Low-Current Density THz Quantum-Cascade Lasers with Operating T > 150K

Scientific Achievement

A CINT User Team demonstrated a three-well GaAs/AlGaAs THz quantum-cascade laser (QCL) design that achieves high operating temperatures while using unusually low peak current-densities, a key step toward practical high-power THz sources for spectroscopy, imaging, and sensing.

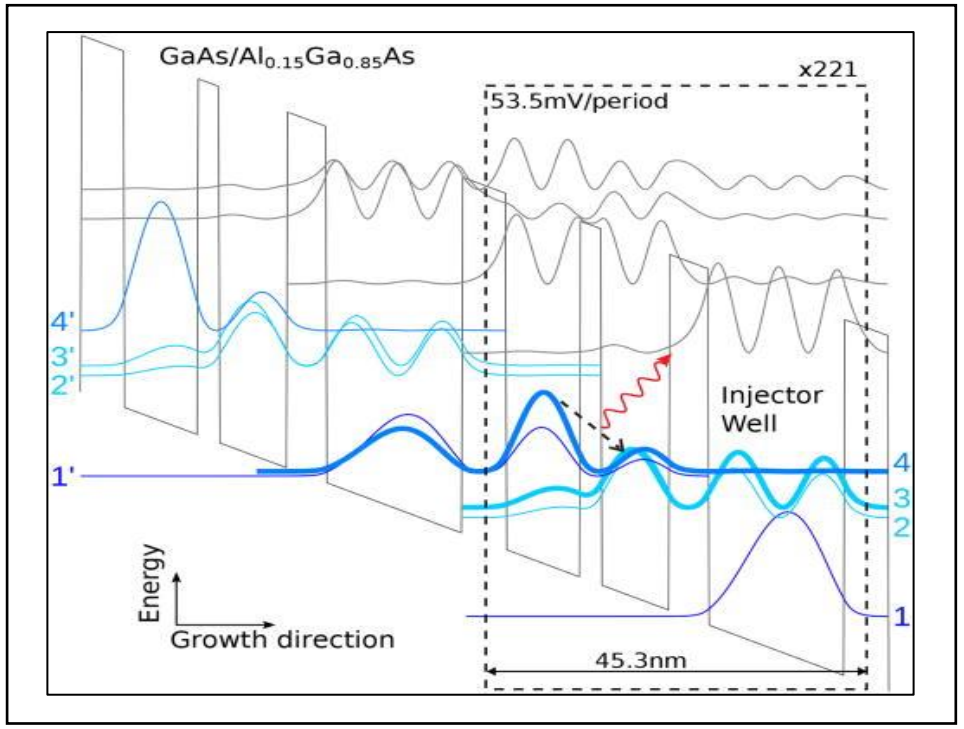

Figure: Conduction band diagram for a three-well resonant-phonon THz QCL design with one-well injector

Significance and Impact

This three-well resonant-phonon, one-well-injector design is simpler to optimize aiding manufacturability and design iteration. Using epitaxial growth with As_2 (dimer) arsenic reduced operating current densities by 20–30% compared to As_4 (tetramer), offering a practical growth parameter to tune electrical performance.

Research Details

- QCLs were grown using molecular beam epitaxy (MBE) alternately with As4 or As2 to compare arsenic species effects.
- This design presented record low peak J = 367 A/cm2 at Tmax ≈ 153 K and continuous-wave (CW) operation to 109 K for a 60 µm-wide Fabry-Pérot cavity.

Work was performed, in part, at the Center for Integrated Nanotechnologies.

Zhu, Q.; Addamane, S. J.; Kumar, S. Low Current-Density Thz Quantum-Cascade Lasers with Three-Well Period, Epitaxially Grown with AS2 and AS4 Sources. *Applied Physics Letters.* 2026.