Georgia Tech

Research News

Georgia Institute of Technology
Research Communications Office
Atlanta, Georgia 30332-0800
404-894-3444

For Immediate Release
May 13, 1991

MIXING OPTICS & ELECTRONICS: NEW TECHNOLOGY MAY OFFER LOW-COST HIGH QUALITY INTEGRATED OPTIC DEVICES

A newly-developed microelectronic process and transfer technique may permit the manufacture of low cost, high quality optical devices for light emission, detection and processing on silicon integrated circuits. By placing expensive optical components only where needed on the silicon circuit, the new manufacturing method -- which uses an epitaxial lift-off technique -- will facilitate the mass production of integrated optoelectronic circuits.

Integrated opto-electronic circuits are vital to the next generation of consumer electronics such as videophones, fiber optic data links and imaging systems such as high definition television. These low-cost integrated optoelectronic transmitters and receivers will help connect computers and homes to optical fibers capable of carrying large amounts of video, voice and alphanumeric data.

Dr. Nan Marie Jokerst and Graduate Student Christophe Camperi-Ginestet study gallium arsenide deposition at Georgia Tech's Microelectronics Research Center. (Color/B&W Avail)

"We are taking the best of both worlds, using the complex circuit capabilities of silicon to put the 'brains' into the devices, and combining that with the light emission, detection and processing capabilities of gallium arsenide," said Dr. Nan Marie Jokerst, assistant professor of electrical engineering at the Georgia Institute of Technology. "We have focused on integrating gallium arsenide and silicon through an easy, efficient manufacturing process which should produce lower cost optical devices integrated directly onto silicon."

FOR MORE INFORMATION:

ASSISTANCE/PHOTO:
John Toon, (404) 894-3444
RESEARCHERS:
Dr. Nan Marie Jokerst, (404) 894-8911
Dr. Mark G. Allen, (404) 853-9419
Dr. Timothy Drabik (404) 853-9450

- OVER -

Gallium arsenide and related compound semiconductors are used to produce the tiny lasers which emit light for transmitting information on fiber optic cables. Devices made from these materials also detect and switch the light signals.

While silicon remains the material of choice for the complex integrated circuits which provide the brainpower for modern computers, it cannot be used to make devices that emit light with electrical stimulation alone. As a result, gallium arsenide must be used to transfer information to these silicon brains from the fiber optic interconnections between computers.

The increasing demand for fiber optic interconnections -- which can carry many more signals at a time than electrical interconnections -- means that silicon and gallium arsenide must be used together. A major electronic engineering concern today is how to best integrate these two materials in a cost-effective and manufacturable way.

"Nature seems to have made it very difficult to build components capable of switching or generating light on silicon devices," said Dr. Timothy J. Drabik, assistant professor of electrical engineering and another member of the research team. "The lack of a good technology for putting light modulators or light generators on silicon hinders progress in computing devices that use electrical inputs and outputs together with optical inputs and outputs. Growing films on relatively large silicon wafers involves considerably more difficulty and expense than growing them on gallium arsenide wafers."

The Georgia Tech team grows gallium arsenide devices atop a gallium arsenide substrate and peels these high quality devices from the substrate using a process recently developed by Bellcore. The original Bellcore process has been modified at Georgia Tech to address manufacturing and cost issues such as alignment of the devices and selective placement onto the host substrate.

The Georgia Tech process involves placing these gallium arsenide devices onto a transparent polyimide (polymer) sheet. This polyimide sheet is then used to align each device or an entire array of devices on top of the silicon host wafer. The device(s) are then transferred from the polyimide to the host substrate.

The gallium arsenide devices, or "chiplets," can be manufactured in sizes from two microns up to one centimeter on a side, and as thin as 1 to 2 microns. The chiplets can be deposited onto nearly any smooth host substrate, including silicon, glass and lithium niobate -- where gallium arsenide cannot directly be grown.

The Georgia Tech researchers are currently studying the use of automated alignment equipment for depositing the chiplets onto host wafers.

"The chiplets are so thin that the flatness of the host silicon wafer is not substantially affected by their presence," said Dr. Mark G. Allen, also a member of the research team and an assistant professor of electrical engineering. "This permits the use of standard semiconductor fabrication processes which may help lower the cost of manufacturing optoelectronic circuits from gallium arsenide on silicon."

> ***"We have focused on integrating gallium arsenide and silicon through an easy, efficient manufacturing process which should produce lower cost optical devices integrated directly onto silicon."***
> ***Dr. Nan Marie Jokerst***

For instance, the wires connecting the silicon and gallium arsenide devices can be produced with the same microscopic metallization techniques now standard in the semiconductor industry, Jokerst noted. "The use of conventional techniques may bring to optoelectronic devices the same economy of scale that has helped lower the cost of conventional silicon circuits," she said.

The devices were fabricated using the microfabrication and clean room facilities of Georgia Tech's Joseph M. Pettit Microelectronics Research Center. Details of the process were presented at the Integrated Photonics Research Conference in Monterey, California on April 9, 1991.

Also participating in this project was Dr. Martin Brooke, also an assistant professor of electrical engineering at Georgia Tech. This research is partially sponsored by the National Science Foundation through the Presidential Young Investigator Program, and by Digital Equipment Corporation and the Newport Research Corporation.