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Diode Laser Turns up the Power in the Mid-IR

EVANSTON, Ill. — Research at Northwestern University has introduced new options for semiconductor lasers operating in the mid-infrared range. Led by professor Manijeh Razeghi, scientists at the university's Center for Quantum Devices have developed high-power interband lasers emitting in the 3- to 5-μm range as well as intersubband lasers emitting at lower powers in the 5- to 12-μm range.

Northwestern's interband lasers are based on bulk and superlattice InAsSb/InPAsSb configurations that lase via the interband electronic transitions between conduction and valance bands. This distinguishes them from superlattice intersubband devices developed at Bell Labs of Murray Hill, N.J., that lase through electronic transitions within the conduction band.

"For emission wavelengths between 3 and 5 μm, these InAsSb/InPAsSb interband lasers are currently the most suitable choice because of high radiative efficiency, low threshold current density and low turn-on voltage," Razeghi said. "No one has ever succeeded in controlling this [material] to have injection lasers at this wavelength and power."

Intersubband lasers, developed at Northwestern as well as Bell Labs, show more promising results for wavelengths between 5 and 12 μm, Razeghi added.

Raising the bar

The university's interband devices raised the bar for lasers emitting at 3.4 μm by achieving peak powers as high as 6.7 W in pulsed mode at temperatures higher than 100 K and with an overall differential efficiency of 34 percent. The diode laser's four semiconductor bands were based on a double heterostructure lattice (InPAsSb/InAsSb/AlAsSb) that contributed to their low leakage current and turn-on voltage.

To produce emission wavelengths above 3.5 μm, Razeghi's group used InAsSb/InAsSb superlattices. In pulse mode, these lasers reached output powers of 546 mW at 4.0 μm, 183 mW at 4.26 μm, 460 mW at 4.45 μm and 230 mW at 4.76 μm. Continuous-wave outputs were 94 mW at 4.0 μm, 30 mW at 4.26 μm and 15 mW at 4.45 μm. Operating temperatures hovered around 150 K.

Lifetime of these interband lasers is very high, Razeghi reported. "Preliminary life testing didn't observe any degradation. Our lasers are exactly like other semiconductor lasers in that their lifetime is related to defects in structure," she said. □

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