Development of Sb-based Mid-IR Interband Cascade Lasers
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Interband cascade (IC) lasers that utilize optical transitions between the conduction and valence bands in a staircase of Sb-based type-II quantum wells (QWs) [1] represent a new class of mid-IR diode lasers. By combining the advantages of quantum cascade (QC) lasers [2] and type-II quantum well interband lasers, type-II IC lasers were projected by simulations [3,4] to operate in cw mode up to room temperature with high output power. Although significant advances toward such a high performance level have been reported [5] in terms of high peak output power and power conversion efficiency, the amount of effort expended in developing Sb-based IC lasers is very limited in contrast to other semiconductor lasers such as InP- and GaAs-based QC lasers, and their performance is still far from the theoretical projections. Here, we will report the development of Sb-based mid-IR IC lasers at the Jet Propulsion Laboratory.

We have recently grown type-II IC laser structures using molecular beam epitaxy (MBE) on GaSb substrates. The laser samples have been examined by x-ray and exhibited many sharp satellite peaks, indicating good crystal structural quality. Broad area stripe lasers were made from the IC laser samples and mounted on Cu-blocks for testing. Lasers made from one sample lased at ~2.8 μm, but didn’t show high quantum efficiency due mainly to the substantial deviations between the actual growth and design. The lasers made from another sample lased near 4 μm with high quantum efficiency. Under pulsed conditions, the 4-μm lasers lased at temperatures up to 220 K, the highest reported in the literature for interband diode lasers at this wavelength. The maximum operation temperature was limited by device damage somehow related to imperfect device fabrication. The 4-μm lasers also lased under cw conditions at temperatures above 80 K. The detailed characteristics of these lasers and the updated results will be discussed.

1. R. Q. Yang, at 7th Inter. Conf. on Superlattices, Microstructures and Microdevices, Banff, Canada, August, 1994; Superlattices and Microstructures 17, 77 (1995).