Manufacturing USA: RIT is involved in seven of 14 Manufacturing USA institutes. Two of the institutes are based in Rochester, with RIT leading the REMADE Institute. This places RIT among the top five most engaged universities in the network. Manufacturing USA advances manufacturing by connecting people, ideas, and technology. The network of institutes reaches across manufacturing, government, and academia. Orange indicates RIT is a contributing member. (Source: Manufacturing USA)

The Manufacturing USA institutes to which RIT has been named as a contributing member:

- **Reducing Embodied-energy and Decreasing Emissions (REMADE) Institute**
  The first RIT-led initiative, this institute selected by the U.S. Department of Energy in January will be headquartered in the Rochester region and focused on clean energy manufacturing.

- **American Institute for Manufacturing Integrated Photonics (AIM Photonics)**
  Also based in Rochester, this institute is tasked with leading the Department of Defense's (DoD) national photonics center.

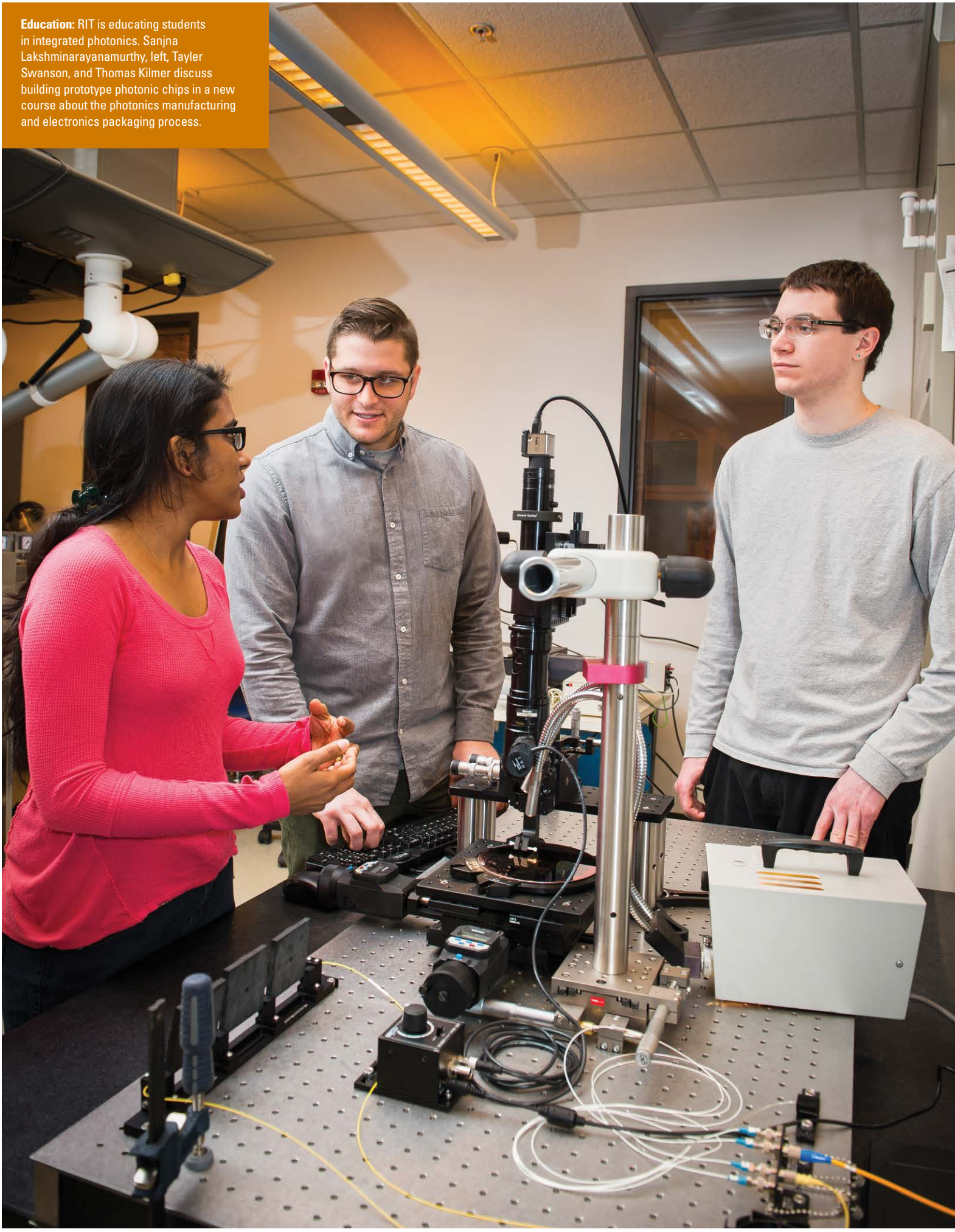
- **Advanced Robotics Manufacturing (ARM) Institute**
  RIT was named a core academic partner of the DoD's new federal robotics institute, led by Carnegie Mellon University.

- **Digital Manufacturing and Design Innovation Institute (DMDII)**
  RIT is playing a key role in the nation's first "digital manufacturing" initiative, selected by the DoD and headquartered in Chicago.

- **Flexible Hybrid Electronics Manufacturing Institute (NextFlex)**
  RIT has been funded on the first two project calls of this San Jose-based consortium awarded a Manufacturing USA grant by the DoD for flexible electronics development.

- **Clean Energy Smart Manufacturing Innovation Institute (CESMII)**
  GIS is part of a federal smart manufacturing initiative, based in Los Angeles, designed to bolster advanced manufacturing across the United States.

- **National Additive Manufacturing Innovation Institute (America Makes)**
  The pilot Manufacturing USA initiative, the Youngstown, Ohio-based America Makes is a national accelerator and the nation's leading collaborative partner for technology research, discovery, creation, and innovation in additive manufacturing and 3D printing.



Education: RIT is educating students in integrated photonics. Sanjna Lakshminarayanamurthy, left, Tayler Swanson, and Thomas Kilmer discuss building prototype photonic chips in a new course about the photonics manufacturing and electronics packaging process.

AIM Photonics Educational and Workforce Development Initiatives are Underway

by Michelle Cometa

RIT is contributing to AIM Photonics' roadmap to expand the photonics industry, providing introductory and advanced educational modules for workforce development. The university will also continue research into breakthrough photonics packaging solutions.

AIM Photonics

Harnessing light through photonics to power today's electronic devices is an industry in the making. Rochester became the focal point of that emerging industry when it was awarded a multi-million dollar federal investment in July 2015 to create a national photonics center, AIM—the American Institute for Manufacturing Integrated Photonics—part of the federal government's Manufacturing USA institutes.

The New York-based consortium includes RIT, SUNY Polytechnic, the University of Rochester, MIT, Columbia University, and the University of Arizona along with more than 90 other universities, government agencies, and corporations. The federal government allocated $110 million for the new national institute, and New York state contributed $250 million, with another $250 million expected from public and private companies. It is part of a major investment in the state that will have an impact for the country, as photonics, an emerging technology with wide-ranging potential, is essential to the nation's manufacturing capabilities in areas such as high-speed data and telecommunications.

As part of the roadmap to bring photonics technology to the forefront, RIT will provide workforce development that will include degree programs for students as well as continuing education and training courses for regional and national companies. The university's laboratories; its experience in microelectronics and microsystems engineering; and its expertise in manufacturing and mechanical systems integration, telecommunications engineering technology, and imaging position RIT to be a major contributor to the industry.

In the Classroom: Microsystems engineering Associate Professor Stefan Preble, center, helped develop the new, special topics course Photonic Integrated Circuits, one of the first to be rolled out for RIT and eventually the AIM Photonics Academy.

Integrated photonics as an industry is in its earliest stages. Contributions by consortium members such as RIT will influence how this industry is built.

Educational Programs

RIT faculty designed an integrated photonics course, one of the first that will be rolled out for AIM Photonics Academy, the educational arm of the consortium. Established in 2015 and overseen by MIT, AIM Academy intends to provide educational programs for differing levels of personnel currently in the photonics field or those seeking to enter the field. Work retraining and certification programs are planned as well as degree programs from undergraduate to doctoral levels.

"AIM Academy is looking to be the worldwide go-to organization for integrated photonics education," said Stefan Preble, associate professor of

Providing Expertise: The new courses being developed at RIT will be used at the university as well as corporate training and education options though the AIM Academy.

microsystems engineering in RIT's Kate Gleason College of Engineering.

Photonic Integrated Circuits, an upper-level course, is a combination lecture and lab class being co-taught by Preble and Dale Ewbank, senior lecturer in the electrical/microelectronic engineering program in the Kate Gleason College. They are joined by Martin Anselm, assistant professor in the manufacturing and mechanical engineering technology department, and Drew Maywar, associate professor in the electrical, computer, and telecommunications engineering technology program, both part of RIT's College of Applied Science and Technology.

This first introductory class has more than 20 students enrolled to learn about the overall photonics manufacturing process and to produce a prototype chip. It will be the basis for degree program concentrations and an eventual master's degree concentration specific to photonics integration and manufacturing, including the complex packaging assembly process.

"We have so many talented, technical people that are looking to move into this technology," said Preble, part of the team at RIT developing the new photonics curriculum. "What are the things we need to be teaching our students? That's really the starting point for us in developing education programs in this field because we need to know what industry is actually looking for."

RIT is working closely with industry to determine skills and training that will best foster job growth in integrated photonics. A team led by Ben Zwickl, assistant professor of physics in the College of Science, and Kelly Martin, assistant professor of communication in the College of Liberal Arts, founded the Photonics and Optics Workforce Education Research group in 2014 to study education and careers in the Rochester-region photonics industry.

They are also collaborating with researchers from two other AIM partner institutions, MIT and the University of California Santa Barbara, on a comprehensive workforce needs assessment study to determine how AIM can best support career paths into integrated photonics. RIT is leading data collection with

companies located in New York, while the other groups are focusing on Massachusetts and California.

Early results from the interim report indicate there are critical skills necessary in the key phases of photonics: circuit design, testing, packaging, assembly, and system integration.

Integrated Photonics Packaging Challenges

A comprehensive photonics ecosystem is a goal for AIM and the AIM Academy. The organization's approach includes developing technological tools for the design of photonics devices as well as establishing high-tech packaging assembly and testing processes and facilities.

This technological work is being combined with multi-layered workforce development objectives. With this structure in place, the ability for companies to integrate the new technology to improve current products or develop newer ones expands the marketplace.

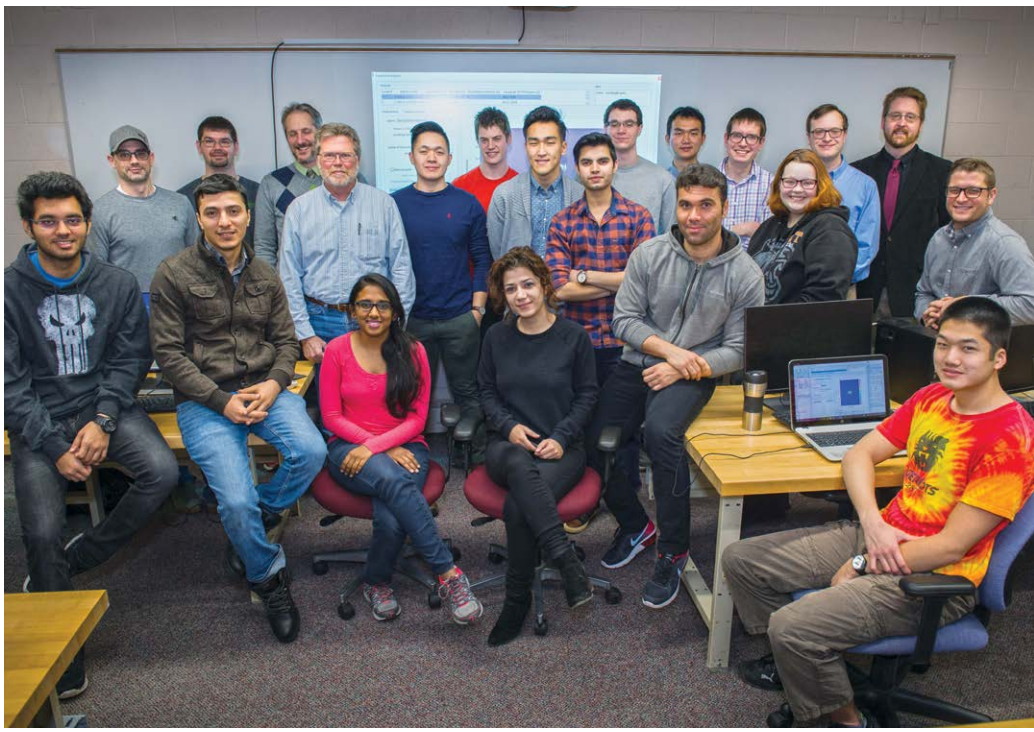
One area where RIT excels is in electronics packaging. Its Center for Electronics Manufacturing and Assembly (CEMA) supports local companies in building test beds for prototype electronics devices that are exposed to different types of electrical, optical, or thermo-mechanical stresses to test reliability and functionality.

"The AIM Photonics organization has plans to do those same types of tests for new integrated photonic circuits, but that is further downstream, and they have more immediate needs right now," said Anselm, a faculty-researcher who also serves as director of CEMA.

Attaching fiber optics to a circuit is a complex and time-consuming part of the process, even before the chips can be mass-produced for devices. Researchers such as Preble and Anselm are working on both fiber attachment solutions and related manufacturing processes.

Fiber must align on the silicon, but it is much smaller than components for an electronic circuit, needing precision and different materials to anchor the fiber to the base chip.

Anselm described the overall process challenges: With an electronic circuit, electrons pass through a conductor such as copper or the soldering material; heated to its melting point, that material coalesces into separate, tiny droplets that align with features on the circuit board to close the electrical circuit.



Introductory Course: Undergraduate and graduate students in the Photonic Integrated Circuits class interact with faculty from the Kate Gleason College of Engineering and College of Applied Science and Technology during the semester, each with expertise in photonic circuit design and electronics packaging.

For photonics, light in an optical fiber needs to be perfectly aligned to a feature on a piece of silicon. Light is sent through the fiber and a reading of its peak intensity is measured.

"Now the challenge becomes how am I going to hold that fiber in place? Researchers are trying to apply electronic circuit attachment concepts to photonics but there is no solution—yet," said Anselm, who added that fibers must be affixed with materials that do not degrade due to heat or humidity inherent in the close proximity of the circuit's structures and interfaces. Further manipulation of the circuit is needed to protect the fiber before testing.

AIM Photonics was created to build streamlined, high-volume manufacturing capabilities. That infrastructure doesn't exist today because the technology to build photonic devices is so sophisticated that only the most elite companies can do it, and usually for only specialized applications such as military heads-up displays, Anselm explained.

Utilizing the model of the electronics industry infrastructure, fine tuning it, and making it more precise is a goal, but comes with a downside. The current outcome is a slower process with higher costs, impacting volume.

"If you do things one or two at a time, and it takes an army of Ph.D. engineers to put something together, then the price is astronomical," said Anselm, who is working with Preble and Maywar in developing photonic packaging education materials to be used for all levels of training needs. "But part of the long-term, broader impacts to all this type of research and work that AIM Photonics is doing—that RIT is doing—is to try to develop the technology that will make it more mass producible."

On the Web

AIM Photonics
www.aimphotonics.com