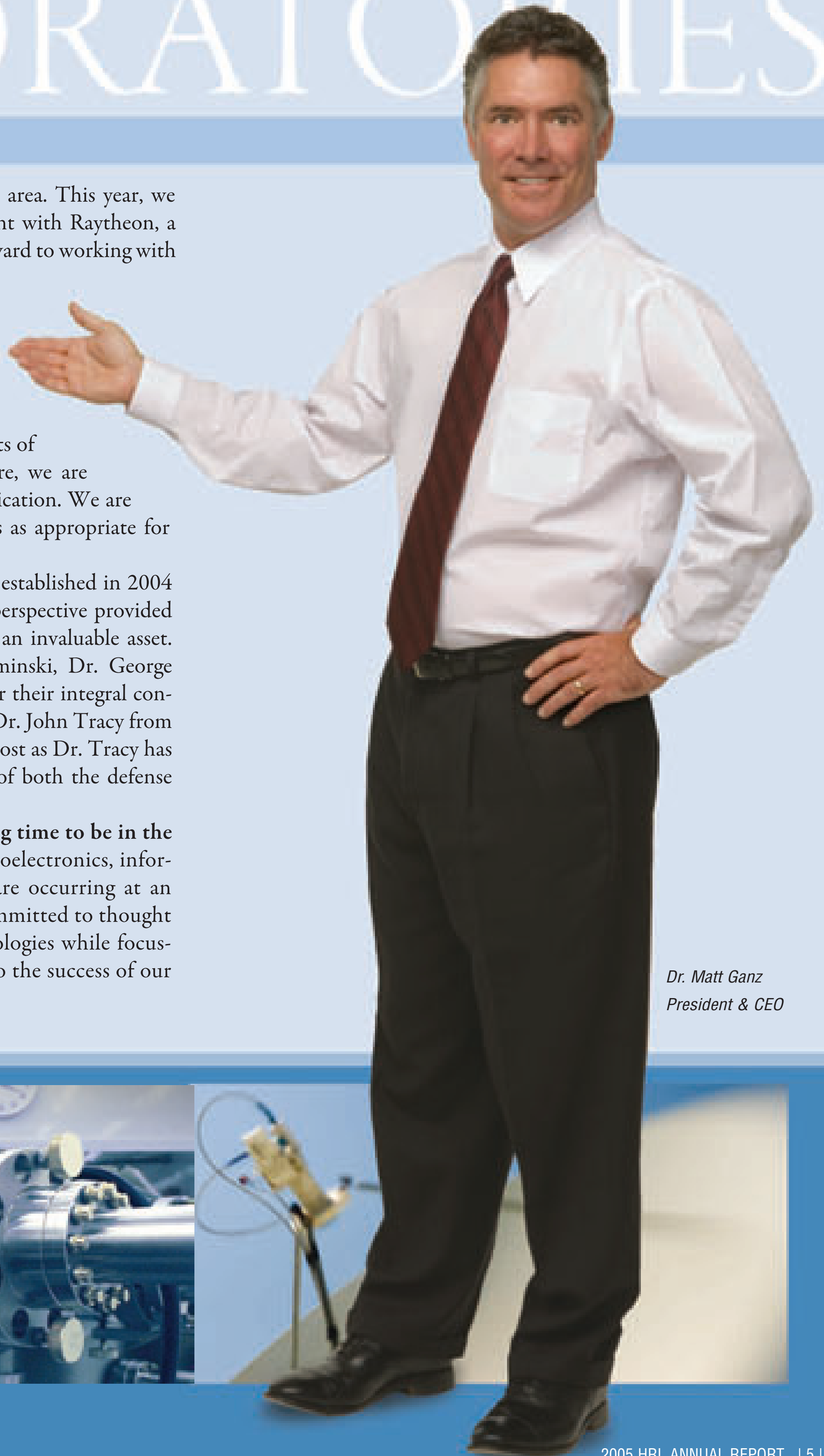
LABORATORIES

choice for many key components in this area. This year, we also signed a major commercial agreement with Raytheon, a former HRL LLC Member. We look forward to working with Raytheon as a key customer in the future.

We recognize the importance of producing a quality product on time and within budget. We continue to improve both our internal processes and standards in order to stress delivery of quality products. For those departments of the company that deliver flight hardware, we are well on our way to AS9100 quality certification. We are also planning to tailor AS9100 processes as appropriate for other departments within the company.

The new governance model that we established in 2004 continues to be successful. The outside perspective provided by our external board members remains an invaluable asset. We would like to thank Dr. Paul Kaminski, Dr. George Heilmeier and Dr. George Whitesides for their integral contributions. The addition to our board of Dr. John Tracy from Boeing has also given the board a great boost as Dr. Tracy has tremendous insight into the operations of both the defense and commercial divisions of Boeing.

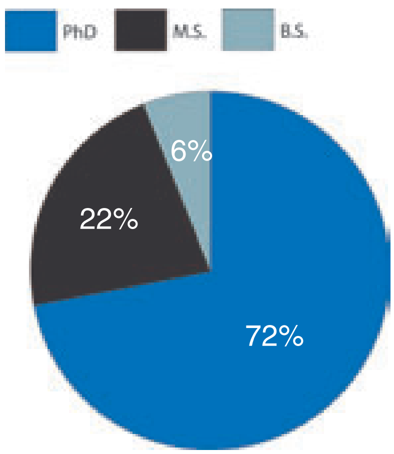
There has never been more exciting time to be in the technology business. Advances in microelectronics, information sciences, and the life sciences are occurring at an unprecedented rate. At HRL, we are committed to thought leadership across a wide range of technologies while focusing in those areas that are most linked to the success of our LLC Members.



Dr. Matt Ganz
President & CEO

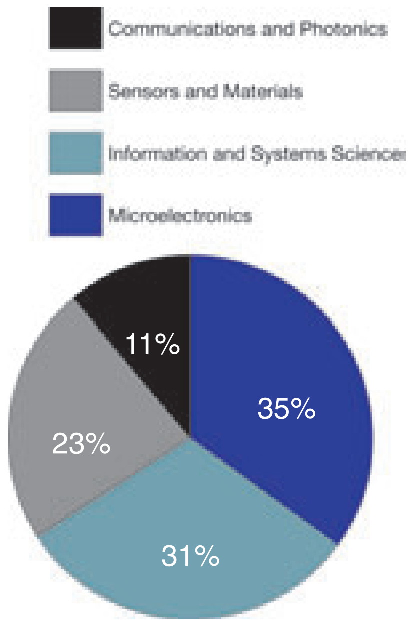

HRL LABORATORIES

HRL in NUMBERS



TECHNICAL STAFF EDUCATION AT HRL

INNOVATIONS THAT LEAD TO SUCCESS



TECHNICAL WORKFORCE DIVISION

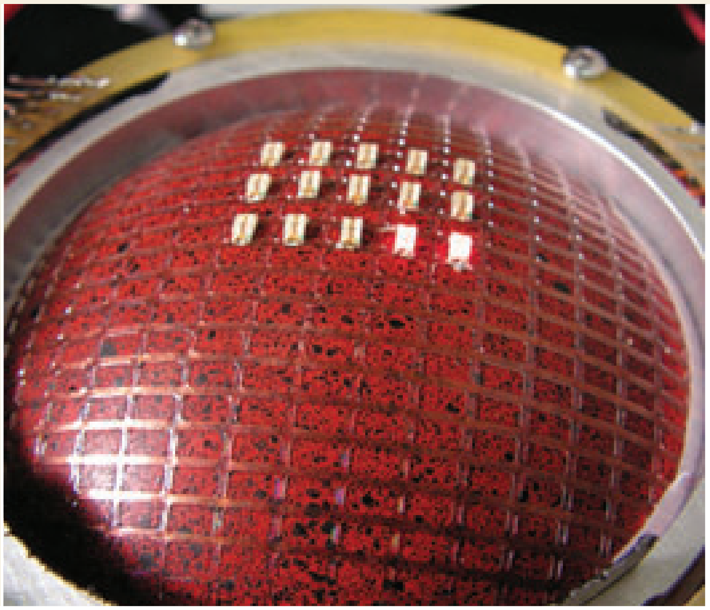
HRL LABORATORIES CLIMBS IN PATENT RANKING

The Patent Scorecard 2006 issued by the Intellectual Property, Intelligence Quotient (ipIQ) identified HRL as **"A Company of Excellence"** in its Industrial Equipment & Materials grouping of industries. As described in the Patent Scorecard, **"The research and development derived from [HRL] may well drive this industry to new levels of innovation."**

The Patent Scorecard is an industry-by-industry ranking of companies based on innovation metrics. It analyzes several decades of patent data collected on over 50,000 companies across 14 industries. Among the metrics are Science Linkage, which measures cutting-edge technology, and Current-Impact Index, which reflects how often a company's patents are used as the basis for other innovation. In both of these metrics, HRL was well above the industry average.

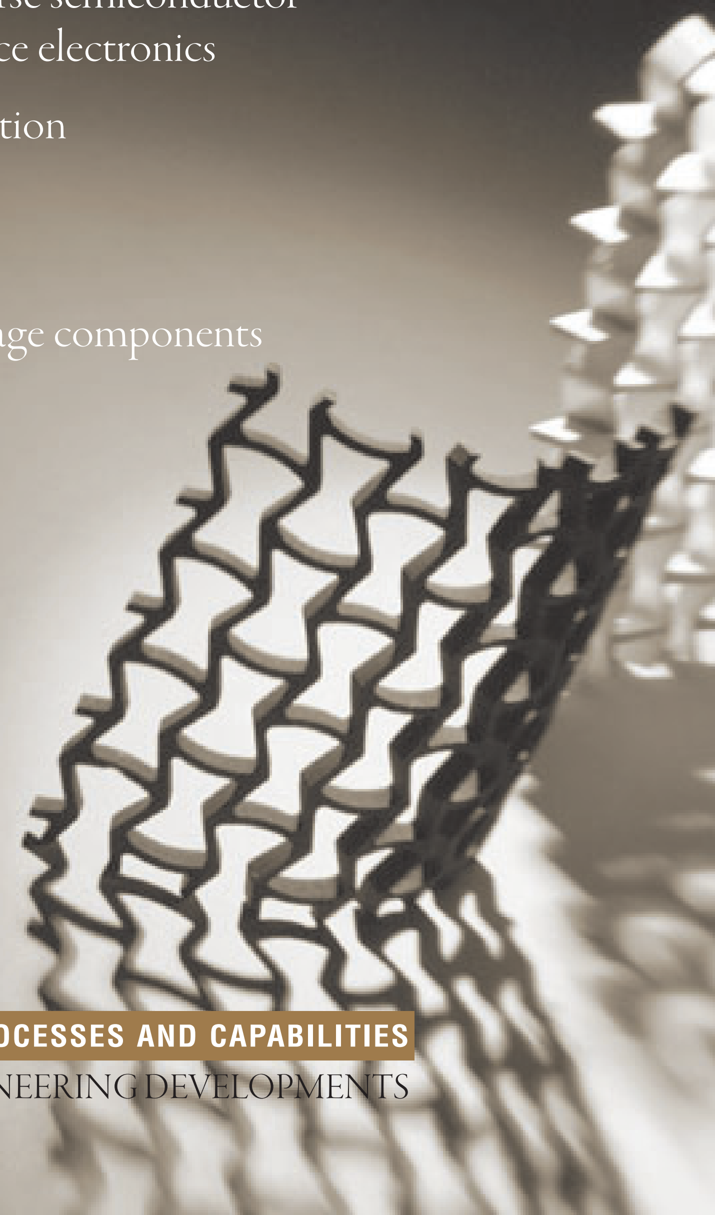
In addition, HRL's Technology Cycle Time metric, which measures the speed in turning research into Intellectual Property, was clearly competitive. As a consequence of these metrics, HRL's ranking on the Patent Scorecard moved to 17th in the Industrial Equipment & Materials industry group for 2005, up from 39th in 2004. Companies within this group include General Electric, Mitsubishi Electric, and Honeywell.

The ipIQ is a Chicago-based entity that focuses on advancing patent-based intellectual property as a measurable financial asset and integrating intellectual property into corporate decision-making, including evaluating mergers and acquisition and identifying areas for capital investment.



HRL is engaged in the creation, demonstration, and transition of emerging materials and chemistry technologies to enable new functionality and system efficiencies for next-generation products and platforms. Staffed with talented chemists, physicists, and engineers, our materials technology portfolio leverages our strengths in novel electronic materials, surface and electrochemistry, and mechanically active materials (materials that can transform from flexible and compliant to rigid to impart motion or force).

- Morphing materials for adaptive mechanical structures
- Novel mechanical actuators for distributed structural control
- Heterogeneous monolithic integration of diverse semiconductor technologies for high-density, high-performance electronics
- Nanoscale electronic materials for next-generation quantum and spin electronics
- Solid state hydrogen storage materials
- Electrochemical analysis of critical energy storage components for system level energy management
- Materials and device theory and simulation



ADVANCED MATERIALS

HRL HAS DEVELOPED A PORTFOLIO OF INNOVATIVE PROCESSES AND CAPABILITIES

The breadth of the technologies we are now developing includes morphing materials used in mechanical structures that can adapt their shape to different conditions; mechanical actuators for distributed structural control; integration of various emerging semiconductor technologies into high-density, high-performance electronics; nanoscale materials for next generation electronics; chemically engineered hydrogen storage materials; analysis of energy storage components for system level management; and material and device theory and simulation.

THE MULTIPLE USES OF NANOTECHNOLOGY

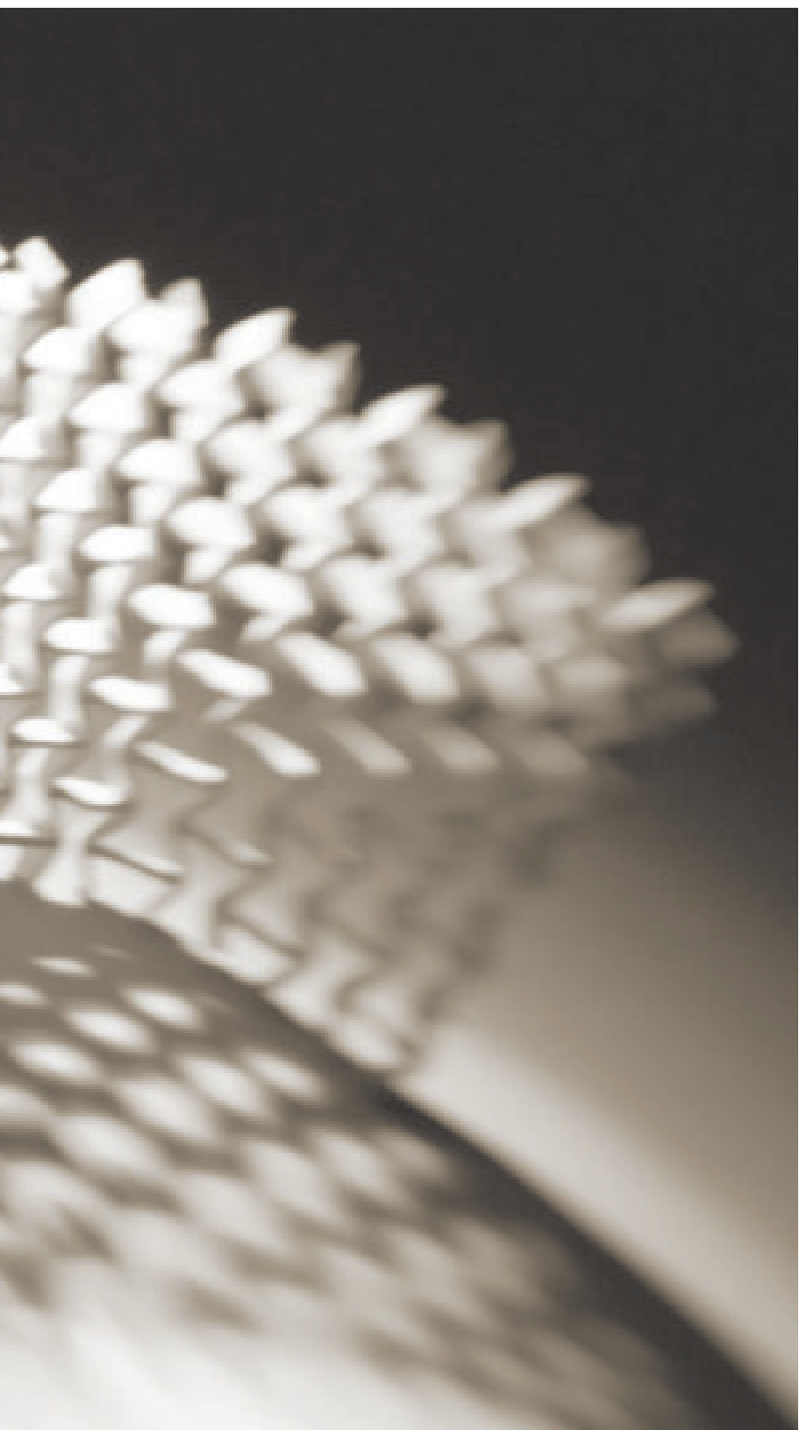
In the area of emerging technologies, we continue to pursue the integration of new materials made possible through nanotechnology, biomimickry (using materials imitating those processes found in nature), and biomediation (using biological agents for a variety of tasks). With nanotechnology, HRL is now also able to boost the performance of heat transfer fluids and influence gas phase reactions.

In the area of active and structural materials, HRL has pioneered the development of variably stiff composites, the foundation of on-demand structural control. Here, material behavior can be switched between structurally stiff and readily moldable states and can be tailored for ultra high strain applications. HRL has developed novel high-strain, high-force mechanisms with superior energy density for ultra-compact actuation. These new mechanisms allow small actuation elements to be embedded and distributed for control.

HRL's expertise in molecular beam epitaxy (MBE) of compound semiconductor materials–a method of thin-film deposition–is the basis for exploring new structures and concepts for future directions in electronic and electro-optic device applications. In newly engineered materials patterned with nanoscale lithography, different states of electrons are employed instead of the traditional method of applying electric current. The up or down "spin" state of an electron can be used to store information, as can its "quantum" state. These concepts can be exploited for high-speed, low-energy, and non-volatile computing components of the future. In addition, HRL has developed a portfolio of innovative processes to allow integration of arrays of high performance electronic elements on a common platform. These tools can be exploited to enable new capabilities such as ultra high-density wafer scale packaging, integrated thermal management, and embedded electronics on flexible skins and surfaces.

NEW APPROACHES

To meet the challenges of energy storage and generation, HRL is exploiting novel thermodynamic approaches and nanomaterials for on-vehicle hydrogen storage. Two of the major limitations of practical hydrogen storage are the speed at which hydrogen can be stored and released, and the energy expended in doing so. HRL is addressing those two issues through the use of artificially manipulated nanostructures and alloy destabilization. Our extensive knowledge of electrochemical systems, combined with state-of-the-art diagnostic tools, provide a capability that is leveraged by our LLC Member colleagues to develop energy management algorithms and reliability predictions for future systems.<<<



EMERGING TECHNOLOGIES IN THE FIELD OF ADVANCED MATERIALS

■ HRL continues to pursue the integration of new material advances, particularly through the use of nanotechnology, biomimickry, and biomediation. HRL has exploited nanotechnology to boost the performance of heat transfer fluids and to increase the kinesis of gas phase reactions.

HRL's Information and Systems Sciences Laboratory (ISSL) is developing innovative technology in video image processing exploitation, radar data and image processing, data and information fusion, and data mining. A contract from the Defense Advanced Research Projects Agency (DARPA) has enabled HRL to launch Biologically Inspired Cognitive Architecture for Integrated Learning, Action, and Perception (BICA-LEAP). BICA-LEAP involves emerging technologies that move us a step closer to mimicking brain-like architecture functionality in intelligent machines and systems. The BICA-LEAP project includes the development of useful, practical algorithms inspired by human brain research for computer vision, audio processing, robot motion, and learning and reasoning.

SWARMVISION

In recent years, HRL has focused on developing and maturing our video processing technology. Our most mature technology–SwarmVision–encompasses a variety of interesting applications, which include visual object recognition and tracking; video analysis without motion or background estimation; and behavior recognition.

HRL developed SwarmVision as a video content analysis software package consisting of various modules installable on PCs running Microsoft Windows 2000 or XP. It is designed for integration into OEM surveillance or other video-based systems and can be customized for specific needs. SwarmVision modules can add supplemental capabilities to OEM systems, such as automatically detecting, tracking, and classifying specific types of objects in video, such as people, cars, and boats, as well as detecting specified simple behaviors involving those objects. SwarmVision can be used for analyzing live or archived video from fixed cameras, as well as from moving mobile, pan/tilt/zoom, and airborne cameras.

Applications of SwarmVision

SwarmVision uses computer vision algorithms derived from years of HRL research for commercial and defense customers. The system is modularized and was developed using proprietary technology, resulting in a scalable, parallel implementation of the algorithms. The term "SwarmVision" was chosen because the software employs principles from the biology of swarms and combines with other proprietary, vision-based object classifiers that are both fast and accurate. The software offers superior performance under changing lighting conditions and moving backgrounds to identify potential threats, actively notify the user, and send only relevant video content while virtually eliminating false alarms. Unlike other video analysis approaches, SwarmVision does not use motion segmentation to recognize objects. This makes our software more accurate, more flexible, and suitable for a wider variety of surveillance applications.

An important advantage of SwarmVision is that its video analysis algorithms are implemented as software modules designed for parallel operation. This allows modules to transparently take advantage of multiple processors and multi-core processors to achieve increased performance even on inexpensive personal computers. The end result is an easily scalable system and maximum flexibility to satisfy OEM requirements.

In summary, key features of SwarmVision include its ability to classify and keep track of stationary or moving humans and vehicles in front of stationary or moving backgrounds, using either visible light or infrared

ALGORITHMS & INFORMATION

INSPIRED BY HUMAN BRAIN RESEARCH FOR LEARNING AND REASONING

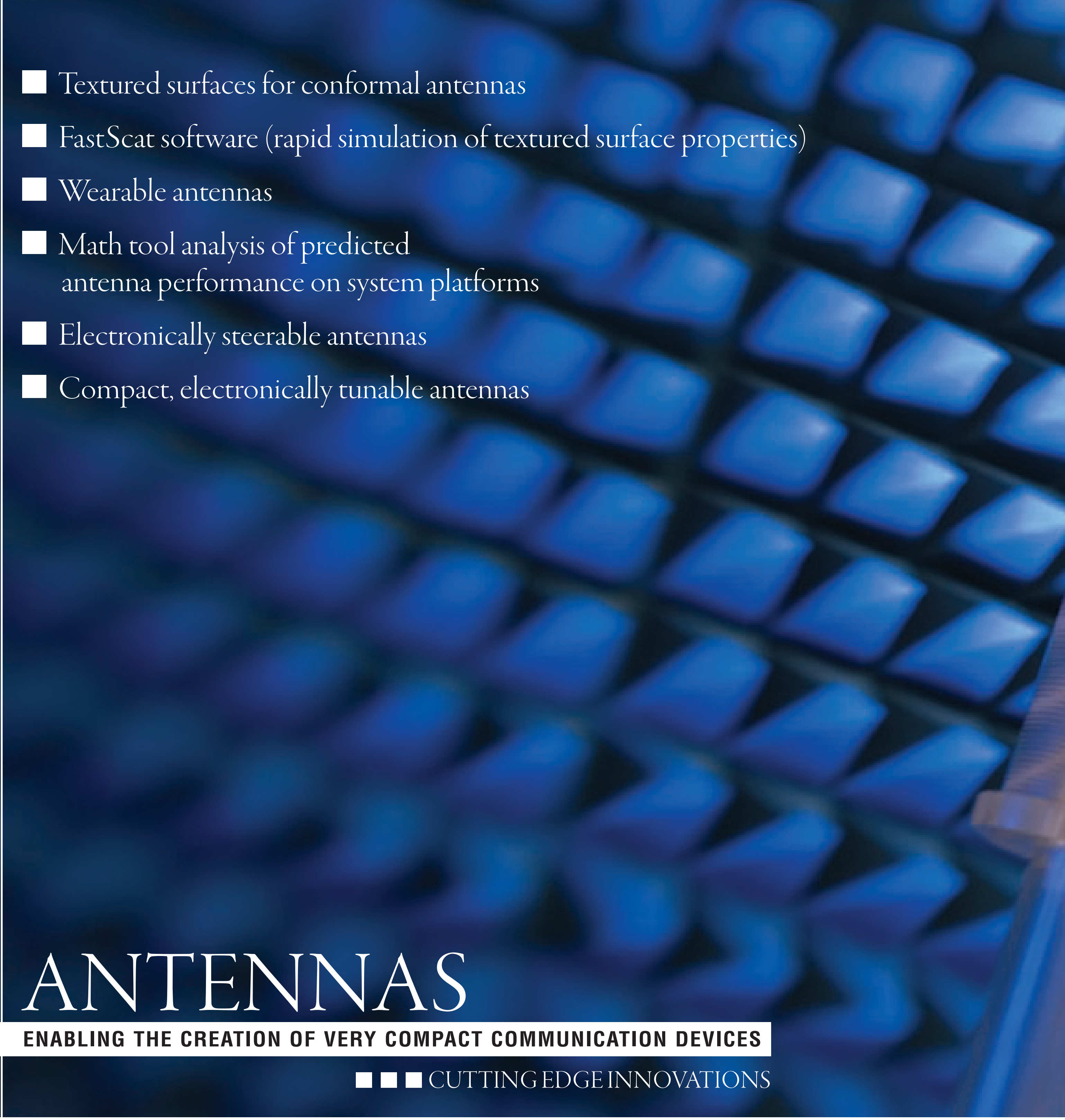
■ ■ ■ DEVELOPING AND MATURING TECHNOLOGY

- Data mining
- Video image processing exploitation
- Radar data and image processing
- Data and information fusion

cameras, and performing with high accuracy and a minimum of false alarms. A SwarmVision installation can be scaled for higher performance or handling of more cameras by using multiple processors, multi-core processors, or computer clusters. The system can also be set to generate alerts for specified simple behavior involving multiple detected objects. Finally, the modular SwarmVision software architecture allows for rapid development of additional functionality for customized OEM requirements.

LOOKING TO THE FUTURE

Future modules will add the ability to detect complex behaviors based on combinations of simple behaviors. We also have encouraging preliminary results in providing "human-like" identification of potentially important areas of arbitrary video images. <<<

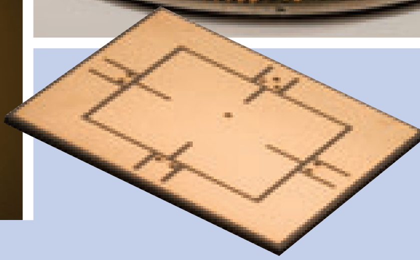


- Textured surfaces for conformal antennas
- FastScat software (rapid simulation of textured surface properties)
- Wearable antennas
- Math tool analysis of predicted antenna performance on system platforms
- Electronically steerable antennas
- Compact, electronically tunable antennas

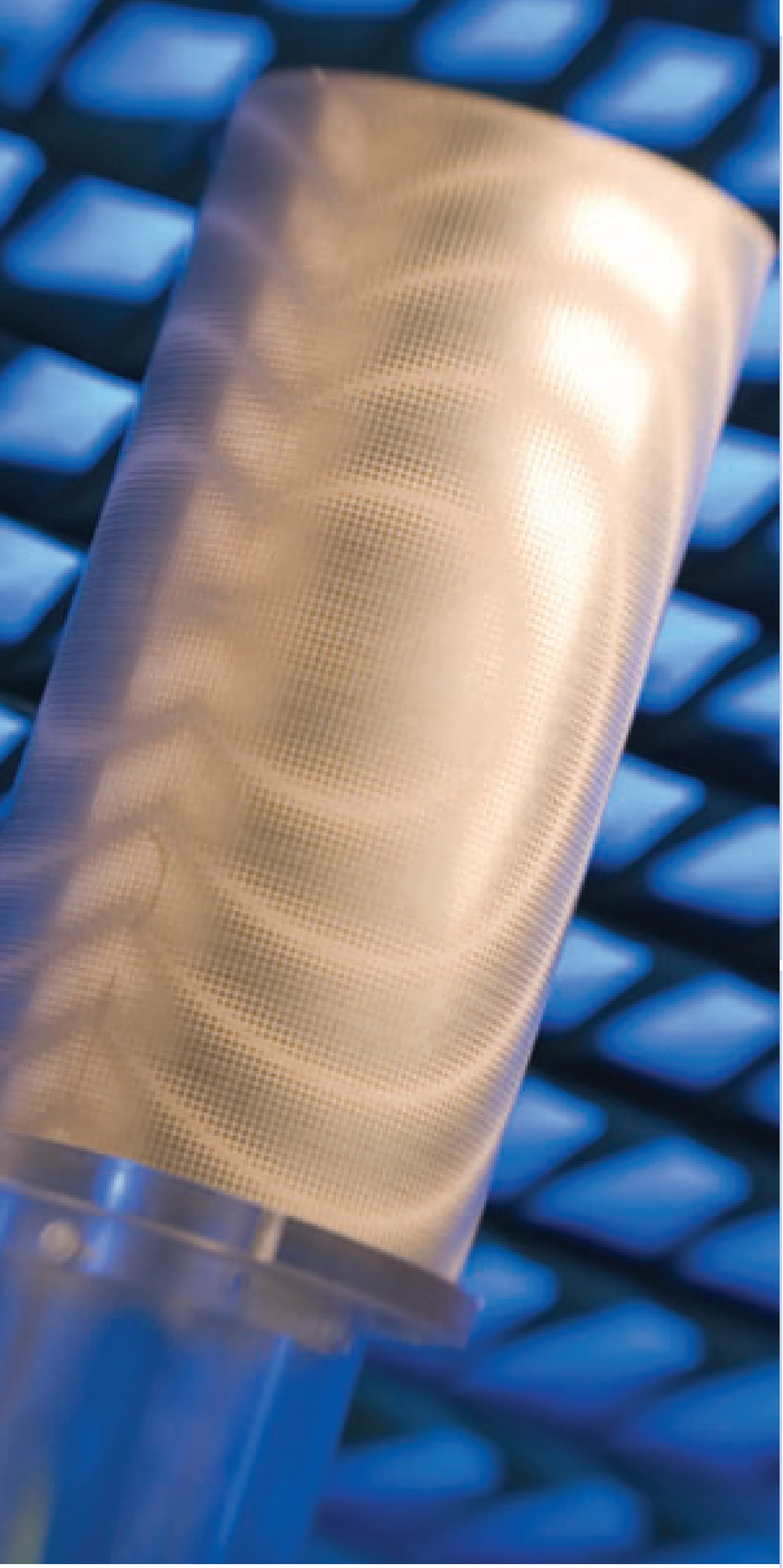
ANTENNAS

ENABLING THE CREATION OF VERY COMPACT COMMUNICATION DEVICES

■ ■ ■ CUTTING EDGE INNOVATIONS



Left: HRL's ultra-compact dual-band antenna for applications such as wireless tags.



HRL continues to be a pacesetter in the development of innovative antenna concepts for a variety of Department of Defense and commercial applications.

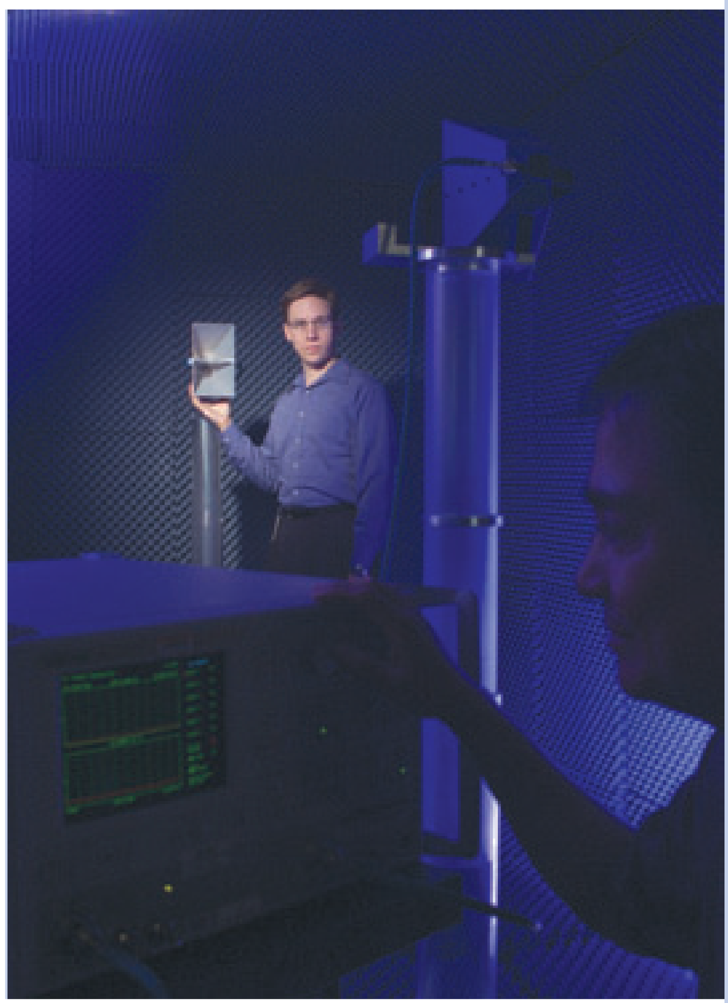
A prime example of our innovation is HRL's development of textured holographic surfaces for conformal antennas–antennas that conform to the shape of an object such as an airplane. We have demonstrated that electromagnetic waves can be controlled so that they wrap around solid objects, and also that our textured surfaces can be used for anti-jamming applications. Further, we have shown that holographic surfaces can improve the radiation of horizontally polarized signals at very small "glancing" angles along vehicles by a factor of 30 or more. A key enabling technology for the development of these holographic antennas is the application of iterative design techniques within HRL's proprietary FastScat software that can reduce undesirable sidelobes (lower level rounded transmission projections, or lobes, along the side of the main direction of the transmission) by a factor of ten.

HRL has also developed compact tunable antennas based on commercially available active devices–devices that increase signal strength with controllable impedance–including switches and varactor diodes, which are used primarily as voltage-controlled capacitors. These antennas enable very compact communication devices for applications such as tags or covert communications, or multi-band radios for vehicle communications.

Another of HRL's cutting-edge innovations is the wearable antenna, whereby the radio signal propagates outside the cable and radiates in all directions, enabling the design of body-wearable communication systems.<<<

"The [HRL antenna] team has exceeded all expectations! The team openly and actively applied Six Sigma Robust Engineering principles to [our] project. [HRL] delivered outstanding work with the DFSS tools and... developed a first class [Tire Pressure Monitoring] systems model."

- Richard Wiese, General Motors



Our Information and Systems Sciences Laboratory (ISSL) is currently developing technology in mobile adhoc network (MANET) protocols design; intra- and inter-vehicles networks; hybrid satellite and terrestrial wireless networks; and MANET optimization and control. We are also working on emerging technologies such as Asynchronous Pulse Processing (APP), under development by HRL's Microelectronics Laboratory. APP has stimulated new thinking about how to integrate communications algorithms, software and hardware into more cost-efficient network solutions.

Recent efforts have focused on developing and maturing our Mission-Intelligent CBMANET Architecture (MICA). MICA was undertaken because existing solutions for the complex problem of resource allocation in mobile adhoc networks are largely fragmented, uncoordinated, and based on obsolete legacy networking paradigms. Although we have found that global resource control in such networks can significantly improve performance, there has yet to emerge a cohesive overall solution that addresses all facets of the problem. Those facets include managing local and global network resources, user versus network constraints, static versus dynamic management and control, and mission versus network priorities.

In response to this need, HRL designed MICA, a scalable and robust overall solution that can optimize resources and self-adapt to specific mission and environmental requirements. MICA is a revolutionary, complete network architecture that seamlessly integrates robust, scalable, and efficient resource optimization services with a novel dynamically reconfigurable mobile adhoc network stack. The result is dramatically improved network performance and utility for war fighters—military personnel charged with conducting warfare—and for moving platforms.

The primary innovations of MICA include a modular, distributed approach that uses separate but tightly integrated control planes–the high-level Macro Control Plane (MCP) and the low-level Dynamic Resource Control Plane (DRCP)–to enable simultaneous and cooperative optimization of both mission and network objectives. The high-level and low-level planes use a variety of powerful and efficient distributed engines to optimize network performance in mobile adhoc networks. MICA also includes robust and efficient algorithms designed specifically for such networks that provide commonly need-

TECHNOLOGY THAT WILL

- Mobile adhoc network (MANET) protocols design
- Intra- and inter-vehicles networks
- Hybrid satellite and terrestrial wireless networks
- MANET optimization and control

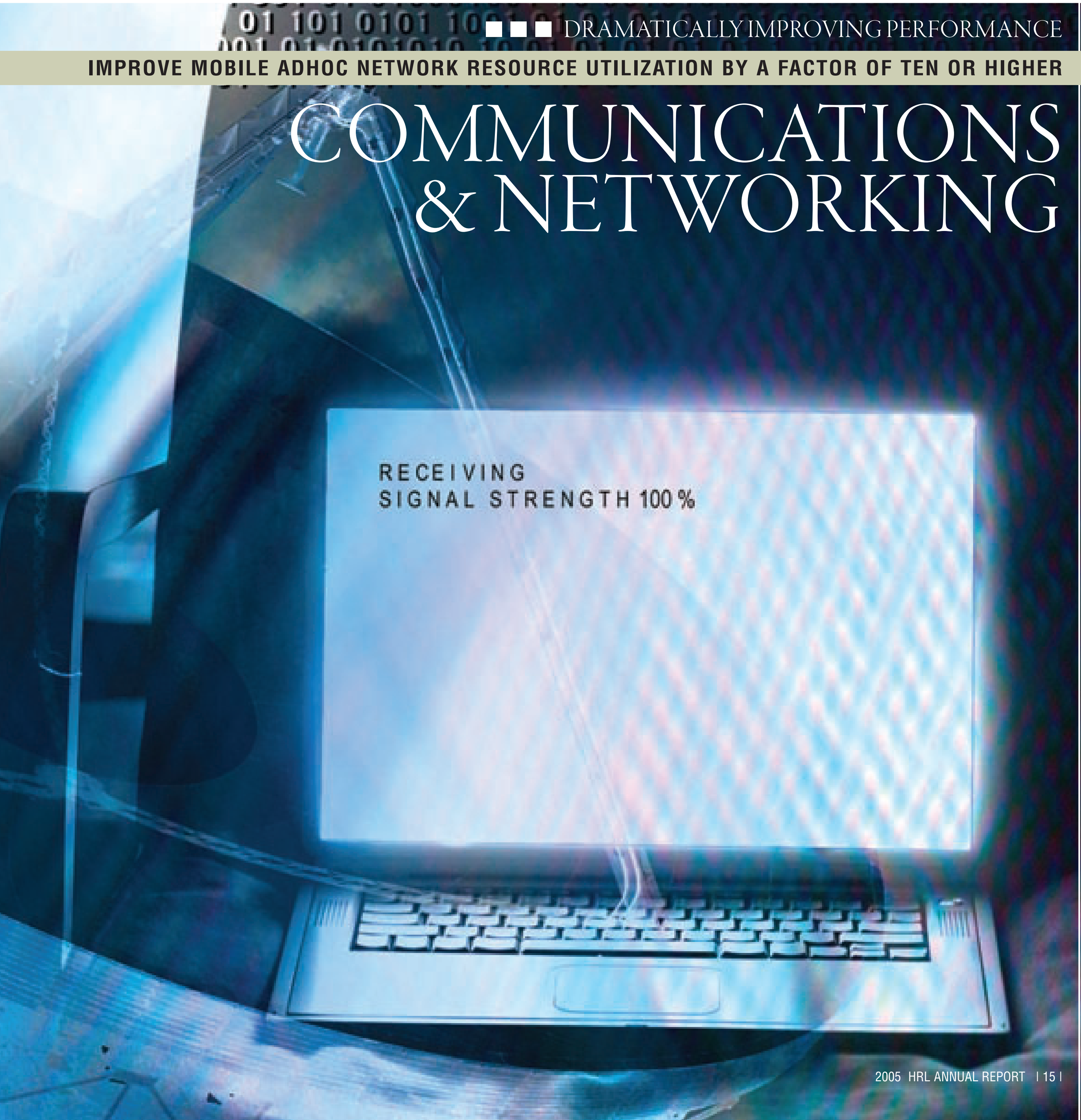
ed services such as clock synchronization, topology control, and information dissemination and aggregation. In order to eliminate the detrimental cross-layer interactions of the older protocol layer approach, HRL designed a novel network stack architecture, structured according to functions and features, that facilitates the design of much more efficient and manageable network protocols. We also developed methods, routing schemes, and multiple-input multiple-output message authentication codes for reliable and power-efficient delivery of tactical broadcast and multicast content.

By replacing the conventional protocol-based stack with a function-based network and novel network protocols, and by using adaptive network control to allow nodes to cooperate and share resources, our new architecture results in vast improvements in network performance and flexibility. Based on our previous experience using these methods in other applications, we project that MICA will improve mobile adhoc network resource utilization by a factor of ten or higher. <<<

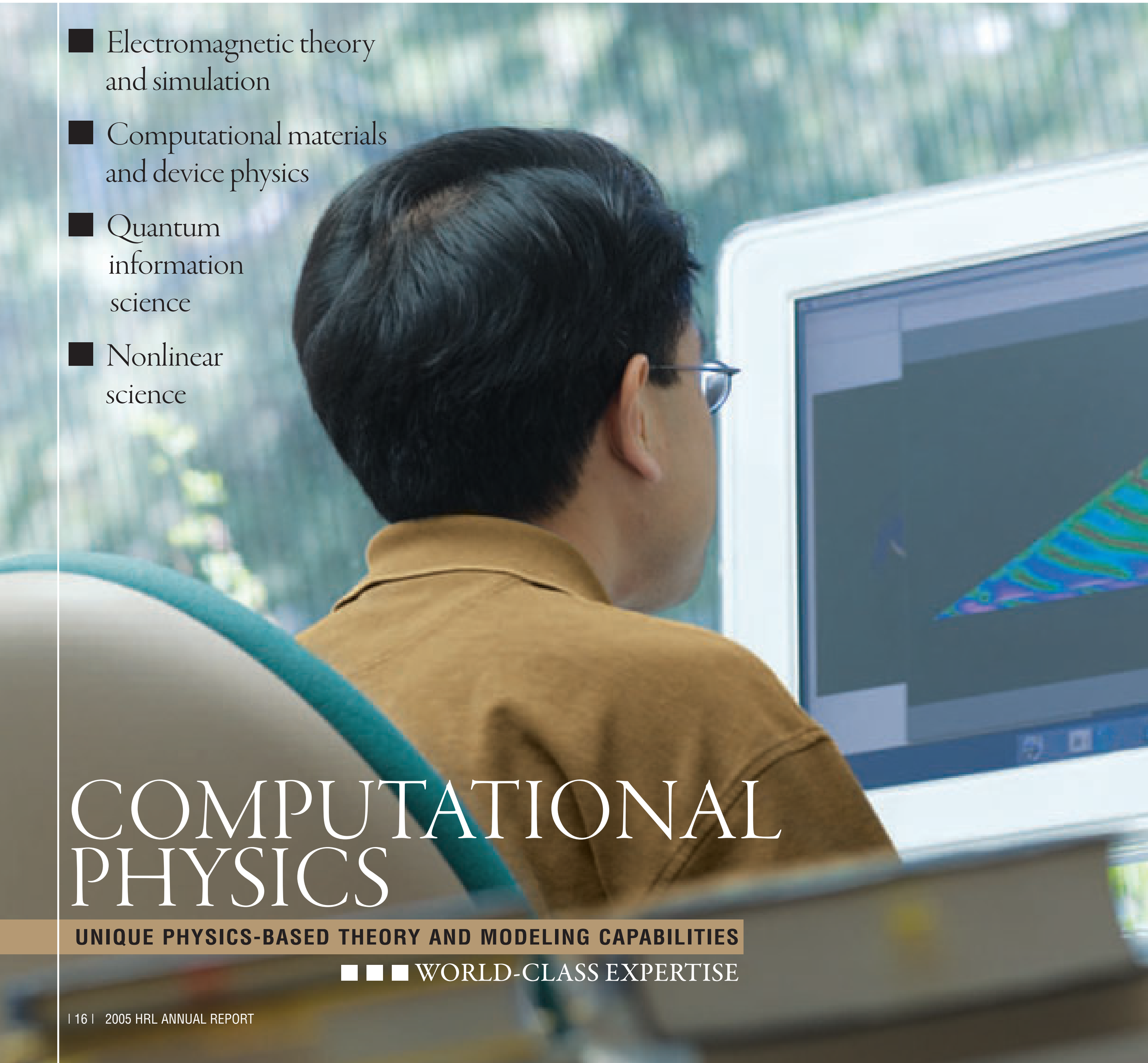
■ ■ ■ DRAMATICALLY IMPROVING PERFORMANCE

IMPROVE MOBILE ADHOC NETWORK RESOURCE UTILIZATION BY A FACTOR OF TEN OR HIGHER

COMMUNICATIONS & NETWORKING



The Computational Physics department provides unique physics-based theory and modeling capabilities that are utilized throughout the four laboratories at HRL. These modeling and simulation technologies are used to provide meaningful input to experimental concepts and designs, as well as to explore new areas with potential impact for HRL and our LLC Members.



- Electromagnetic theory and simulation
- Computational materials and device physics
- Quantum information science
- Nonlinear science

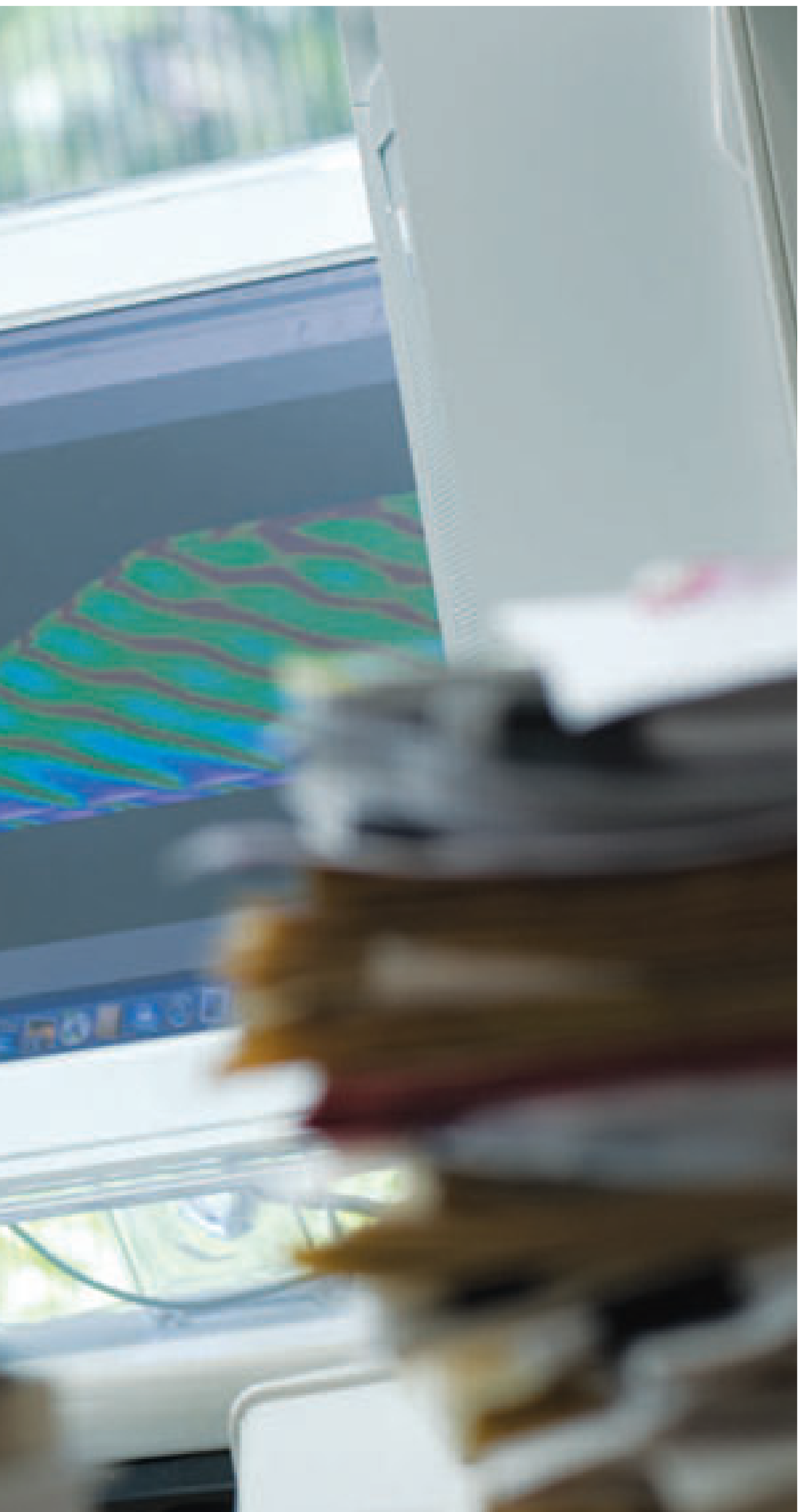
COMPUTATIONAL PHYSICS

UNIQUE PHYSICS-BASED THEORY AND MODELING CAPABILITIES

■ ■ ■ WORLD-CLASS EXPERTISE

There are four areas in which the Computational Physics Department maintains world-class expertise. The first two–computational electromagnetics and computational materials and device physics–fall into the category of providing input to experimental concepts and designs, with the main emphasis being on the development and use of theoretical and computational techniques in support of important experimental programs. Two others–nonlinear systems and quantum information science–are meant to explore new areas where we use our expertise to first understand underlying scientific principles, and then explore their application potential.

Emerging technologies associated with these four areas include novel conformal antennas for military platforms and automotive applications; nanoelectronic devices for spintronics (which use a quantum property of electrons for a variety of semiconductor purposes), nonlinear science approaches to high-power coherent optical and millimeter wave sources; and quantum information processing technologies for communication and defense applications.

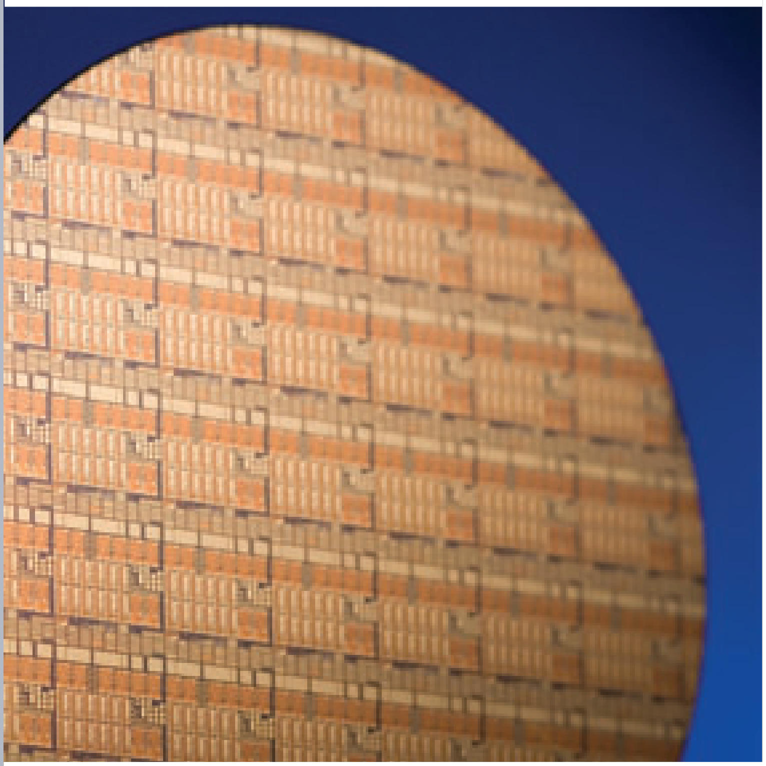


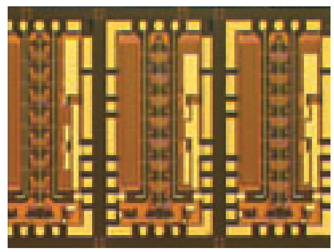
Computational electromagnetics is a mature area at HRL, and we possess world-leading expertise in frequency domain algorithms and implementation. The FastScat code developed in the 1990s by HRL is recognized as perhaps the most accurate code in the world for radar cross-section calculations. Over the past few years, FastScat has been applied to other frequency domain electromagnetic problems with great success. Most notable among these is the design of a new class of antennas that utilize a variable impedance surface to shape currents to produce any desired antenna pattern, independent of the shape of the surface. FastScat has played a critical role in this effort by enabling accurate calculations of large surfaces.

In the computational materials and device physics modeling area, codes developed at HRL and elsewhere have been applied extensively to design semiconductor heterostructures and devices for spintronics (also called magnoelectronics) and quantum information processing applications.

Our work in nonlinear science–the study of systems and situations that have complex causes and effects–has produced a potential breakthrough solution for generating more power in the optical and millimeter wave regimes. This solution utilizes intrinsic nonlinearities and between fiber lasers or millimeter wave oscillators to produce "self-organized" and very stable states that have no need for active control.

Finally, as devices become ever smaller, the principles of quantum mechanics become increasingly important. Therefore, HRL's quantum information science area has begun exploring architectures that could enable powerful quantum information processing based on novel semiconductor devices. <<<





We are working on several innovative technologies in digital and mixed-signal subsystems. For example, our delta-sigma modulator analog-to-digital converters use a process that measures errors and then automatically compensates for them, while our analog-to-information conversion aims to extract information via methods other than standard analog-to- digital conversion. HRL is also exploring novel analog signal processing techniques, Antimonide Based Compound Semiconductor (ABCS) HBT integrated circuit technology, fast direct digital synthesis integrated circuits and the emerging field of nanoscale HBTs.

- Delta-sigma modulator analog-to-digital converters
- Novel analog signal processing techniques
- Analog-to-information conversion
- TFAST InP DHBT technology
- ABCS HBT IC technology
- Direct digital synthesis ICs

UNIQUE PROCESS

Under the Defense Advanced Research Projects Agency (DARPA) Technology for Frequency Agile Digitally Synthesized Transmitters (TFAST) program, HRL developed a unique ultra-low power Indium Phosphide Dual Heterojunction Bipolar Transistor (InP DHBT) process. “Heterojunction” refers to a semiconductor junction that consists of layers of different materials. This translates into excellent high frequency operation and low leakage. Our unique advantage stems from the excellent combination of high frequency performance and low power consumption in our InP DHBTs. The underlying transistor technology has a high unity current gain cutoff frequency of 420 GHz. The cutoff frequency is the frequency at which the current gain of the transistor falls to one. Using this technology, HRL demonstrated a digital circuit with a clock rate of 150 GHz and power dissipation of only 22 milliwatt per latch (an electronic circuit that can store one bit of information). Our unique advantage stems from the high cutoff frequency of the transistors obtained at significantly lower voltage than the competition. This enables us to create faster, simpler, and lower-power logic gates. HRL’s circuit required just one-ninth the power of the only other competitor to meet the circuit clock rate goal, with the results being verified by the Mayo Foundation as an independent

DIGITAL & MIXED SIGNALS SUBSYSTEMS

HRL IS THE LEADER IN HIGH PERFORMANCE, LOW POWER INTEGRATED CIRCUITS

■ ■ ■ A UNIQUE ADVANTAGE

DARPA test facility. This clearly establishes HRL as the leader in high performance, low power integrated circuits.

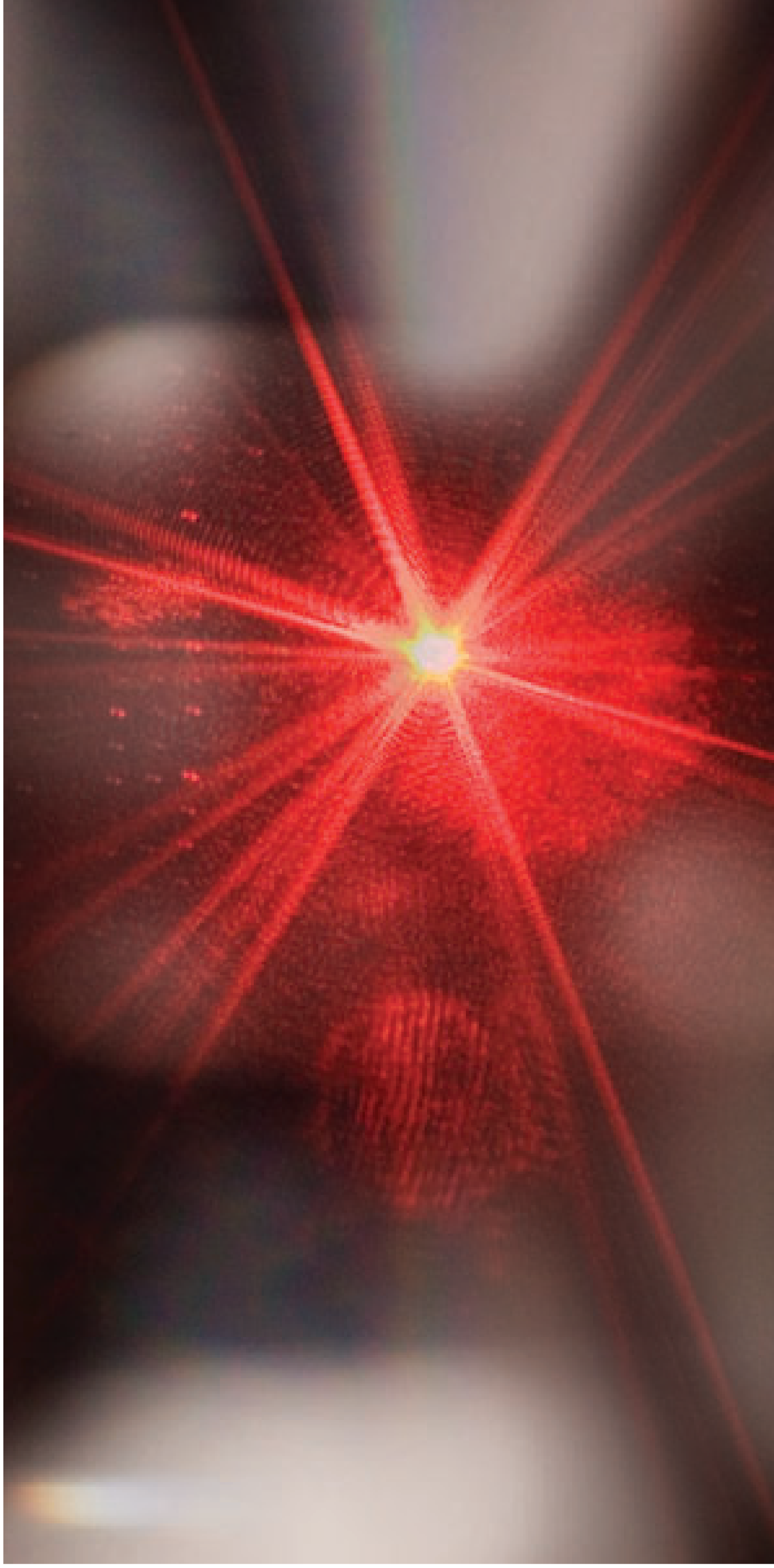
In the same technology area, HRL demonstrated a Direct Digital Synthesizer (DDS) circuit with 6,600 HBTs, an output from 25 MHz to 12.1 GHz and an approximate 25 MHz resolution. The low power and relatively high complexity of this technology is of great interest to HRL's LLC Members as an enabler for various communications and radar applications.

In addition, HRL continues to be a leader in the development of wideband sigma-delta modulator analog-to-digital converters, pushing the state-of-the art for sample rate and resolution. <<<

EMERGING TECHNOLOGIES IN THE DIGITAL AND MIXED-SIGNAL SUBSYSTEM FIELD

Nanoscale HBTs ■

Ever since the operation of the first laser by HRL scientists in 1960, we have been developing new concepts, devices and applications of optics. In the recent past, we have focused on the development and application of lasers and related components to weapons, radar, sensors and free-space laser communication—"free-space" meaning that the laser light travels in free space between two points instead of using a fiber optic cable. Currently, we are leveraging our knowledge in laser technology to utilize existing lasers for long range detection of chemicals, and to create inexpensive sources of TeraHertz–or submillimeter–waves that may be used for increased imaging sensor performance of visually hidden objects. We are also investigating new approaches to mid-infrared lasers, using HRL's expertise in semiconductor materials, laser thermal issues, and modeling capabilities. We have demonstrated "phased array" amplifiers and lasers that adjust optical phases to provide maximum beam control and power scaling of efficient lasers.



EMERGING TECHNOLOGIES IN THE LASER FIELD

- Coherent combining of lasers
- TeraHertz sources
- Electrically pumped MidIR lasers
- Fiber-guided prime power remoting

FROM PAST TO PRESENT

Over the past decade, HRL pioneered the development of a solid-state lasers using a new material, Yttrium Aluminum Garnet crystal (Yb:YAG). HRL's work culminated in achieving high efficiency and a record 2.65kW from a single laser rod. The Yb:YAG laser and the phase conjugation mirror technologies (reflective devices that replicate the phase of a laser beam exactly) that we have developed are forming the basis for the next generation of high power lasers for directed energy weapons. For improved efficiency, we are also developing "waveguide shaped, clad crystal lasers." Waveguides are pipes that confine and guide the laser beam, while cladding is used to confine the pump beams, protect against scattering of the beam, and give increased structural strength.

HRL is also developing and demonstrating methods to obtain brighter and more powerful beams from existing fiber and diode lasers. Fiber and diode lasers are efficient, flexible, and have minimal thermal problems compared to other solid-state lasers, but their power output has been limited. We're using a physical and mathematical phenomenon called "self-organization" and applying its principles to fiber lasers. The result is a simple system that does not need active control of individual fibers. HRL has demonstrated this intriguing approach with low power fiber lasers and is now scaling it to higher power systems. We have also developed concepts to apply these principles to the much more efficient diode lasers.

Taking advantage of the recent progress in fibers and diode lasers, we have developed many specialized fiber lasers and amplifiers that can generate very flexible optical pulse formats–from continuous operation to high repetition rate to mode-locked operation. We have built fiber lasers with higher precision ("coherence") and power output than was previously possible. HRL works with outstanding specialty diode laser and fiber manufacturers and takes advantage of the unique features of each prod-

HRL HAS BROAD EXPERTISE IN LASER TECHNOLOGY AND ITS UNDERLYING CONCEPTS

LASERS

- Fiber lasers and amplifiers
- Free space laser communication
- Nonlinear optics
- High power, high efficiency solid state lasers
- LADAR
- Volume holograms

uct in our quest to achieve maximum performance. All of these developments combine to enable us to design new generations of imaging, radar, illumination and, targeting systems.

HRL's EXPERTISE

HRL has broad expertise in laser technology and its underlying concepts. Our laser communications efforts are currently concentrated on free-space propagation to serve our LLC Members as well as the needs of our other customers.

An example of our expertise in these arenas is a simple method to "phase lock"—combine—multiple fiber amplifier arrays while retaining the energy efficiency, robustness, and flexibility of fibers. HRL has applied this fiber amplified "phasing" to laser-based communication and has built a power-scalable laser transmitter that can minimize the effects of atmospheric turbulence and thus increase the received signal tenfold. This architecture has many advantages, and we have demonstrated the utility of the concept in HRL's outdoor communications test range. This approach also enables totally transparent free space optical communication links between two fiber optic end points without optical to electrical to optical conversion of existing systems. <<<

Photonics—*the science of generating and managing photons*—began with the invention of the laser and was first demonstrated by HRL scientists in 1960. Today, HRL's focus is on the application of photonics for microwave signal distribution and processing, and on the development of lasers and components for free space optical communication, radar, weapons, and sensors.

These photons lie in the visible or infrared part of the optical spectrum and can be used as an optical carrier in broadband telecommunication networks that are immune to electromagnetic interference. A primary advantage of optical communication is the secure and efficient distribution of analog/digital signals through optical fibers or free-space links.

A COLLABORATIVE TECHNICAL ALLIANCE

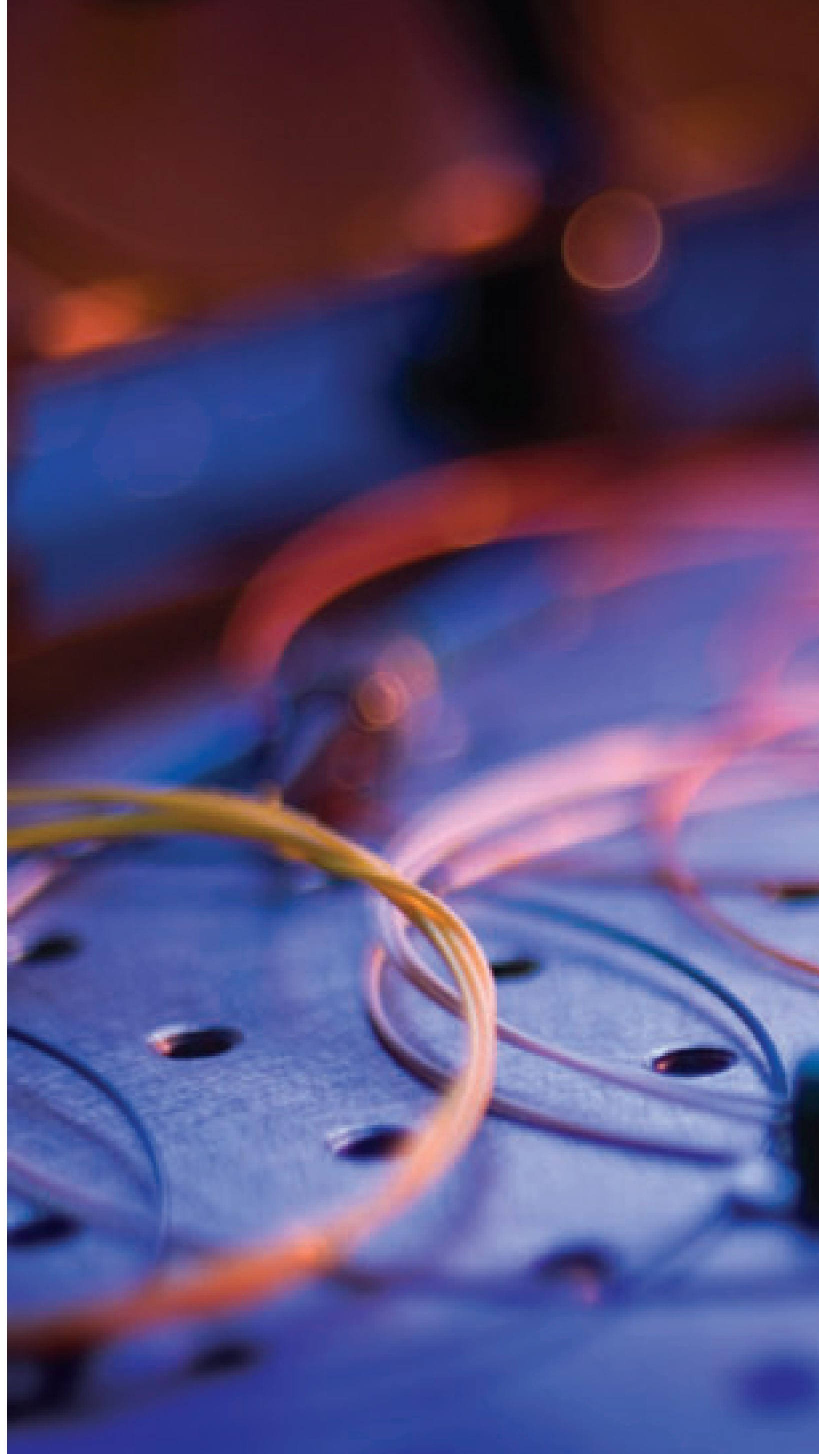
Using a multidisciplinary approach, we leverage our knowledge in existing and emerging photonic technologies to create products for future military and commercial use. Our expertise in state-of-the-art photonics, lasers, and optical device fabrication combine to help realize photonic and electronic subsystems that can be integrated on a chip. Miniaturizing a variety of photonic devices will enable them to be integrated with high-performance electronics. We also create and improve design tools to facilitate a rapid transition of laboratory demonstrations to user-friendly photonics hardware and software solutions.

Among the many photonic products and technologies under development at HRL are key components and subsystems that allow antennas to be remoted far away from receivers where expensive and sensitive equipment are typically housed ("antenna remoting"); the photonic steering of microwave phased arrays ("optical beamforming"); wideband signal processing, including high speed photonic-assisted analog-to-digital conversion; and signal-transport via the use of multiple wavelengths ("wavelength division multiplexing") in fiber-based or free-space optical networks.

Our photonic signal distribution network can also deliver ultra-stable clock signals to multiple analog-to-digital converters at remoted antenna sites. Our low phase noise photonic oscillator generates very precise frequency-spread waveforms for radar applications.

Exploiting photonics' inherent low loss, wide bandwidth, and immunity to electromagnetic interference, our reconfigurable RF-photonic transversal filters have demonstrated substantial enhance-

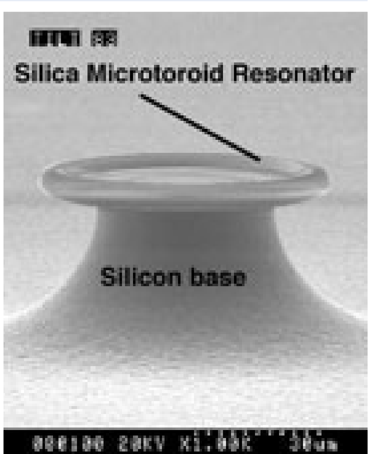
Below left: This very high Q (>10^7) microresonator enables very narrow bandwidth (~100MHz) photonic filters
Below right: HRL fabricated very high speed (>50GHz) lithium niobate electro-optic modulators for optical communication

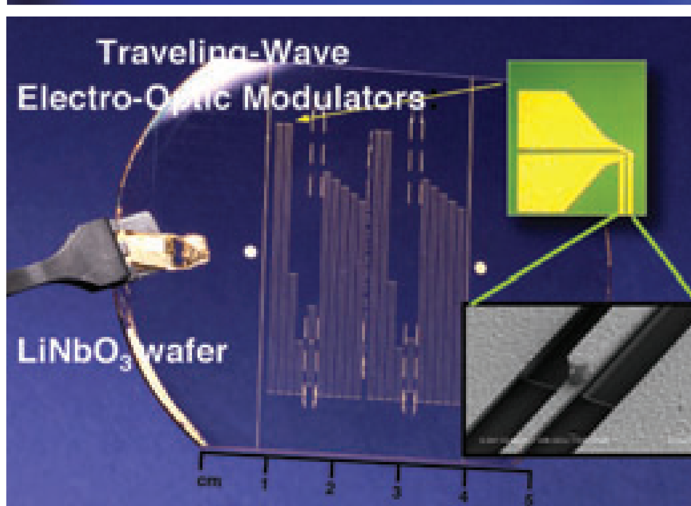


LEVERAGING OUR KNOWLEDGE

EMERGING TECHNOLOGIES IN THE PHOTONICS FIELD

- Microphotonics (electronics and photonics on the same chip)





Photonics for microwave signal processing ■
Photonics for digital/analog networks ■
Sampling for fast analog-to-digital conversion ■
Fast modulated retro reflectors based on MQW ■

PHOTONICS

IN EXISTING AND EMERGING PHOTONIC TECHNOLOGIES TO CREATE PRODUCTS FOR FUTURE USE

■ ■ ■ TRANSFORMING THE FACE OF MODERN TECHNOLOGY

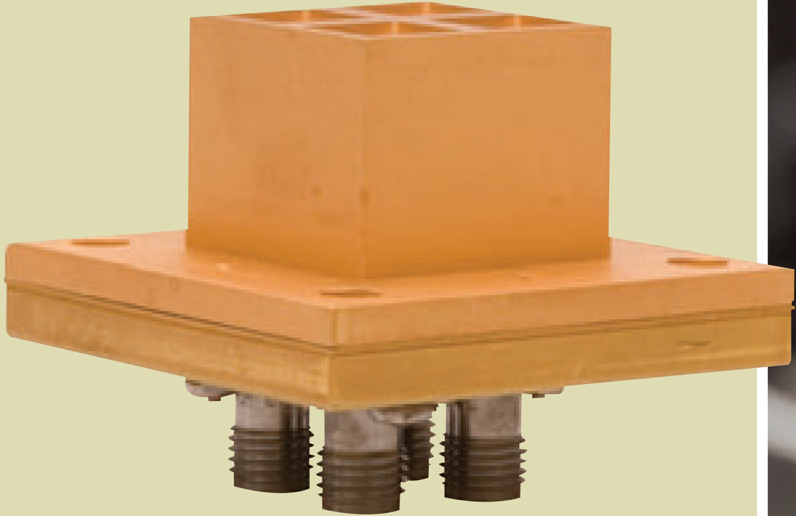
ments in instantaneous bandwidths over conventional microwave filters. In addition, we have developed technologies to fabricate " microresonators"—a way to store light with long lifetimes on silicon chips. This technology can be exploited to create filters that are several orders of magnitude smaller in size and narrower in passbands than present technologies.

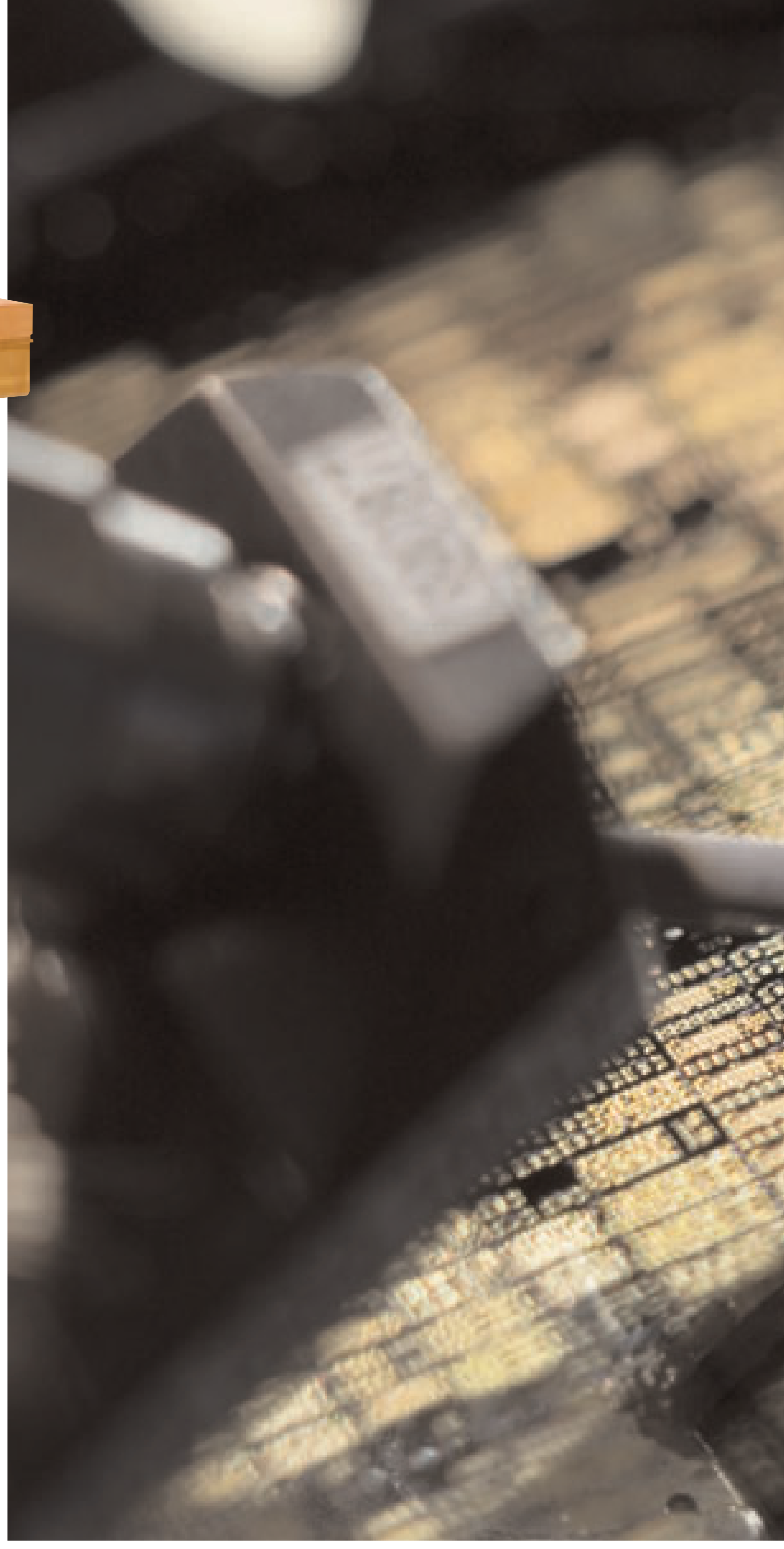
ADVANCED PHOTONICS

Finally, HRL is developing optical modulating retro-reflectors, or MRRs. These MRRs are used for communication with remoted sites and vehicles that do not possess their own transmitters. Our MRRs are designed for high-speed, high-contrast and low-voltage operation, and their modulator pixels can be placed on any "cats-eye" reflector surface. MRRs allow communicating with a site that has very little power and space available.

To accomplish the design and fabrication of these advanced photonic components, we utilize our expertise in processing technologies for indium phosphide/gallium arsenide III-V semiconductors; lithium niobate, which has excellent electro-optic modulation properties; and erbium-doped fibers, an optical amplifier.

Our research, as well as our fabrication expertise in the rapidly advancing field of photonics, will continue to result in exciting new concepts, devices, and applications for many practical problems. <<<





HRL continues to be at the forefront of the development of high performance "monolithic" (single crystal chip) millimeter-wave integrated circuits (MMICs) based on Gallium Nitride (GaN) and Indium Phosphide (InP) materials technologies. MMICs are very small integrated circuits that operate in the millimeter/microwave frequencies. Their size and ability to be mass-produced makes them desirable for small radio frequency devices in a wide range of RF applications, including wireless communications, radar, and electronic warfare.

Currently, HRL is applying a variety of advanced integrated circuit and manufacturing technologies to develop power amplifiers, low noise amplifiers, detectors, and miniature filters. In addition to optimizing existing technologies, we are utilizing complex modeling and simulation to advance emerging technologies in the field.

In 2005, HRL demonstrated millimeter-wave 35 GHz Ka-band and 44 GHz Q-band Gallium Nitride MMICs with high amplification and power output of 4 W. We also demonstrated the development of 75-111 GHz (W-band) low-noise amplifiers using Indium Phosphide high electron mobility transistor (HEMT) technology with small-signal gain = 30dB and an outstanding very low noise figure of just 2.5dB. Finally, as a major organization with established capability, HRL maintains supremacy in broadband, robust, low-noise amplifiers based on Gallium Nitride heterostructure field effect transistor (HFET) technology.

HRL also remains the industry leader in passive millimeter wave W-band imaging detectors based on our patented Sb-diode (Schottky barrier Antimonide diode) technology. The imaging sensor array developed for the Defense Advance Research Projects Agency MIATA (Microantenna Arrays: Technology and Applications) program represents a potentially revolutionary technology for passive and active millimeter wave imaging. The primary goal of the program is to develop a millimeter wave detector with significantly higher sensitivity than the current state-of-the-art.

Under the MIATA program, HRL integrated detectors directly into a W-band antenna package that minimized electrical resistance losses and provided excellent response. The measured results for Phase I showed a sensitivity performance level that was four times better than the program's go/no-go requirement. Achieving the Phase II goals of a sensitivity of under 2 degrees Kelvin–noise temperature as a performance measure of the minimum detectable temperature variation in a scene–would enable

EMERGING TECHNOLOGIES IN THE RF ANALOG FIELD

■ Advanced Modeling and Simulation

- InP HEMT MMIC low noise amplifiers
- InP DHBT MMIC power amplifiers
- Sb Diode detectors and arrays
- InAs-channel HEMT MMIC low noise amplifiers
- Miniature filters
- GaN HFET MMIC power amplifiers and broadband low noise amplifiers

RF ANALOG

UTILIZING COMPLEX MODELING AND SIMULATION TO ADVANCE EMERGING TECHNOLOGIES

UNFALTERING PLEDGE TO REACH OUR GOALS

imaging arrays to be produced without the use of W-band low-noise amplifiers. This would represent a breakthrough in millimeter wave W-band imaging because all current passive imagers require low noise preamplifiers (LNAs) to overcome the sensitivity limitations of today's detectors. Eliminating the LNAs would provide significant cost savings for imaging arrays, as LNAs currently cost at least $25 per element, and typical non-scanning imaging arrays have tens of thousand of elements. If successful, this technology would make possible low cost non-scanning imaging arrays for applications including concealed weapons detection, aircraft all-weather guidance, vehicle all-weather vision assistance, and battlefield imaging through dust and smoke. <<<

"HRL has a rich history of development and delivery of critical components for some of our most important products. HRL also provides a broad set of talented eyes looking over the horizon at the global technologies and issues that will drive our business in the future." –Dave Whelan, Vice-President Strategic Growth, The Boeing Company

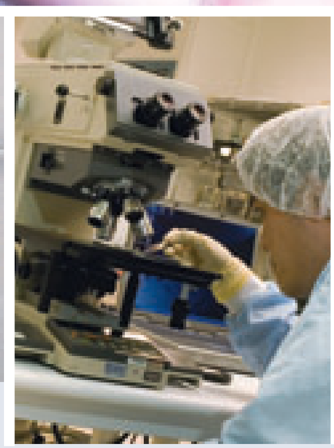
- Low defect HgCdTe materials for state-of-the-art infrared detector arrays
- Novel diodes for millimeter-wave imaging
- Unique quartz-based MEMS processing for ultracompact filters, oscillators and resonators

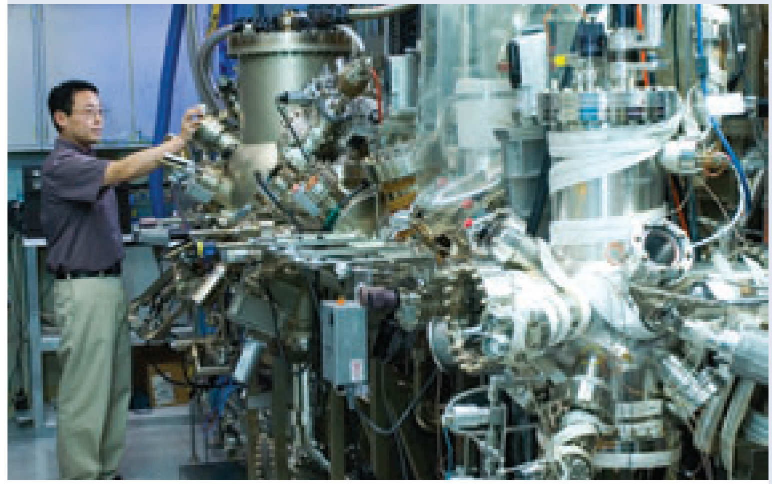
SENSORS

HRL HAS DEVELOPED NOVEL MEANS OF INERTIAL, CHEMICAL, AND BIOLOGICAL SENSING

■ ■ ■ CREATING NEXT-GENERATION DEVICES

Ultra-small scale sensing device.





Our strengths in engineered electronics materials, processing and architecture of micro-electro-mechanical structures, and fundamental device physics, have enabled us to build the technological foundation for new and improved sensing systems. With a talented team and dedicated, modern laboratory facilities, HRL has developed a portfolio of key enablers for sensors that span the electromagnetic spectrum and include novel means of inertial, chemical, and biological sensing.

HRL continues to develop world class mercury cadmium telluride (HgCdTe, also called MCT) based materials. MCT is an alloy of mercury telluride and cadmium telluride and, like silicon and gallium arsenide, is an important semiconductor. The alloy composition of MCT determines its electrical and optical properties, making it ideal for applications such as high performance dual-band infrared detectors and avalanche photodiodes (photodiodes that internally amplify current) for laser radar (LADAR) systems. Backed by state-of-the-art molecular beam epitaxy equipment—equipment that uses a special method of thin-film deposition—and strong knowledge of the growth, processing, and physics of relevant material systems, HRL can design and produce extremely low-defect device structures on a variety of substrates and size formats for high yield, high performance detector arrays.

We have developed innovative backward tunneling diodes for ultra-low noise detection, particularly in the millimeter wave range. These special diodes operate at room temperature and at very low voltage, forming the basis for a unique approach to millimeter-wave imaging. By sensing ambient radiation, backward tunneling diodes can essentially see through solid material. This capability will lead to many other novel applications.

HRL has developed a portfolio of unique processes for the fabrication of microscale quartz structures that can be readily integrated with traditional microelectronic technologies. These capabilities have enabled us to develop new high-Q filters—with "Q" standing for the sharpness of the response of a filter—as well as oscillator and resonators. All three have a direct applicability to a variety of communication devices, and to chemical and biological sensing.

We are also pursuing research in emerging sensor technologies based on nanoscale materials (particles that measure less than 100 nanometers) for performance enhancement and new detection mechanisms to enable next-generation sensing devices. <<<

EMERGING TECHNOLOGIES IN THE SENSORS FIELD

■ HRL continues to investigate new nanoscale technologies that provide performance enhancement and new detection mechanisms for next-generation sensing devices.

IN THE HEART OF MALIBU ■ Located on Malibu Canyon Road, HRL is only a stone's throw from California's scenic Highway 1, known as the Pacific Coast Highway. This famous highway winds along and through the Malibu Community, which encompasses 21 miles of breathtaking coastline and 45,000 acres of mesas, mountains, canyons, and beaches.

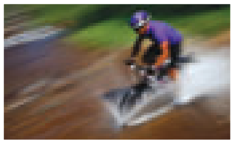
HRL is tucked away in the Santa Monica Mountains and enjoys an endless vista of the Pacific Ocean and nearby Catalina and Santa Barbara Islands. HRL employees enjoy Malibu's world-renowned beaches, varied dining establishments and lavish shopping, as well as occasional encounters with movie and TV celebrities. For those who prefer quiet time, the rustic canyon and hillsides that are only minutes away provide solitude and an abundance of wildlife.

In addition, HRL has the unique advantage of being located within proximity of numerous major Southern California universities and colleges.

HRL EMPLOYEES ALSO ENJOY

- Running, jogging, and walking on the HRL campus
- Beach volleyball
- Surfing
- SCUBA diving
- Weekly on-site Yoga classes
- Sailing
- Ocean swimming
- Golf
- Skateboarding
- Basketball, swimming, volleyball and tennis through special arrangements with a neighboring university





HRL's Involvement in the Malibu Community

- HRL is an active participant in the Malibu Community, with employees on the Board of Directors of the Chamber of Commerce and with long-standing membership in the Malibu Optimists' Club.
- Among the local events supported by HRL through the Chamber of Commerce and the Optimists' Club are the annual Malibu Arts Festival, the Malibu Golf Tournament, Wine Tasting, and Malibu Garden Tour.

MALIBU, CALIFORNIA

CALIFORNIA PARADISE AT YOUR FINGERTIPS ■

Although HRL is nestled in the sanctuary of Malibu, it is only 30 minutes away from the Santa Monica Airport, 45 minutes from Los Angeles International Airport (LAX) and one hour from downtown Los Angeles. The J. Paul Getty Museum and other fine art galleries are readily accessible, as are the most popular Malibu beaches: Surfrider, Zuma, Malibu, and Leo Carillo.

PATENTS

Issued to HRL in 2005

L. W. Chow
W. M. Clark, Jr.
G. Harbison
J. P. Baukus
■ 6979606 Use of silicon block process step to camouflage a false transistor

R. L. Kubena
D. T. Chang
■ 6975009 Dual-wafer tunneling gyroscope and an assembly for making the same

A. T. Hunter
P. D. Brewer
■ 6974604 Method of self-latching for adhesion during self-assembly of electronic or optical components

D. M. Pepper
G. J. Dunning
D. S. Sumida
■ 6973830 Time-reversed photoacoustic system and uses thereof

J-S. Moon
■ 6972702 1-Of-N A/D converter

S. Livingston
J. J. Lee
J. H. Schaffner
R. Y. Loo
■ 6965349 Phased array antenna

D. Yap
Y-M. So
■ 6963442 Low-noise, switchable RF-lightwave synthesizer

K. R. Sayyah
D. M. Pepper
P. D. Brewer
A. Au
■ 6954302 Conformal retro-modulator optical devices

J. J. Lynch
D. F. Sievenpiper
■ 6952190 Low profile slot antenna using backside fed frequency selective surface

R. L. Kubena
D. T. Chang
■ 6951768 Single crystal, dual wafer, tunneling sensor or switch with substrate protrusion and a method of making the same

N. Srinivasa
S. S. Medasani
■ 6950813 Fuzzy inference network for classification of high-dimensional data

P. D. Brewer
■ 6946322 Large area printing method for integrating device and circuit components

J. P. Baukus
L. W. Chow
W. M. Clark, Jr.
■ 6940764 Memory with a bit line block and/or a word line block for preventing reverse engineering

J. Cruz-Albrecht
K. Elliott
■ 6937175 Amplifier linearization using delta-sigma predistortion

R. L. Kubena
■ 6933164 Method of fabrication of a micro-channel-based integrated sensor for chemical and biological materials

K. R. Sayyah
■ 6930020 Method for fabricating large area flexible electronics

J-S. Moon
■ 6929987 Microelectronic device fabrication method

W. M. Clark, Jr.
LW. Chow
J. P. Baukus
P. O. Yang
■ 6924552 Multilayered integrated circuit with extraneous conductive traces

R. L. Kubena
R. J. Joyce
■ 6922118 Micro electrical mechanical system (MEMS) tuning using focused ion beams

B.C. Love
■ 6920439 Method and apparatus for incorporating decision-making into classifiers

J. P. Baukus
L. W. Chow
W. M. Clark, Jr.
■ 6919600 Permanently on transistor implemented using a double polysilicon layer CMOS process with buried contact

K. D. Sisalem
S. K. Dao
■ 6910024 System for pricing-based quality of service (PQoS) control in networks

K. W. Kirby
J. J. Vajo
J. Jankiewicz
J. Herold
C. Valenzuela
F. Judnich
W. Anderson
■ 6908680 Method for obtaining reduced thermal flux in silicone resin composites

K. R. Sayyah
D. Yap
■ 6906309 Injection-seeding of multi-tone photonic oscillator

S. I. Ionov
■ 6901177 Optical top hat pulse generator

L. W. Chow
W.M. Clark
J.P. Baukus
■ 6897535 Integrated circuit with reverse engineering protection

N. X. Nguyen
P. B. Hashimoto
C. Nguyen
■ 6897137 Process for fabricating ultra-low contact resistances in GaN-based devices

D. T. Docter
K. Kiziloglu
■ 6897132 Method of reducing the conductivity of a semiconductor and devices made thereby

D. S. Sumida
H. W. Bruesselbach
A. A. Betin
■ 6895152 Guided-mode laser apparatus with improved cladding structure and a method of fabricating thereof

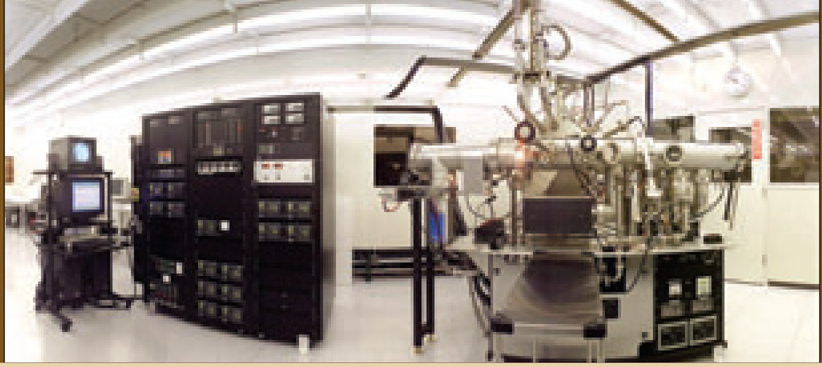
J. J. Lynch
■ 6894654 Waveguide for a traveling wave antenna

M. Micovic
D. T. Docter
■ 6894325 Fabrication of low resistance non-alloyed, ohmic contacts to InP using non-stoichiometric InP layers

J. P. Baukus
L. W. Chow
W. M. Clark, Jr.
■ 6893916 Programmable connector/isolator and double polysilcon layer CMOS process with buried contact using the same

S. I. Ionov
D. S. Sumida
■ 6891987 Multi-aperture beam steering system with wavefront correction based on a tunable optical delay line

R. R. Hayes
■ 6888982 Recursive optical delay line filter with neutralization



J. H. Schaffner
R. Y. Loo
■ 6888420 RF MEMS switch matrix

D. W. Payton
R. Estkowski
■ 6885303 Motion prediction within an amorphous sensor array

T. Hussain
M. Micovic
P. Hashimoto
G. Peng
A. K. Kurdoghlian
■ 6884704 Ohmic metal contact and channel protection in GaN devices using an encapsulation layer

S. I. Ionov
■ 6882781 Coherent power combining of single-mode sources in waveguide fiber couplers

B. Shi
■ 6875268 Method of improving a surface of a substrate for bonding

D. Yap
■ 6872985 Waveguide-bonded optoelectronic devices

J. J. Lynch
J. S. Colburn
■ 6870511 Method and apparatus for multilayer frequency selective surfaces

P. D. Brewer
D. H. Chow
■ 6870234 Optically- and electrically-addressable concentrators of biological and chemical materials

W. W. Ng
D. Yap
■ 6867904 Integrated optical circuit for effecting stable injection locking of laser diode pairs used for microwave signal synthesis

J. H. Schaffner
J. J. Lynch
D. F. Sievenpiper
■ 6867741 Antenna system and RF signal interference abatement method

J. J. Lynch
J. S. Colburn
■ 6864856 Low profile, dual polarized/pattern antenna

D. F. Sievenpiper
■ 8664848 RF MEMS-tuned slot antenna and a method of making the same

P. D. Brewer
■ 6858537 Process for smoothing a rough surface on a substrate by dry etching

D. H. Chow
K. R. Elliott
■ 6855948 Low base-emitter voltage heterojunction bipolar transistor

D. F. Sievenpiper
H. P. Hsu
J. H. Schaffner
G. Y. Tangonan
■ 6853339 Low-profile, multi-antenna module, and method of integration into a vehicle

M. Micovic
T. Hussain
P. B. Hashimoto
J. R. Duvall
■ 6852615 Ohmic contacts for high electron mobility transistors and a method of making the same

D. Yap
■ 6852556 Waveguide-bonded optoelectronic devices

S.T. Wu
Q. Zhang
S. Marder
■ 6852248 Dopants for liquid-crystal devices

J. J. Ottusch
H. Contopanagos
J. L. Visher
V. Rokhlin
S. M. Wandzura
■ 6847925 Method and apparatus for modeling three-dimensional electromagnetic scattering from arbitrarily shaped three-dimensional objects

J. Fox
M. J. Daily
■ 6847888 Method and apparatus for geographic shape preservation for identification

T. Y. Hsu
A. E. Schmitz
R. Y. Loo
■ 6847277 Torsion spring for electro-mechanical switches and a cantilever-type RF micro-electro-mechanical switch incorporating the torsion spring

D. Laney
M. Matloubian
L. D. Larson
■ 6847266 Microelectro-mechanical RF and microwave frequency power regulator

D. S. Sumida
H. W. Bruesselbach
■ 6845111 Laser apparatus with improved thermal stress resistance

R. M. Stephens
■ 6844848 Wavelength division multiplexing methods and apparatus for constructing photonic beam-forming networks

T. Y. Hsu
A. E. Schmitz
R. Y. Loo
■ 6842097 Torsion spring for electro-mechanical switches and a cantilever-type RF micro-electro-mechanical switch incorporating the torsion spring

R. L. Kubena
D. T. Chang
■ 6841838 Microelectro-mechanical tunneling gyroscope and an assembly for making a microelectro-mechanical tunneling gyroscope therefrom

S. T. Wu
■ 6838017 Polar tolane liquid crystals

"We are committed to thought leadership across a wide range of technologies..."

–Matt Ganz, President & CEO

"There's never been a more exciting time to be in the technology business...."
– Matt Ganz, CEO

HRL Team Designs, Fabricates Robust GaN MMIC LNA Circuits

HRL Researchers working under funding from various Government agencies have developed wideband gallium nitride (GaN) low noise monolithic microwave integrated circuits (MMICs) that will enable a wide range of new applications at frequencies up to 20 GHz. Moreover, despite being wide-band-gap devices designed mainly for high power applications, these GaN heterostructure field-effect transistors (HFETs) have demonstrated excellent noise performance over a wide range of DC power levels.

Current results are the culmination of a multi-year effort at HRL to advance GaN HFET technology and demonstrate GaN MMIC low-noise amplifiers (LNAs) capable of simultaneously achieving low noise, high gain, good linearity and high RF survivability performance. Present data illustrate that the GaN MMIC process is a quickly maturing technology that will be suitable for system insertion in the foreseeable future. Specifically, these components will begin making inroads in the market of high-end microwave and millimeter-wave gallium arsenide (GaAs) pseudomorphic high electron mobility transistor (pHEMT) components, significantly enhancing the performance of Department of Defense (DoD) radio-frequency (RF) systems.

HRL has also designed a high dynamic range two-stage LNA that has demonstrated greater than 15 dB of gain with less than 2.5 dB of noise figure and OIP3 of 40 dBm in the frequency range of 6 to 18 GHz. The two-stage LNA uses a 4x75 micrometer gate width GaN device in the first stage and a bigger 6x100 micrometer gate width GaN device in the output stage. The LNA first stage device is biased at Vds ~3 V for low noise figure and high gain. The second stage is biased at Vds~10 V for higher gain and linearity performance. Similarly, this LNA exhibited excellent survivability under harsh RF illumination.

HRL Awarded Contract To Supply Detector Diodes for Sensors

LOS ANGELES, November 8, 2005 — HRL continues to be the preeminent world supplier of W-band millimeter wave detector diodes to the burgeoning millimeter wave camera market. The company has just obtained a new contract from Xytrans, Inc. to supply tens of thousands of detector diodes for sensors Xytrans is developing for 100 GHz military and commercial passive imaging systems. A major application is concealed weapons detection beneath clothing. HRL's detector capitalizes on the Malibu Labs' expertise in Sb (antimonide) based electronics, which has been developed over more than a decade and supported by internal research and development funds, as well as Defense Advanced Research Projects Agency (DARPA) contracts.

HRL's Software and Algorithms Enable Automatic Alerts for Security Applications

HRL has developed algorithms and software that fuse the images from multiple video cameras to enable three-dimensional tracking of objects. The technology works equally well from moving or fixed cameras. HRL has also developed algorithms and software to identify selected human behavior such as entering or leaving a vehicle. The combination of these two capabilities enables automatic alerts for security applications such as attempted auto theft from parking lots and people climbing over fences.

CRUCIAL STEPS IN SHOWCASING OUR ABILITIES AND ENHANCING OUR CREDENTIALS

HRL Announces Installation of Video Analysis Test Facility

LOS ANGELES, December 22, 2005 — HRL is installing a 39-camera video analysis test facility at its Malibu facility for development, testing, and demonstration of video analysis algorithms and software. The facility will be used for developing military, homeland security, and commercial security applications. The facility will be in operation by February of 2006. Innovative tools for improving the performance and efficiency of security systems will be demonstrated in an actual industrial security environment.

A YEAR OF INNOVATIONS

Larry Burns of GM (left) and Matt Ganz of HRL with GM's HydroGen3 fuel-cell van, which was displayed at the Hydrogen Storage press briefing.

■■■ HRL Hosts GM Press Briefing on Hydrogen Storage

On March 8, 2005, HRL offered the breathtaking backdrop for the General Motors Hydrogen Storage "Deep Dive." The event was an opportunity for GM and HRL to present a snapshot of the challenges, goals, and progress in advanced hydrogen storage. Such storage is the key, according to scientists from both companies, to the future of the hydrogen-powered automobile and a non-polluting future.

Attending the press briefing were writers from *Scientific American*, *Reader's Digest*, *Detroit Free Press*, *Forbes*, *Road & Track*, *e Magazine*, *FuelCellWorks*, the *Ventura County Star*, and the *Daily News*.

Presenters included Larry Burns, GM Vice President of Research and Technology, Jim Spearot, Director, GM Chemical and Environmental Sciences Laboratory, Matt Ganz, HRL President and Chief Executive Officer, Leslie Momoda, HRL Sensors and Materials Laboratory Director, and John Vajo and Greg Olson, prominent HRL researchers on hydrogen storage. Referring to the Sensors and Materials division, Jim Spearot said, "The Materials Group at HRL has been an essential element within the GM Hydrogen Storage Team, and the scientific contributions by HRL have been augmented by contracts…[and] integrated within the larger corporate storage development effort."

■■■ HRL's Breakthrough in Object Detection Technology

LOS ANGELES, December 22, 2005— HRL has developed algorithms and software for identifying the presence and location of humans and other objects in real time video by recognizing their shapes. Unlike most other methods, HRL's technology does not use motion of the objects in the algorithms. Therefore, detection from a moving video camera is no more difficult than from a stationary camera. The detection accuracy for humans is on the order of 98%. Novel biologically-inspired search algorithms are used to rapidly find humans and other objects in a scene. The software will be shown April 5-7, 2006 at ICS West at the Sands Expo and Convention Center, Las Vegas.

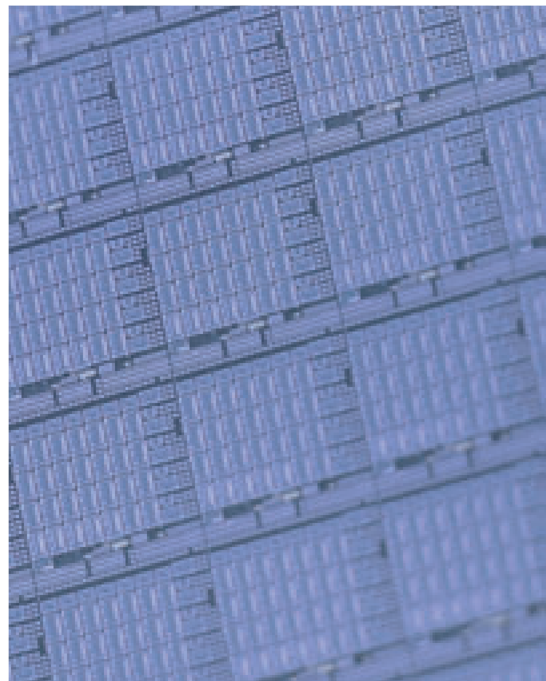
■■■ HRL Labs Demonstrates G-factor Engineering In Nano Materials

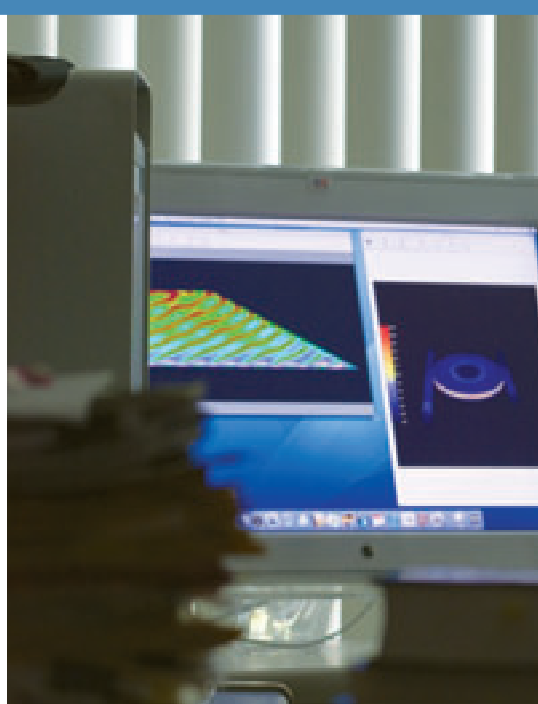
Scientists at HRL have successfully grown and characterized ultra-thin (less than 2.6 nanometers) designer materials in which the magnetic properties of electrons in semiconductors are intentionally changed in a controlled and predictable fashion. This result demonstrates g-factor engineering, a process in which the precession-rate of spinning electrons in a magnetic field can be changed based on control of the solid's composition and structure.

The ability to tune the electron's g-factor is a crucial step in the development of quantum repeaters–devices that will allow the next generation of quantum computers to talk to each other using fiber-optic light beams, in which single photons (particles of light) are used to transfer data to be stored on individual, spinning electrons. The results were first presented in December 2004, at the 5th International Conference on Low-Dimensional Structures and Devices held in Mexico, and more recently in a paper entitled "Direct Electrical Measurement of the Electron g Factor in Ultra-Thin InGaAs/InP Single Quantum Wells," which appeared in *Microelectronics Journal* [Croke et al., *Microelectronics Journal* 36, 379-382 (2005)].



Looking to 2006 as an open door to new and exciting possibilities to be pioneered by the bright minds of HRL.



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