McCormick News Article

Researchers Create High-Power Single Mode Quantum Cascade Lasers

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New laser technology developed by researchers at Northwestern University may soon allow long-distance chemical analysis that could potentially be used in spills and warfare.

Because chemicals absorb light in the infrared, it is possible to detect specific chemicals by using a laser and analyzing how much light is returned from the beam. By scanning the laser across all objects within view (especially from above), a chemical distribution map can be generated rapidly without endangering human life.

But this long-distance mapping of chemicals by laser isn't yet possible because researchers haven't created a suitable laser source. Manijeh Razeghi, Walter P. Murphy Professor of Electrical Engineering and Computer Science in the McCormick School of Engineering and Applied Science, and her group have created new laser technology that combines the high-power output of a broad area mid-infrared quantum cascade laser (QCL) with a two-dimensional diffractive resonator design that controls both the wavelength and beam quality with the laser. Their results were recently published in the journal *Applied Physics Letters.*

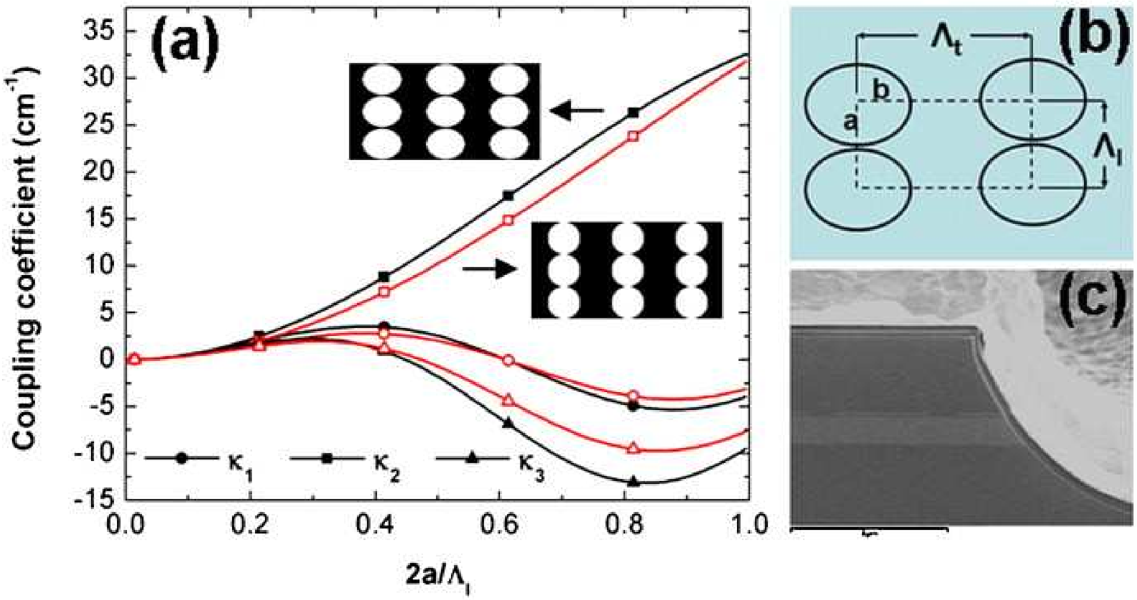
Currently, chemical detection is usually done on-site by a worker or a robotic system. The process is slow, and in cases where the chemical isn't stationary, it is nearly impossible to stay ahead of the distribution. Researchers previously realized that in order for a laser to be suitable for chemical detection it would need to be compact, inexpensive, and based on diode laser technology (similar to what is found in a DVD player). The wavelengths most strongly absorbed by many chemicals are beyond the reach of traditional diode lasers, however, and in order to detect chemicals from a distance, the laser would need output powers in the range of 10-100 watts.

The idea for the combined laser technology was first proposed by researchers at the Naval Research Laboratory. After creating the laser, Razeghi, who leads the Center for Quantum Devices, and her group demonstrated up to 34 watts of peak power at room temperature and near-diffraction-limited beam quality around a specific emitting wavelength (4.3 microns) in the infrared, which is near the absorption frequency of several important chemicals. That represents almost a factor of three improvement in output power for this type of laser source — a significant improvement in the emission spectrum.

Razeghi's work is partially supported by the Defense Advanced Research Projects

Agency’s Efficient Mid-Infrared Laser (EMIL) program. Additional funding was provided by the Office of Naval Research.

You can read the *Applied Physics Letters* paper [here]().



(a) κ_1, κ_2, and κ_3 coupling coefficients of rectangular PhC lattice with an aspect ratio of 2 with elliptical and circular features. (b) Depiction of the rectangular lattice dimensions with elliptical holes. (c) The cross section view of a cleaved facet and buried gratings on the finalized device.