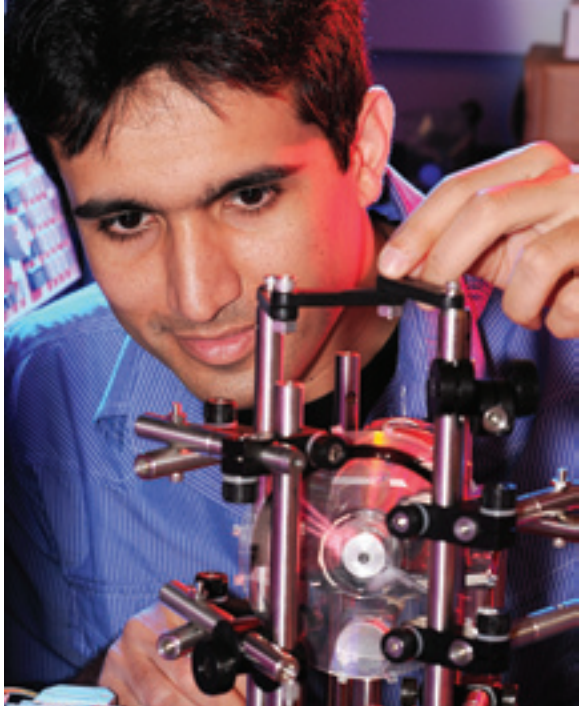

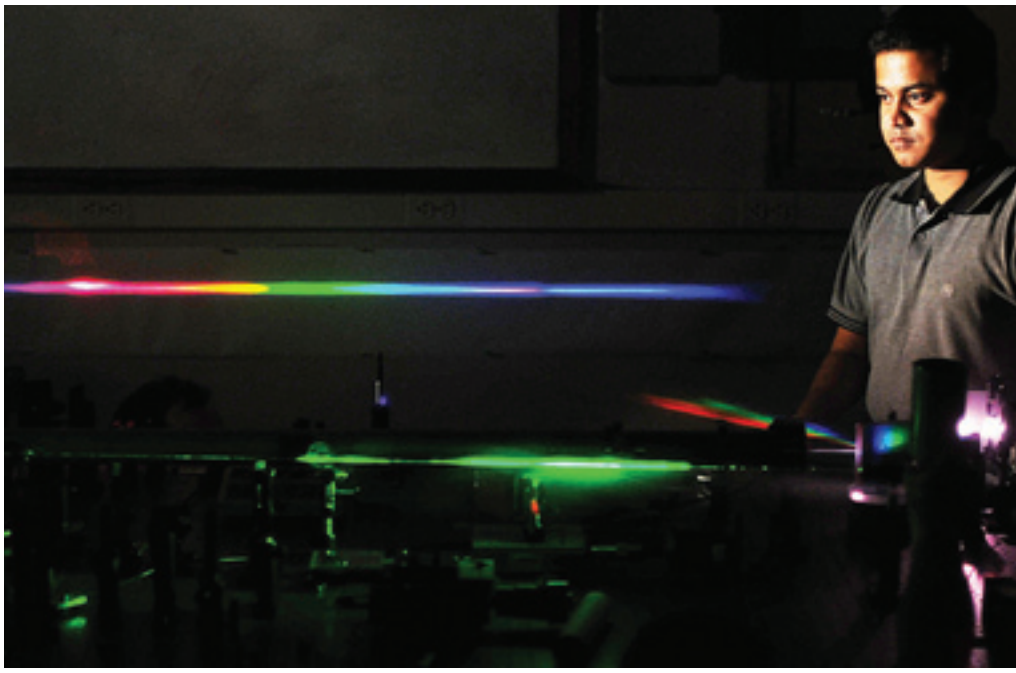

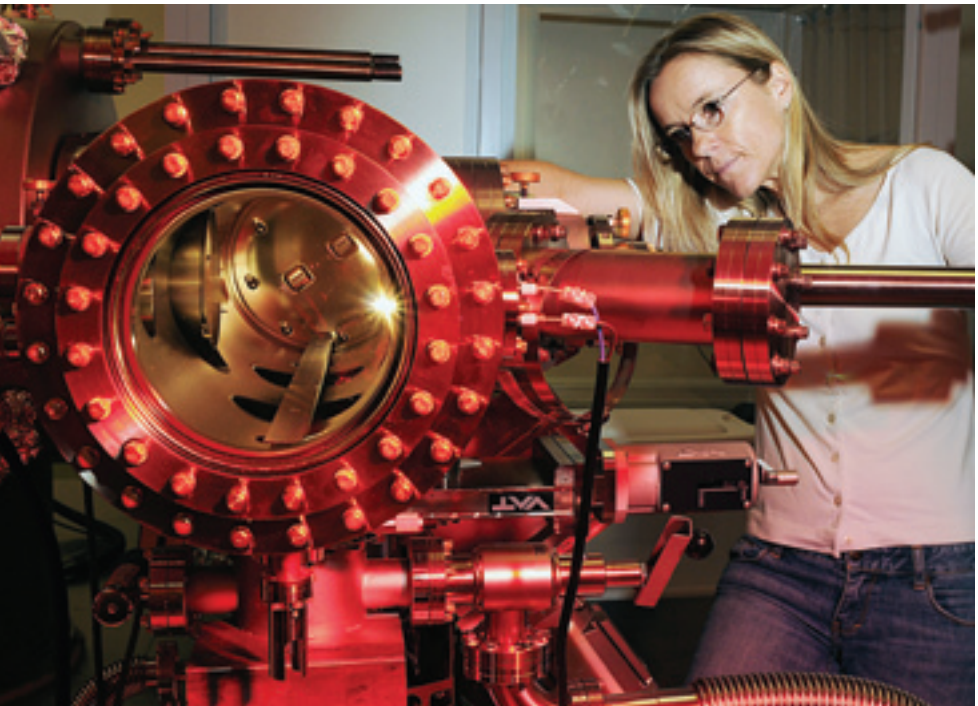

Patricia Daukantas

CREOL at 25

A Full Spectrum of Achievements

A quarter-century ago, the Florida legislature funded an optics center to diversify the economy of the state's central region. Today, the center has grown into a full-fledged photonics college known for world-class research.

On the side of a brick building on a modern, well-groomed campus, a diffraction-grating sculpture breaks the blazing Florida sunshine into its shimmering spectrum. The pure colors, however, only hint at the brilliance of the work going on inside.

The institution within that building—CREOL, the College of Optics and Photonics at the University of Central Florida in Orlando—is marking the 25th anniversary of its founding in 1987. From its beginnings as a specialized center with temporary space and faculty appointed to scattered departments, CREOL has become a full-fledged college within one of the largest universities in the United States. Indeed, it was the first college of optics in America. It retains the CREOL acronym in homage to its roots as the Center for Research in Electro-Optics and Lasers.

Today, CREOL encompasses a next-generation laser physics center, the Townes Laser Institute and the Florida Photonics Center of Excellence—a state-funded program to develop optical technologies in areas of rapid market growth. The college has an incubator for fledgling companies and a solid track record of placing its alumni in the optics industry. Research spans the spectrum from terahertz frequencies to X-rays. Faculty members hold degrees in various subjects—chemistry and materials science as well as physics and engineering—but they work together in a tight-knit, collegial environment.

(Facing page) CREOL personnel conduct research in (clockwise from top right) geometrical optics, white-light continuum generation, nonlinear optics, molecular-beam epitaxy, lasers, and optical materials. Scientists pictured include Mohammad Piracha, Himansu Pattanaik, Soroush Shabahang, Sabine Freisem, Ulka Patel, Joshua Kaufman and Esmaeil-Hooman Banaei, respectively. (This page) Ayman Abouraddy, assistant professor of optics, demonstrates one of CREOL's two fiber-optic drawing towers.

Photos by Jacque Brund

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Peter Delfyett (center) in his CREOL lab.

Jacque Brund

Delfyett: A Passion for Public Outreach

Peter J. Delfyett wants youngsters to know: It's possible to go through an urban public school system and become a leader in a highly technical profession. He should know: He's done it.

Delfyett, who moved to CREOL from Bell Laboratories in 1993, grew up in the New York borough of Queens. Although his grades qualified him for one of the city's public science academies, his father worried about sending him on a long bus ride every day, so he went to the nearby public comprehensive high school. Later on, he got his degrees (except for a master's at the University of Rochester) from the City College of New York.

One reason why Delfyett chose CREOL was to have the opportunity to work with outstanding scientists. Another was that it gave him a chance to help shape and grow the young institution.

Delfyett, whose professorship is in physics and electrical engineering as well as optics, heads CREOL's ultrafast photonics group, which studies high-power ultrashort pulses from mode-locked semiconductor lasers. His team members presented nine papers at CLEO:2012 in San Jose, Calif.

Delfyett has also logged many hours of service to OSA and other groups, including a term on OSA's Board of Directors and four years as president of the National Society of Black Physicists. In addition, he co-founded the company now known as Raydiance Inc., which manufactures and sells femtosecond-pulse lasers.

One of Delfyett's passions is showing public school students, especially those from minority populations, what being a "real scientist" is all about. The lab-coat-and-messy-hair stereotype doesn't appeal to anyone, he asserts.

"If you can show them that what you're doing is exciting, and that you have a heck of a lot of fun doing it, and that it can be financially rewarding, then you've got their attention," he says.

Like other professors, Delfyett encourages CREOL's student association to engage students of all ages in educational outreach activities.

"I've told students that when you do science, you can actually have an idea that no one else has had before," he adds. And with a lot of hard work, "you can become the first person in the known universe to see this effect happen. You become the world leader of a particular area of science."

The beginning: A caravan from Texas

In the early 1980s, then-governor Bob Graham (D-Fla.) convened a group of business leaders to figure out how to attract more non-agricultural, high-paying jobs to central Florida. Since the area already had a toehold in the nascent optics industry, the idea for a research center was born, said M.J. Soileau, CREOL's founding director.

In 1986, the Florida legislature appropriated $1.5 million annually to launch the center at the University of Central Florida (UCF), a young institution in a city better known for tourism than higher education. UCF had awarded its first degrees only in 1970, and by the mid-1980s it had about 17,000 students across all departments.

Meanwhile, optical scientists at the University of North Texas had not been making as much progress in establishing a major research center as they had hoped. They looked at what other universities could give them; some held out five-year grants, but only UCF offered "$1.5 million forever," says one of the scientists, Eric Van Stryland. Thus, the research group pulled up stakes and moved en masse to Florida. Soileau (now UCF's vice president for research), future CREOL professors Van Stryland and David Hagan, seven graduate students and 42,000 pounds (19,000 kg) of lab equipment arrived to face an uncertain future.

"Everything was a challenge," recalls Van Stryland, who eventually became the director of CREOL, the first dean of the College of Optics and Photonics and the 2006 OSA President. UCF was a young university without the infrastructure for traditional research, such as a system for recruiting and evaluating postdoctoral fellows. According to Van Stryland, Soileau had to bear the brunt of the financial battles with the university administration to get CREOL the human capital and physical infrastructure that it needed.

However, Van Stryland adds, the CREOL team could never have built such a center from scratch at an established university. "It was important that we could start with a university that didn't know what they were doing so we could teach them how to do it right the first time," he says. When the University of Arizona's optics school became a college shortly after CREOL did in 2004, its director-turned-dean, James Wyant, thanked his counterparts at CREOL for their pioneering efforts, because Wyant had been trying to make such a change happen for a long time.

CREOL's goal from the beginning was to be competitive with similar programs, according to Soileau. "We emulated, but not imitated, the Institute of Optics [at the University of Rochester] and the Optical Sciences Center [at the University of Arizona]," he says. "Both demonstrated that excellence could lead to good faculty and good students. We wanted to be mentioned in the same breath as these established programs."

Education at CREOL

At its founding, CREOL had no authority to grant degrees. The earliest graduate students, who had arrived with Soileau

CREOL's special agreement with two European universities, Friedrich Schiller University in Jena, Germany, and the University of Bordeaux in France, allows graduate students to receive dual master's degrees.

and Van Stryland, officially received their degrees from the University of North Texas. In subsequent years, students who had done their research through CREOL graduated from other UCF departments and received a "certificate of appreciation" from the optical center. In January 1996, the Board of Regents approved the M.S. and Ph.D. degrees in optical science and engineering, a few months before CREOL became a school within UCF.

The college now has about 129 graduate students, who take up to six core courses and a number of electives depending on the terminal degree. Three CREOL faculty members have won the highest campus-wide prize, the Pegasus Professor Award, for continued excellence in teaching and service—Peter J. Delfyett in 2001, Shin-Tson Wu in 2010 and Townes Laser Center director Martin C. Richardson in 2012. A professor with a joint appointment in optics and chemistry, Kevin Belfield, also won the award in 2012.

In addition to its robust graduate program, CREOL is awaiting final approval to add a bachelor's degree in optics to its curriculum. It already hosts a Research Experience for Undergraduates program with U.S. National Science Foundation funding. By offering research experience to students from other campuses, this program is helping to to recruit potential graduate students to UCF. It impresses on all participants the importance of optics and photonics in modern science and engineering.

CREOL's special agreement with two European universities, Friedrich Schiller University in Jena, Germany, and the University of Bordeaux in France, allows graduate students to receive dual master's degrees. Clemson University in South Carolina is also part of the consortium, which is called the Atlantis-MILMI Program (for Master International in Laser, Materials science and Interaction). CREOL has a strong reputation with several Mexican universities, says optics professor Delfyett, a member of the technical committee for the next Latin America Optics and Photonics Conference in Brazil.

Four scientific societies, including OSA, have chapters at CREOL; in addition, an umbrella group called the CREOL Association for Optics Students coordinates interactions among the chapters and organizes educational outreach activities, including the annual CREOL open houses for the UCF community.

Scientific accomplishments

One measure of the scholarship of CREOL's faculty is the national and international awards its members have received, according to Bahaa E.A. Saleh, who became the college's dean in January 2009. For example, CREOL has notched three of OSA's R.W. Wood Prizes for an outstanding discovery or invention: Van Stryland and CREOL alumnus Mansoor Sheik-Bahae (now at the University of New Mexico) in 2012, Demetrios N. Christodoulides in 2011 and George Stegeman (now an emeritus professor) in 2003.

Saleh groups CREOL's diverse research tracks into five broad, interdependent categories.

Lasers. CREOL has invented several new materials for lasers. Today's research group focuses on high-power lasers, especially for industrial uses like cutting and welding and developing new ceramics for these lasers, Saleh said. CREOL has recently established a new group developing attosecond lasers and ultra-precise frequency combs for use in metrology applications.

Optical fiber. CREOL is proud of its two fiber drawing towers, one for high temperatures and one for low. Not many universities have their own towers, according to Saleh. The college's researchers are producing nanostructured fibers that incorporate multiple materials. They also study mid-infrared fiber lasers and next-generation coherent optical communication systems.

Semiconductors and integrated photonics. The "hot topics" in this area include quantum dots, nanostructures, photonic crystals and holographic optical elements. The college is well known for oxide-confined vertical-cavity surface-emitting lasers, Saleh says. CREOL has a clean room for device

CREOL by the Numbers

Current faculty members
27

Cumulative papers published by faculty and students
>1,900

Cumulative paper citations
~27,000

Books published by faculty members
27

OSA Fellows
20

M.S. recipients
330

Ph.D. recipients
220

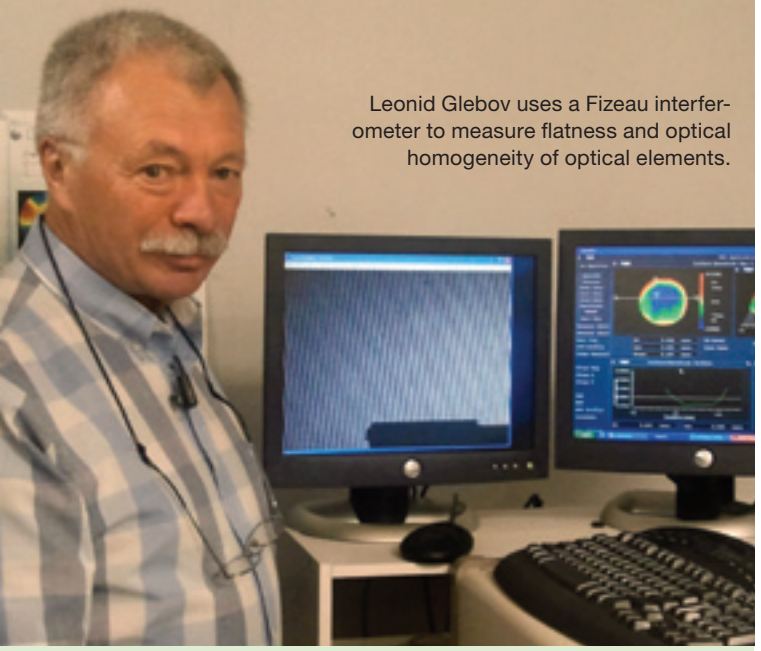
Spinoff companies
23

Industrial affiliates (current membership)
63

Patents granted over 25 years
230

Joint projects with industry over 25 years
170

Editors-in-chief of OSA journals over 25 years
6



Leonid Glebov uses a Fizeau interferometer to measure flatness and optical homogeneity of optical elements.

Julien Lumeau, CREOL/UCF

Glebov: From Soviet Lab to U.S. Company

When Leonid B. Glebov was growing up, he didn't know what a business was. Today, he is the co-owner of one.

A research professor at CREOL and the Florida Photonics Center of Excellence, Glebov grew up in St. Petersburg, Russia, when the city was known as Leningrad and part of the Soviet Union. As a college student in the 1960s, he was preparing for the field of nuclear physics when news of the laser arrived, and he eagerly switched his concentration to optics.

He finished his doctoral studies at the State Optical Institute (SOI) in Leningrad in 1974. He stayed on at SOI for almost 20 years, branching out into several areas connected to lasers. Eventually, he specialized in photosensitive glasses.

When the Soviet Union dissolved in December 1991, however, scientists lost their jobs en masse and the country did not invest in science for about a decade. Researchers had to find another source of income. But for Glebov, it was easier to change countries than careers.

Seventeen years ago, the Glebov family immigrated to the United States. After a brief stint at an industrial laboratory, Leonid joined CREOL as a research professor in September 1995. Moving to the United States was a huge change; although he knew how to read English, he had to improve his speaking fluency and adjust to the way American society works. He credits the CREOL team for helping him get acclimated—and for making the phenomenon of induced refraction into a useful technology.

Today, Glebov, a U.S. citizen, heads a 15-person research group at CREOL. In 1999 he co-founded a company now known as OptiGrate Corp., which makes volume Bragg gratings for spectroscopy and lasers. He credits UCF vice president M.J. Soileau for helping him navigate the startup waters. "I spent my whole life in the Soviet Union—I had no idea how to incorporate a company," he says. "Myself, I never would do this."

Glebov headed OptiGrate for a few years, until it grew too big for him to manage. In 2008, he turned the president and chief executive officer role over to one of his three scientist sons, Alexei. The company has doubled in size over the last three years. Leonid's wife, glass specialist Larissa Glebova, also divides her time between CREOL and OptiGrate. The company employs some former UCF students as well as Glebov's former SOI graduate student, Vadim Smirnov, who is chief technology officer.

fabrication, and it recently built a new laboratory dedicated to silicon photonics.

Nonlinear and quantum optics. Van Stryland and Sheik-Bahae invented the so-called Z-scan method for measuring higher orders of nonlinearities in optical materials. Another recent highly cited CREOL discovery, made by Demetri Christodoulides, is called the Airy beam: light that travels along curved lines in space. Several other researchers study nonlinear waveguides, quantum walks in integrated optics and plasmonics.

Imaging, sensing and display technologies. CREOL scientists are studying how to use polarization optics for biomedical imaging and nonlinear optics in microscopy for high-resolution applications. The college has a track record of developing liquid crystal display technology, including so-called blue-phase LCDs, with faster switching for smoother-looking image motion.

CREOL and industry

"The primary intellectual property that comes out of a university is the students—they get hired," Soileau says. The hiring often leads to contracts between the laboratory and the company, and may culminate in technology transfer to business or even the founding of a new company.

CREOL's business incubator operates in 10 different sites in and around Orlando, Soileau says. Sometimes a company gets big enough to "graduate" and move into its own facility, as professor Leonid Glebov's OptiGrate Corp. is doing (see sidebar). Many have received Small Business Innovation Research or Small Business Technology Transfer grants from the U.S. federal government. "This is probably one of the best universities for the transition of technology from university to industry," Glebov says.

Partnerships with universities also benefit companies, says Delfyett, who helped spin off Raydiance Inc. with technology invented under contract with the U.S. Defense Advanced Research Projects Agency (DARPA). Sometimes for-profit companies can contract with university faculty members to do cutting-edge research at a fraction of the overhead cost that it would take for the business to pursue that work.

"That kind of mix was the hope when we started, and that's the kind of mix we have," Soileau says.

Looking to the future

In the near future, CREOL leaders are looking forward to the start of the baccalaureate program "to graduate the next generation of optical engineers that is needed by industry," Saleh says. UCF's new medical school, only a few years old, should present the optics college with additional opportunities for joint research in biomedical imaging and laser surgery. The fiber optic drawing towers, also relatively new, should boost CREOL's research in optical communications, according to Saleh.

UCF's new medical school, only a few years old, should present the optics college with additional opportunities for joint research in biomedical imaging and laser surgery.

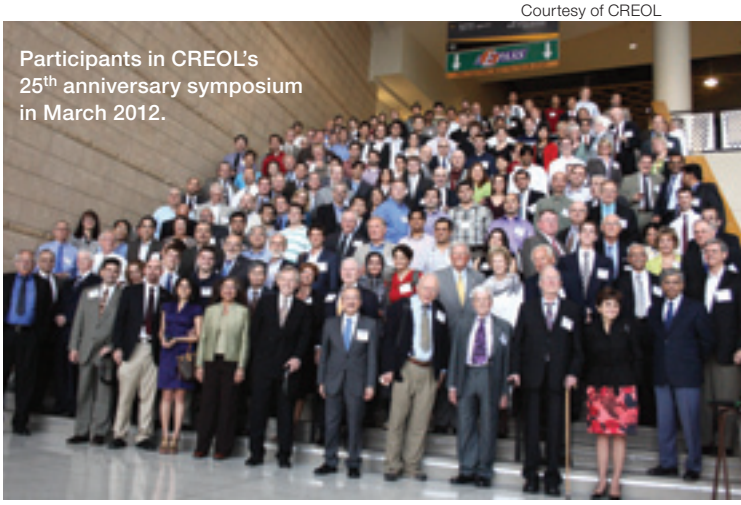
Kathleen Richardson, who worked at CREOL in the 1990s and is returning to the college's faculty this year, says she is excited that CREOL is diversifying into new research areas while maintaining its legacy strengths.

Many faculty and administrators speak of CREOL's unique environment of camaraderie and collaboration. Glebov calls it "very well-organized freedom for research." Van Stryland says that the highlight of his decade of serving as an administrator was the people he got to hire.

Certainly CREOL has come a long way from the days when the faculty lacked a dedicated building and the students had to lug around optical tables. Wherever the photonics industry goes in the next 25 years, CREOL is sure to play a major role.

Patricia Daukantas (patd@nasw.org) is a freelance writer specializing in optics and photonics.

Courtesy of CREOL



Participants in CREOL's 25th anniversary symposium in March 2012.

Richardson: From CREOL to Clemson and Back

Almost eight years after leaving CREOL, Kathleen Richardson is returning to find the college more academically diverse than ever.

Clemson University

Richardson, who develops novel glasses and ceramics for infrared optical applications, is rejoining CREOL this autumn—and bringing her research team with her. She says that the trend toward making the UCF optics college more interdisciplinary reflects the growing diversification of the field itself.

Richardson grew up in Rochester, N.Y., where she and many of her classmates always thought their careers would involve optics, the premier regional industry. She obtained her undergraduate degree in ceramic engineering at Alfred University, a short drive from the southwestern New York town of Corning and its eponymous glass company.

After graduation, Richardson spent seven years getting on-the-job optics training as an engineer in the Laboratory for Laser Energetics at the University of Rochester. She then returned to Alfred, where she received her doctorate in glass science and engineering from the New York State College of Ceramics at Alfred University.

Her first postdoctoral job, at the U.S. Naval Air Weapons Station in China Lake, Calif., required some equipment that the Navy laboratory didn't have. Her husband, Martin Richardson, had taken a job at CREOL (where he now directs the Townes Laser Center), and through him she learned that physicist Bruce Chai's lab at UCF had the right facilities for her high-temperature ceramics experiments. She became familiar with then-director M.J. Soileau and other CREOL researchers. After the state of Florida lifted a temporary hiring freeze, she joined the optics school as a junior faculty member in 1992.

Richardson then found herself feeling a little out of place as a materials scientist inside a traditional optics program focused on lasers and optical systems. In 2004, she made the strategic decision to become the director of the school of materials science at Clemson University in South Carolina, where she flourished.

After five and a half years, Richardson stepped down from the directorship to refocus her energies on her research and educational opportunities for her students. Then she decided to return to CREOL, which is strengthening its materials science program. This fall she'll return as a senior faculty member, along with three technical staff members and five doctoral students. The students will eventually receive their materials science degrees from Clemson.

"The objective is to minimize the disruption to them and their degree, but still provide them with the resources they need to finish their work," she says. "I expect to be taking on new students at CREOL as well."

Richardson's group excels at designing the composition and properties of new glass or glass-ceramic materials for bulk-form optical applications, thin films for chemical sensing and optical fibers. Their work includes precision glass-lens molding and integrated chalcogenide glass biochemical sensors.

Richardson is thrilled to be back at the same institution as her spouse, and she says that the growing number of women at CREOL reflects its diversification in research areas.

Several of the college's recent hires have research interests that overlap Richardson's. "I'm interested in working with these extremely talented colleagues to support, collaborate with, and, where appropriate, mentor them. My wish is to make optical materials at Central Florida one of the new areas that we really become known for," she says.