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Active mode-locking of mid-infrared quantum cascade lasers YONGRUI WANG, ALEXEY BELYANIN, Department of Physics and Astronomy, Texas A&M University — Active mode locking, i.e. modulation of gain or losses at the cavity round-trip frequency is one of the methods for generating ultrashort pulses in lasers. For Quantum Cascade Lasers (QCLs), it is believed that their short gain recovery time $\sim 1\,\mathrm{ps}$ as compared to a much longer cavity round-trip time ($\sim 50\,\mathrm{ps}$) prohibits generation of mode-locked pulses. We perform space-time domain simulations of QCL dynamics solving coupled density-matrix equations and Maxwell's equations with a realistic transport model of the active region. We find that active gain modulation of a short section of a two-section monolithic laser cavity leads to robust mode locking and generation of picosecond pulses over a broad range of laser parameters. This finding shows a viable path towards achieving ultrashort pulse generation in QCLs.

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