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标题: Modeling of electron relaxation processes and the optical gain in a magnetic-field assisted THz quantum cascade laser
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来源出版物: PHYSICA SCRIPTA 卷: T149 文献号: 014017 DOI: 10.1088/0031-8949/2012/T149/014017 出版年: APR 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: 22
摘要: We present a detailed model for calculating the optical gain of a quantum cascade laser (QCL) that operates in the terahertz spectral range, when subjected to a strong magnetic field, as well as the total relaxation rates due to the emission of longitudinal-optical phonons and interface roughness scattering, as a function of the applied field. When the magnetic field is applied in the direction perpendicular to the plane of the layers, each energy state is split into a series of discrete Landau levels, which are magnetically tunable, and it is therefore possible to control the modulation of the population inversion and consequently the optical gain just by varying the magnetic field. In this model, the gain is obtained by solving the full system of rate equations, from which one can calculate the carrier density of each level. The simulations are performed on a system that comprises a two-well design QCL that operates at 4.6 THz, implemented in GaAs/Al0.15Ga0.85As. Numerical results are presented for magnetic field values from 1.5 T up to 20 T, while the band non-parabolicity is taken into account.
入藏号: WOS:000303523500018
语种: English
文献类型: Article
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出版商: IOP PUBLISHING LTD
出版商地址: TEMPLE CIRCUS, TEMPLE WAY, BRISTOL BS1 6BE, ENGLAND
Web of Science 分类: Physics, Multidisciplinary
学科类别: Physics
IDS 号: 935MR
ISSN: 0031-8949
29 字符的来源出版物名称缩写: PHYS SCRIPTA
ISO 来源出版物缩写: Phys. Scr.
来源出版物页码计数: 5