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标题: Extended density-matrix model applied to silicon-based terahertz quantum cascade lasers

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来源出版物: PHYSICAL REVIEW B 卷: 85 期: 23 文献号: 235427 DOI: 10.1103/PhysRevB.85.235427 出版年: JUN 12 2012

在 Web of Science 中的被引频次: 0

被引频次合计: 0

引用的参考文献数: 48

摘要: Silicon-based terahertz quantum cascade lasers (QCLs) offer potential advantages over existing III-V devices. Although coherent electron transport effects are known to be important in QCLs, they have never been considered in Si-based device designs. We describe a density-matrix transport model that is designed to be more general than those in previous studies and to require less a priori knowledge of electronic band structure, allowing its use in semiautomated design procedures. The basis of the model includes all states involved in interperiod transport, and our steady-state solution extends beyond the rotating-wave approximation by including dc and counterpropagating terms. We simulate the potential performance of bound-to-continuum Ge/SiGe QCLs and find that devices with 4-5-nm-thick barriers give the highest simulated optical gain. We also examine the effects of interdiffusion between Ge and SiGe layers; we show that if it is taken into account in the design, interdiffusion lengths of up to 1.5 nm do not significantly affect the simulated device performance.

入藏号: WOS:000305116700007

语种: English

文献类型: Article

KeyWords Plus: INTERSUBBAND ELECTROLUMINESCENCE; DESIGN

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出版商: AMER PHYSICAL SOC

出版商地址: ONE PHYSICS ELLIPSE, COLLEGE PK, MD 20740-3844 USA

Web of Science 分类: Physics, Condensed Matter

学科类别: Physics

IDS 号: 956VE

ISSN: 1098-0121

29 字符的来源出版物名称缩写: PHYS REV B

ISO 来源出版物缩写: Phys. Rev. B

来源出版物页码计数: 7