

69. Title: Material configurations for n-type silicon-based terahertz quantum cascade lasers

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Abstract: Silicon-based quantum cascade lasers (QCLs) offer the prospect of integrating coherent terahertz (THz) radiation sources with silicon microelectronics. Theoretical studies have proposed a variety of n-type SiGe-based heterostructures as design candidates; however, the optimal material configuration remains unclear. In this work, an optimization algorithm is used to design equivalent THz QCLs in three recently proposed configurations [(001) Ge/GeSi, (001) Si/SiGe, and (111) Si/SiGe], with emission frequencies of 3 and 4 THz. A systematic comparison of the electronic and optical properties is presented. A semiclassical electron transport simulation is used to model the charge carrier dynamics and calculate the peak gain, the corresponding current density, and the maximum operating temperature. It is shown that (001) Ge/GeSi structures yield the best simulated performance at both emission frequencies.