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Effect of Multi-Resonance Subband Structure on the Kerr Nonlinearity of Quantum-Cascade Lasers JING BAI, University of Minnesota Duluth — This work focuses on the investigation of the optical Kerr lensing effect in quantum-cascade lasers with multiple resonance levels. The Kerr refractive index n_2 is obtained through the third-order susceptibility at the fundamental frequency $\chi^{(3)}($ $\omega)$. Resonant two-photon processes are found to have almost equal contributions to $\chi^{(3)}(\omega)$ as the single-photon processes, which result in the predicted enhancement of the positive n_2, and thus may enhance mode-locking of quantum-cascade lasers. Moreover, an isospectral optimization strategy for further improving n_2 through the band-structure design is also demonstrated, in order to boost the multimode performance of quantum-cascade lasers. Simulation results show that the optimized stepwise multiple-quantum-well structure has a twofold enhancement on n_2 over the original flat quantum-well structure. This leads to a refractive-index change Δn of about 0.01, which is at the upper bound of those reported for typical Kerr medium. This stronger Kerr refractive index may be important for quantum-cascade lasers ultimately to demonstrate self-mode-locking.

Jing Bai
University of Minnesota Duluth

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