Room-temperature transistor laser is step closer to commercialization

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Researchers at the University of Illinois at Urbana-Champaign have demonstrated the room-temperature operation of a heterojunction bipolar transistor laser, moving it an important step closer to commercialization. The scientists describe their work in the Sept. 26 issue of the journal Applied Physics Letters.

"We have shown that the transistor laser, even in its early state of development, is capable of room-temperature operation at a speed of 3 gigahertz," said Nick Holonyak Jr., a John Bardeen Chair Professor of Electrical and Computer Engineering and Physics at Illinois. "We expect the device will operate at much higher speeds when it is more fully developed, as well as play an important role in electronic-photonic integrated circuits."

Room-temperature transistor lasers "could facilitate faster signal processing, large capacity seamless communications, and higher performance electrical and optical integrated circuits," said Milton Feng, the Holonyak Chair Professor of Electrical and Computer Engineering at Illinois. Feng's research on heterojunction bipolar transistors has produced the world's fastest bipolar transistor, a device that operates at a frequency of 600 gigahertz or more, and is a natural platform on which to develop a transistor laser.

The Illinois researchers first reported the demonstration of a light-emitting transistor in the Jan. 5, 2004, issue of Applied Physics Letters. They described the first laser operation of the light-emitting transistor in the Nov. 15, 2004, issue of the same journal. At that time, the transistor laser had to be chilled with liquid nitrogen to minus 73 degrees Celsius.

Room-temperature operation is ultimately required for large-scale commercial applications, said Holonyak, who also is a professor in the university's Center for Advanced Study, one of the highest forms of campus recognition. "If this device operated only at low temperature, nobody would want it, except as a laboratory curiosity or for very limited applications."

After the demonstration of the first semiconductor laser (as well as the first practical light-emitting diode) in 1962, "it took the effort of many people eight years to get the diode laser to operate at room temperature," Holonyak said. "Then it took an additional two years to make it reliable. But the big payoff has only now just begun, after more than 40 years of additional work."

In comparison, it has taken the Illinois researchers less than a year to move the transistor laser from cold operation to room-temperature operation. "Who knows where this new transistor laser technology will be in another 40 years," Holonyak said. "The payoff part of scientific and technological advances never occurs rapidly, at least not the 'big payoff.'

"The transistor laser is still a primitive, laboratory device that will require a lot more work," Holonyak said. "Eventually, optimizing the design and fabrication will result in higher speed laser operation and improved performance, as well as a naturally advantageous way to realize electronic-photonic integrated circuits."

Co-authors of the paper with Feng and Holonyak are postdoctoral research associates Gabriel Walter and Richard Chan. The Defense Advanced Research Projects Agency funded the work.

Source: University of Illinois at Urbana-Champaign