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Monolithic Integration of Quantum Cascade Structures

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INTRODUCTION

- Quantum Cascade Lasers (QCLs) are the stand-out mid-infrared light source due to:
  - Compactness
  - Widely tailorable emission characteristics
  - Room temperature operation
  - High brightness
- Quantum Cascade Detectors (QCDs) can be fabricated from the same epitaxial structure as QCLs
- Monolithic integration of QCLs/QCDs on an InP-based waveguiding platform affords:
  - High optical coupling efficiencies
  - Small area detector for noise suppression
  - Long detector path length for increased quantum efficiency
  - Robustness
  - Portability

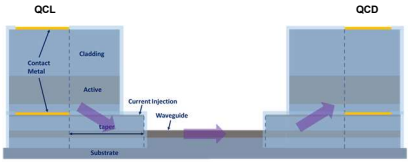

Figure 1 Monolithically integrated QCL, passive waveguide, QCD.

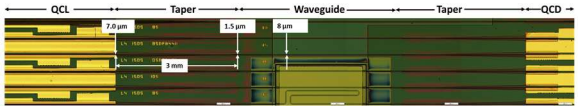

Figure 2 Fabricated QCL/QCD chip.

FABRICATION PROCESS

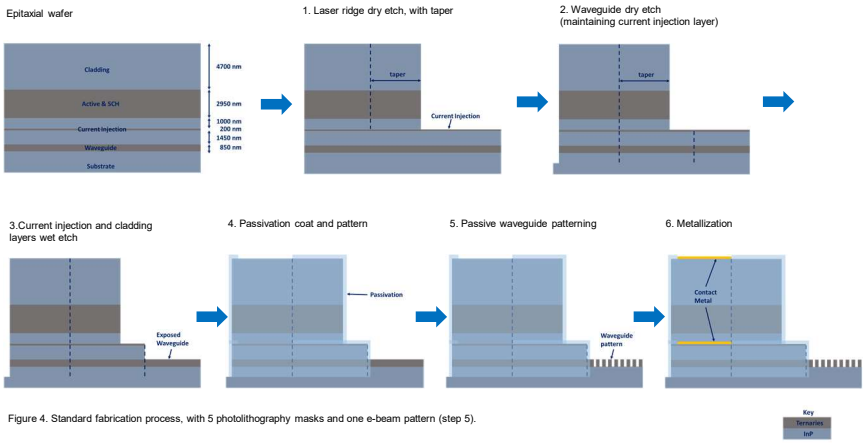

Figure 4. Standard fabrication process, with 5 photolithography masks and one e-beam pattern (step 5).

SIMULATION

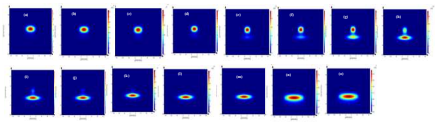

Figure 3. Evolution of fundamental TM mode from QCL active region to passive waveguide

APPLICATION

Portable trace gas sensor, based on:
- Subwavelength patterning, or
- Photonic crystal
- Waveguide suspension

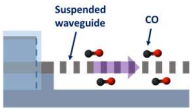

Figure 5. Passive region patterned with a suspended subwavelength structure for trace gas sensing

UPCOMING WORK

Device evaluation of:
- Lasing
- Coupling
- Detection

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