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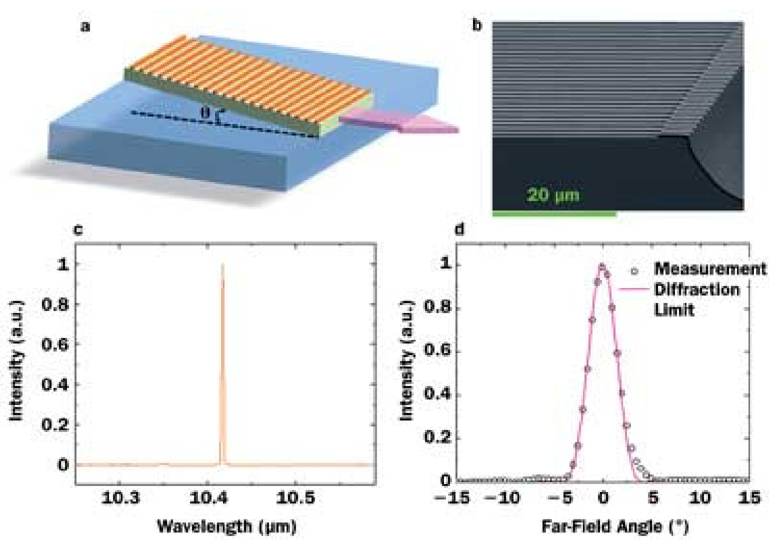
Lasers improved for standoff sensing

EVANSTON, Ill. – A new resonator design that controls both wavelength and beam quality enables the purest, brightest and most powerful beams ever from a single-mode infrared quantum cascade laser. The work improves the accuracy of the devices, critical for boosting the standoff detection of gas, explosives or other hazardous materials to even greater distances.

Almost all chemicals – including nerve gases and toxic industrial materials – can be identified by infrared absorption in the 8- to 12-µm range, making the wavelength attractive for military and industrial uses. And the relative transparency of the atmosphere at these wavelengths is useful for standoff sensing.

Successful standoff sensing applications require a high-power, single-mode laser source with exceptional beam quality. Incorporating all three qualities into a single device has presented a significant challenge, and many complex structures have been proposed with limited success.



A new distributed feedback mechanism called B-DFB has helped in the creation of a new resonator to improve laser-based standoff sensing. (a) Schematic of a B-DFB. (b) Scanning electron microscope image of the fabricated device. (c) Spectrum. (d) Far field.

Manijeh Razeghi, the Walter P. Murphy Professor of Electrical Engineering and Computer Science at Northwestern University's McCormick School of Engineering and Applied Sciences, and colleagues developed the resonator using a new type of distributed feedback mechanism called B-DFB, a simple diffractive feedback in an angled laser cavity.

The group demonstrated >6-W peak power with nearly diffraction-limited beam quality at a 10.4-µm wavelength – the highest-power single-mode semiconductor laser demonstrated at a wavelength >10 µm. Greater output power is expected with further refinement, particularly related to optimization of the cavity design and the gain medium.

"Our resonator is the most promising device for creating high-power, single-mode laser sources with good beam quality, and it is inexpensive and can be realized at room temperature," said Razeghi, who also leads the Center for Quantum Devices.

The B-DFB development is complementary to active research efforts within the Center for Quantum Devices but is not yet directly funded.

The findings appeared in *Applied Physics Letters* (doi: 10.1063/1.4747447).

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