Low Threshold Long Wavelength Interband Cascade Lasers

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Interband cascade lasers (ICLs) [1-2] employ type-II quantum wells (QWs) as the active region and can cover a wide range of mid-IR spectrum with high performance especially in wavelength range from 3 μm to about 6 μm [2-4]. In this work, we report significant improvements in long wavelength ICLs in terms of reduced threshold current density J_{th} and voltage V_{th} compared to previous ICLs [5]. For example, in cw operation, the J_{th} at 80 K is below 9 A/cm^2 with output power exceeding 100 mW/facet and with a lasing wavelength near 10.7 μm close to 140 K as shown in Fig.1. Such a low J_{th} indicates a weak SRH recombination, suggesting a good material quality. The threshold voltage V_{th} at 80K is 3.61 V with a voltage efficiency of 73%, which is quite high considering that the photon energy (126meV) is low at such a long wavelength (9.83 μm at 80 K). ICLs from another wafer EB7910 lased at a longer wavelength in cw mode near 11.4 μm at 80 K with a J_{th} of 24.9 A/cm^2 and V_{th} of 3.95 V, corresponding a voltage efficiency of about 55%. These ICLs were able to operate at wavelengths exceeding 12 μm in pulsed mode at 135 K as shown in Fig. 2, the longest ever reported for ICLs with standard W-shape QW active regions. Detailed results will be presented at the conference.

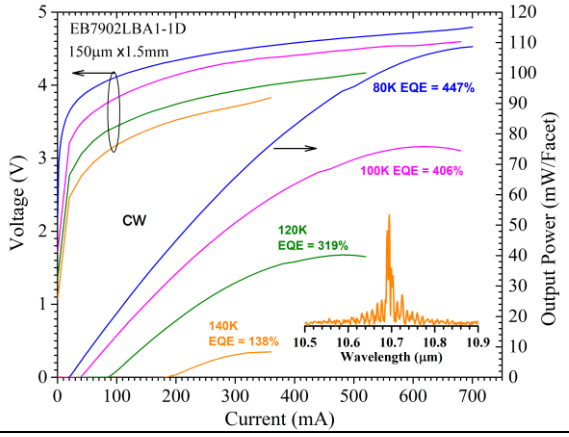

Fig. 1 IVL and a spectrum of an ICL from EB7902.

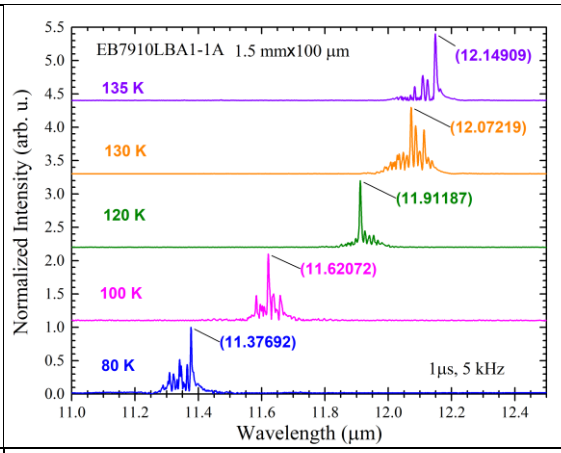

Fig. 2. pulsed lasing spectra of ICL from EB7910.

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[1] R. Q. Yang, Superlattices Microstruct., **17**, 77 (1995).
[2] J. R. Meyer, *et al*., Photonics **7**, 75 (2020)
[3] R. Q. Yang, *et al*. IEEE J. Sel. Top. Quantum Electron. **25**, 1200108 (2019).
[4] J. Nauschutz, *et al*., Laser & Photonics Reviews, 2200587 (2023).
[5] J. A. Massengale, *et al*., Semicond. Sci. Technol. **38**, 025009 (2023).

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