Quantum cascade laser with low threshold and high characteristic temperature $T_0 > 300K$ at $\sim 14 \ \mu m$\textsuperscript{1} XUE HUANG, WILLIAM CHARLES, CLAIRE GMACHL, Princeton University, MIRTHE TEAM — High-performance quantum cascade (QC) lasers with wavelength in $4 \sim 12 \ \mu m$ range are widely used in trace gas sensing. However, lack of high performance for longer wavelength in the $12 \sim 16 \ \mu m$ range, where exist the strongest absorption lines of BTEX (benzene, toluene, ethylbenzene, and xylenes) and Uranium Hexafluoride, prohibits QC laser applications in sensing these important gases. The QC laser emitting at $\sim 14 \ \mu m$ we investigate here is based on a diagonal-transition design. The depletion of the lower laser state is achieved by a one-phonon-continuum scheme instead of the widely used “continuum” lower mini-bands in existing long-wavelength lasers. This scheme reduces LO scattering from the upper laser state, the leakage from the injector and thermal back-filling to the lower laser state, thus attaining population inversion efficiently. The laser shows low threshold ($J_{th} = 2.4 \ kA/cm^2$ for a 1.97-mm-long laser at room temperature), and a high characteristic temperature $T_0 = 309K$ fitted from $J_{th}(T) = J_0 e^{T/T_0}$, which is comparable with the record highest characteristic temperature. The peak power is $1.4W$ at $80K$ and $0.25W$ at $300K$.

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