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Monolithic Mid-Infrared Photonic Integration of a Quantum Cascade Laser and a Passive Semiconductor Waveguide KALE J. FRANZ, CLAIRE GMACHL, Princeton University, KUEN-TING SHIU, STEPHEN R. FORREST, University of Michigan, Ann Arbor and Princeton University — On-chip integration of a quantum cascade (QC) laser with a passive semiconductor waveguide is reported. We use conventional semiconductor processing techniques to fabricate a QC laser directly coupled to a passive waveguide, where the unbiased active region and the lower cladding layers of the QC laser are used as the waveguide. The QC architecture is compatible with this technique due to the different allowed optical transitions when the QC structure is biased (for laser operation) and unbiased (for the passive waveguide). Thus the same epitaxial layers are made to emit light under bias and not absorb that same light when unbiased. The waveguide portion of the structure is fabricated by using a selective etch to remove the top InP cladding layers above the QC active core. We find the effective refractive index contrast provided by the etch step between the laser and waveguide to be sufficient for providing optical feedback for the laser. For our structure, we calculate a laser-waveguide “facet” reflectivity of about 3% based on a 25% increase in threshold current density compared to the same laser structure with two cleaved facets.

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