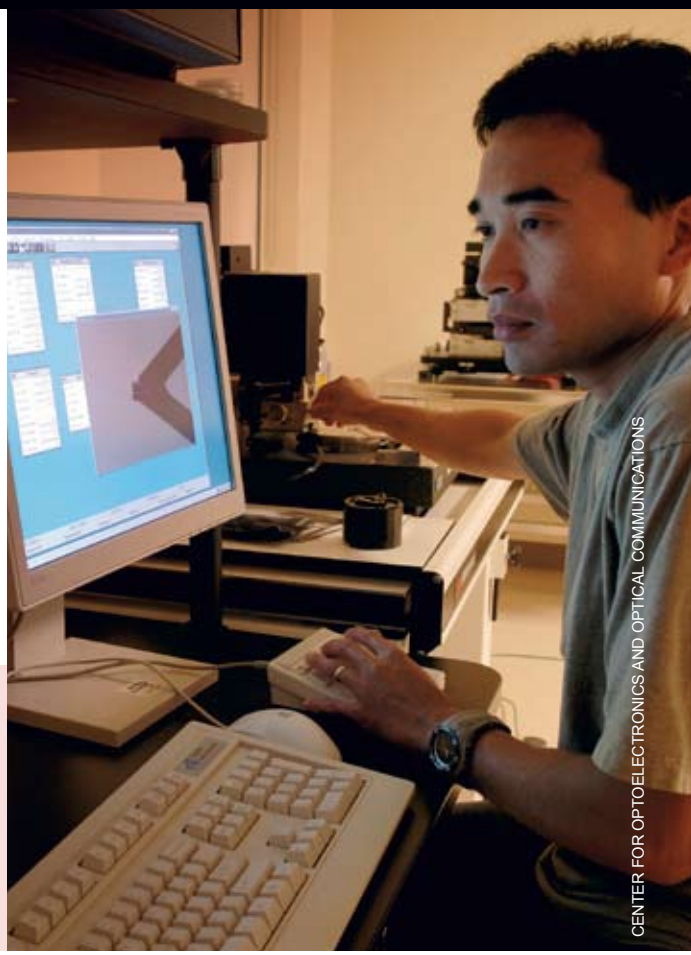
Optics — Charlotte's Focus on the Future

OPTICAL TECHNOLOGIES PERMEATE almost all hi-tech industries, and the future for optics is even brighter. For researchers in the fields of optical science and optoelectronics engineering, the spotlight is on Charlotte, a growing hotspot for photonics-related R&D.

Photonics technology can already be found in nearly every home, office and manufacturing plant. Technological innovations in areas as varied as entertainment systems, displays, data storage, telecommunications systems, internet connectivity, printers, photocopiers, lasers, security systems, surgical devices, biosensors and weapons systems are all made possible by photonics advancements. World-wide sales of technologies enabled by photonics approaches $1 trillion in 2010 according to the Optoelectronics Industry Development Association, and growth continues to be steady.

Photonics is the quintessential enabling technology. Innovations achieved through optical technologies enable the development of other new technologies, giving this high-tech area economic impact that far exceeds the technology itself. For example, fiber optics provide a means for transferring enormous amounts of data at high speed, far more than traditional wire: advances in high speed sources, detectors and all-optical networks, promise even high data rates each year. The personal communication and home entertainment industries, currently restrained by the data limits of electronic data transfer, will grow enormously. They will be revolutionized by new low-cost fiber to the home technologies that promise tens of giga-bits per second of connectivity as compared with a few mega-bits today. We should not forget that e-commerce and global information exchange depends on increased penetration of fiber technologies, which are equally critical to improving local wireless connectivity since traffic between cell-towers needs optical connectivity.

UNC-CHARLOTTE'S DOCTORAL PROGRAMS IN **OPTICAL SCIENCE** ENSURE **CONTINUED GROWTH** IN THIS AREA.



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Innovation at Light Speed

Already home to over 130 photonics facilities, North Carolina long ago recognized the potential of optical technologies. At the center of the region's optics belt (along the I-85/I-40 corridor stretching from Spartanburg, SC in the southwest to the Research Triangle Park in the northeast), Charlotte is home to one of the nation's major optical technology clusters.

As with any emerging technology, major advancements in photonics rarely take place without community synergy — the assemblage of a diverse group of industry, research and educational resources in close proximity to each other creates the critical mass or cluster necessary for collaboration, innovation, partnership and business development. Charlotte has attracted a dynamic combination of resources and is now a major center for new, photonics-driven industries.

Enlightened Research Institutions

High technology industries require close relationships with research institutions to thrive. One reason for the growth of photonics industries in the Carolinas is the presence of numerous strong research universities that provide a steady stream of advancements in the field, generate spin-off companies with optics specializations and produce a sizable workforce of highly trained optical scientists and engineers. A more subtle but equally important reason is a regional academic culture that actively seeks out and encourages collaboration among universities and with industry partners.

The University of North Carolina at Charlotte is a rapidly growing research university committed to university-industry partnerships. The university is economically involved

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CHARLOTTE IS THE **CENTER** OF THE **CAROLINAS' OPTICS CLUSTER.**

with local industry and is very application-oriented in its research. UNC-Charlotte is ranked first in the nation by the Association of Technology Managers in patent applications, second in inventions, third in patents issued and fourth in technology licenses for each $10 million of funded research.

UNC Charlotte's industry-oriented research led to the creation of the Charlotte Research Institute (CRI), a major university investment in research partnerships with strong economic potential. With facilities centered at the university's highly accessible Millennial Campus, CRI is specifically focused on the rapid development of targeted areas of university research strength such as precision metrology and manufacturing, e-business technologies and optoelectronics.

The Center for Optoelectronics and Optical Communications, a key component of CRI, combines the activities of over 30 university researchers in optical science and engineering with laboratories and user facilities that support the needs of industrial partners and start-up companies in a new 90,000 square foot building. Opened in 2006, this major facility contains state-of-the-art equipment for the design, fabrication and testing of photonics components and devices, including a 3,000 square foot clean room. The Center's equipment includes state-of-the-art materials growth and fabrication tools such as electron beam lithography, and one of only two nanoimprint tools of its kind housed in a university. Numerical modeling, imaging, test and characterization tools provide a complete capability for the production and evaluation of integrated photonic and microelectronic optical devices and systems, for industry, medicine and defense. Several new graduate programs, including a program in optical science and engineering and another in nanoscale science are aimed at producing scientists and engineers with skills in applied optical science and engineering, micro-optics and nanophotonics. UNC Charlotte is training the next generation of researchers alongside private-sector partners, providing a steady flow of discovery and innovation.

UNC Charlotte has also developed partnerships with other university optics programs that amplify the possibilities for industry collaboration in photonics research and technology development. The Carolinas MicroOptics Triangle is a partnership of UNC Charlotte, Clemson University and Western Carolina University, and provides joint resources and an affiliates program for the optics industry. The combined alliance offers optical science and engineering programs, 225,000 square feet of new building space, and $29 million in research equipment to support the growth of optics industries. The MicroOptics Triangle can support materials development,

fabrication, testing and rapid prototyping of optical components and systems. A larger consortium focused more on technology transfer and outreach to industry is the Carolinas Photonics Cluster that includes the MicroOptics Triangle schools, North Carolina State University, Duke University and East Carolina University.

With the growth of optics research in Charlotte, the future is bright for further development in optics-related industries. Fertile university-industry relationships are accelerating the growth of Charlotte's large pool of industry talent and creating dynamic partnerships that capitalize on new sources of grant funding and government contracts in areas such as defense and homeland security.

Start-up Industry — Spark For the Economy of the Future

Charlotte's optics industry and research institutions are creating a fertile breeding ground for transformative ideas and innovation, the foundation for growth in high technology. UNC Charlotte and its optical science and engineering programs have already spawned a number of new companies, among them Digital Optics Corporation (now Tessera), OpSource Inc., Albany Instruments Inc., Nanoresist Technologies Inc. and Dot Metrics Inc. Charlotte-based Tessera is an internationally known company in the field of micro-optics and now employs a professional workforce of more than 150.

What is Photonics?

Photonics refers to the generation, manipulation and detection of light or photons, primarily for conveying information in a communication, imaging and sensing systems, but is also important in energy harvesting and energy conservation. Photonics technology includes lighting, displays, solar cells, environmental sensors and a host of other applications built on the fundamental science, engineering and technology of generating, transporting and detecting light. Optics, optoelectronics and photonics are all terms used to describe this very broad field. Photonics research is aimed at scientific discoveries and technological advancements that arise from the study of the physics of photons' interactions with any kind of organic or inorganic materials. Many new discoveries have been made in the last few years relating to the interaction of light with matter, especially at the nanoscale, the realm of atoms and molecules.

Much of high technology is currently based on electronics — the manipulation of the flow of electrons, which are negatively charged particles of matter found in every atom. The unique properties of photons, however, offer enormous physical advantages that promise to move much of our most advanced technology to a new generation of technologies where electron and photon interactions are are controlled at the nanoscale. Our ability to fabricate and control these interactions at the nanoscale is the secret to exploiting fundamentally new phenomena for our technological advantage. Photons are not charged and do not interfere with each other. The interaction of electrons and photonics on the nanoscale and new fields such as nanoplasmonics are rich with the potential to create new industries in much the same way as the semiconductor industry progressed over the last 30 years and gave us the silicon integrated circuit, or "chip." Integrated photonic circuits are on the horizon, and their impact on future technologies will be at least as great as that of the silicon chip on society's recent past. Inexpensive and superfast integrated photonic chips, manufactured at a low cost for example by nanoimprinting is a driving force stimulating much of the growth we see today in new information and energy related photonics technology ranging from smarter phones to more efficient lighting.

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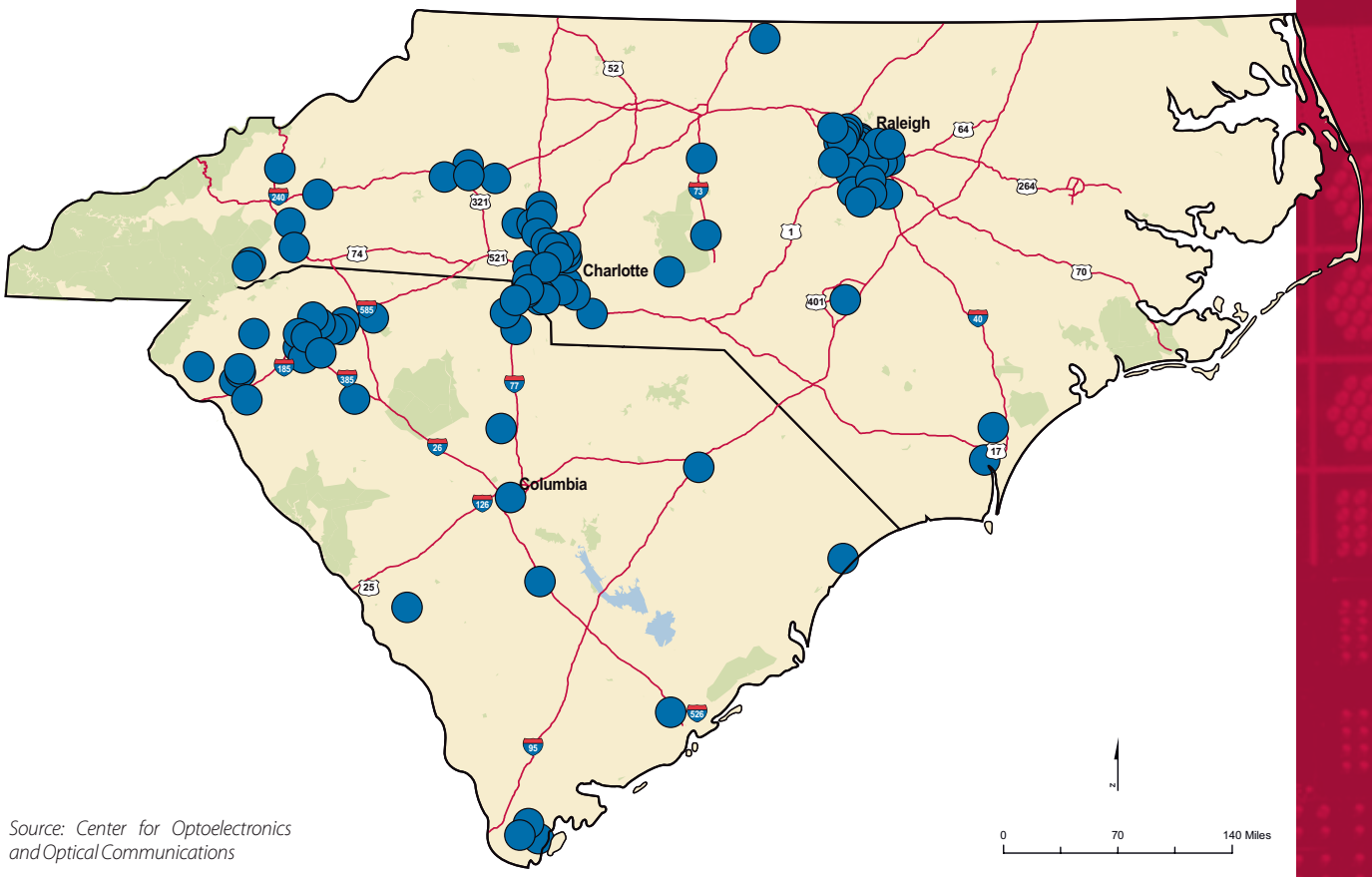
OVER **30 UNIVERSITY RESEARCHERS** IN **OPTICAL SCIENCE** ARE AVAILABLE **LOCALLY**.

Attracted to the Light

Why is Charlotte in the limelight for photonics-based and optics-related industries? Just as the city is a hub for other sectors such as finance, information technology and defense, Charlotte offers new technology companies an environment in which they

Photonics Facilities in the Carolinas



Source: Center for Optoelectronics and Optical Communications

can combine high quality of life, reasonable cost-of-living, strong educational institutions, and a highly trained and diverse workforce with a progressive, pro-business climate.

Charlotte matches technical and cultural sophistication with a relaxed, "small-town" feel. It's a city where history and traditions have melded with a decidedly 21st century atmosphere. Photonics' light-speed technologies will continue to make Charlotte's future bright.

Center for Optoelectronics and Optical Communications

Dr. Michael A. Fiddy, Director
UNC Charlotte, Charlotte, NC 28223
704-687-6078
mafiddy@uncc.edu
http://opticscenter.uncc.edu

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