Continuous wave operation of InAs-based quantum cascade lasers above 20 μm

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The wavelength range between 20 and 60 µm is of great interest for many application such as spectroscopic sensing and astrophysics. Because of the difficulty of developing high-performances lasers sources at these wavelengths, this optical range is still underdeveloped. Indeed, in this region, absorptions by optical phonons of III- V semiconductors and free carriers are very strong. InAs/AlSb quantum cascade lasers (QCL) are promising for the development of far infrared lasers thanks to the small electron effective mass in InAs and to the resulting large inter-subband optical gain [1]. Recently we demonstrated QCLs made of InAs operating at a wavelength of 20 µm [2]. The low threshold current densities of 4.3kA/cm² in pulsed mode at room temperature that have been subsequently achieved confirmed the assets of the small effective mass in InAs.

Here, we report much lower threshold InAs/AlSb quantum cascade lasers emitting at 20.5 µm. The devices are based on an improved vertical design similar to those employed previously in [2], in which the doping level of the active core is considerably decreased. The lasers exhibit a threshold current density as low as 1.16kA/cm² in pulsed mode at room temperature and can operate in this regime up to 380K. The continuous wave regime of operation has been achieved in these devices at temperatures up to 180 K.

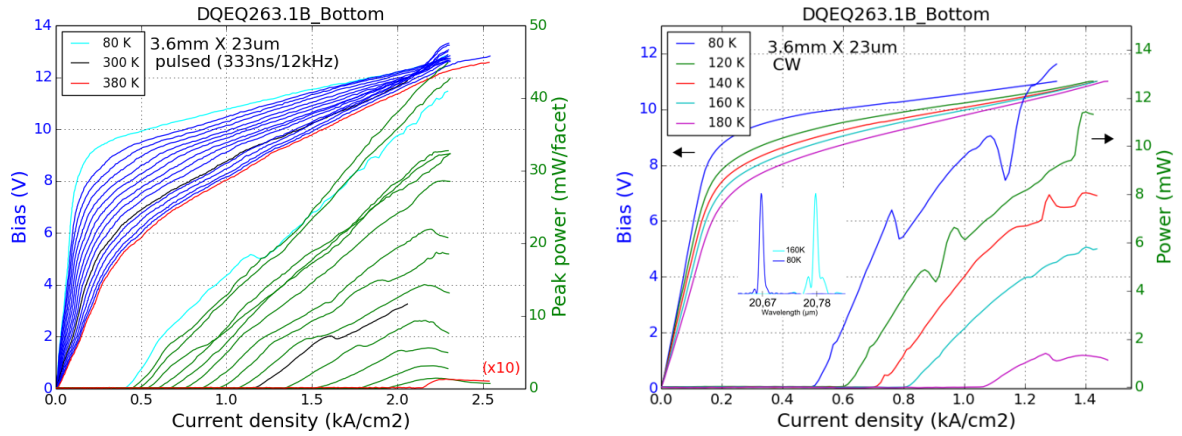

Fig.1. Electrical and optical output characteristics of InAs/AlSb QCL emitting above 20 µm in pulsed mode regime (left), and continuous wave regime (right). Insets show emission spectra in continuous wave regime.

References

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[2] M. Bahriz, G. Lollia, a. N. Baranov, and R. Teissier, "High temperature operation of far infrared (λ ≈20 µm) InAs/AlSb quantum cascade lasers with dielectric waveguide," Opt. Express, vol. 23, no. 2, p. 1523, Jan. 2015.