World's first 1.3µm wavelength quantum dot laser capable of operating in high-temperature environments

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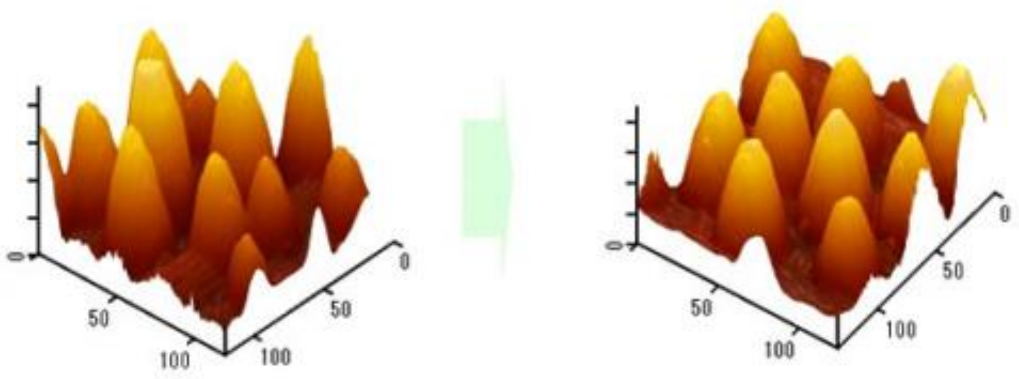

Figure 1: Conventional quantum dot dispersion (Left) and improved uniformity (Right)

QD Laser, Fujitsu Laboratories, and the Institute for Nano Quantum Information Electronics, the University of Tokyo today announced the world's first successful operation of a 1.3µm wavelength semiconductor laser at temperatures over 200°C. This was accomplished by utilizing quantum dots—nanometer-sized semiconductor artificial particles. By enabling a broader range of semiconductor laser applications, this technology shows promise for use in extremely high-temperature operating conditions, such as those encountered in oil and gas exploration.

Details of the technology will be presented at the European Conference on Lasers and Electro-Optics and the Quantum Electronics and Laser Science Conference (CLEO/Europe -EQEC 2011), held from May 22, 2011, in Munich, Germany. A portion of this research was funded by the Special Coordination Funds for Promoting Science and Technology MEXT (Ministry of Education, Culture, Sports, Science and Technology).

Expanding beyond conventional optical communication and storage fields, recent years have seen semiconductor lasers utilized in a variety of industrial areas—even in extremely high temperature operations. The exploration of oil and gas resources is one such area. When drilling a deep well it is necessary to sense whether or not what is being drilled is actually oil. However, 1.3μm wavelength semiconductor lasers used for such sensing and other applications in exploration have been limited to operations at temperatures no higher than 175°C.

Quantum dot lasers—a type of semiconductor laser that apply quantum dots to light-emitting material—surpass conventional semiconductor lasers with cutting-edge characteristics. Achieving quantum dot laser operation at high temperatures requires having as many quantum dots as possible to contribute to the laser's operation. This has consequently led to the issues of how to improve density and uniformity of quantum dots on light-emitting material.

The two types of technological advances that have enabled laser operation at high temperatures of over 200°C are as follows:

1. Improved density and uniformity of quantum dots

Improvements to quantum dot crystal manufacturing technology have reduced the degree of quantum dot dispersion and enhanced uniformity at the high density level of 60 billion dots per 1 cm^2 (Figure 1).

2. Quantum dot multiple stacking technology

Stacking eight layers of these high-density and uniform quantum dots enables 1.3μm wavelength semiconductor lasers to be operated at high temperatures of over 200°C. Under repetitive operating conditions, tests confirmed usability of lasers at temperatures of up to 220°C, and over 2 mW of optical output was obtained even at 200°C (Figure 2).

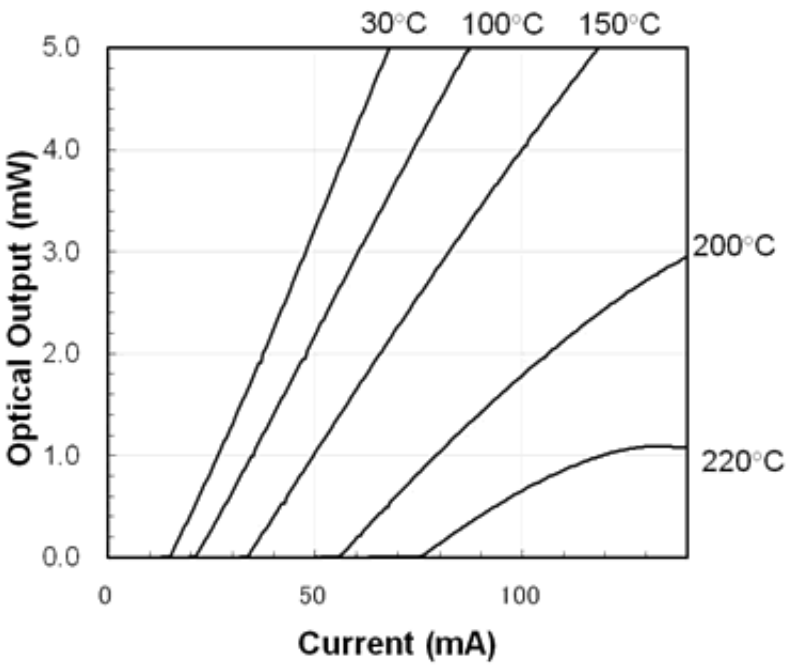

Figure 2: Current vs. optical output characteristics for quantum dot lasers

Given their operability at high temperatures, quantum dot lasers present opportunities as semiconductor lasers that can be used in severe environments too hot for conventional semiconductor lasers. Based on this technological advance, QD Laser is moving forward on the commercialization of semiconductor lasers that can be operated in environments of up to 200°C.

QD Laser will exhibit its products at LASER World of PHOTONICS in Munich, Germany, held May 23–26, 2011. Featured products will include its high-temperature laser QLF1335-AD, a 1.3μm wavelength semiconductor laser capable of operating in environments of up to 150°C, which makes it suitable for future automotive data communications and resource exploration.

Source: Fujitsu