Colin Boylea et al., J Phys Chem Biophys 2014, 4:5
http://dx.doi.org/10.4172/2161-0398.S1.007

Metal/semiconductor grating-coupled substrate-emitting quantum cascade lasers for high-power cw operation in the mid-infrared

Colin Boylea, C Siglera, J D Kircha, L J Mawsta, T Earlesb and **D Boteza**
University of Wisconsin, USA

Monolithic surface-emitting semiconductor lasers hold promise for significant advantages over edge-emitting lasers in terms of both reliable operation and manufacturing cost. Grating-coupled episode-down distributed feedback (DFB) surface emitters offer a path to achieving high power, single-spatial-mode and single-frequency CW operation. A second-order, metal/semiconductor grating-based device is desirable as a means to efficiently diffract the laser light through the substrate, as reported in the near-IR. Although such TE-polarized near-IR-emitting devices have produced multi-watt CW powers, in the mid-IR, where quantum cascade lasers (QCLs) naturally emit TM-polarized light, only low (~10 mW)2,3 peak pulsed powers have been achieved at room temperature from devices with DFB sections terminated by cleaved facets. Our design studies 4 indicate that symmetric-longitudinal-mode operation (i.e., single-lobe far-field) is highly favored through the use of a second-order DFB metal/semiconductor grating with a properly chosen duty cycle. The DFB grating suppresses anti symmetric-mode operation via strong absorption due to resonant coupling of the optical mode to the grating anti symmetric surface Plasmon mode, while, for an infinite-length devices, adding negligible (~0.1 cm^{-1}) loss to the symmetric mode. Thus, we project multi-watt CW single-lobe operation.4 in actual devices metal patterning and electrical isolation techniques are used to create distributed Bragg reflectors (DBR) at both ends of the DFB region, to suppress edge losses and avoid uncontrollable reflections from cleaved mirrors. Gratings have been written via e-beam lithography to adequately control the duty cycle, and etched into ridge waveguides to controllable depths by using an etch-stop layer and a highly selective vertical etch.

Biography

Colin Boyle completed a BS in Physics at Miami University in 2009 and is currently a PhD candidate at the University of Wisconsin. His research involves development of quantum cascade laser technology.

caboyle@wisc.edu