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作者: Bogdanov, A (Bogdanov, Andrey); Suris, R (Suris, Robert)
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摘要: In this work we analyze free carrier absorption (FCA) and polarization ratio (transversality degree) for eigenmodes of a quantum cascade laser (QCL) waveguide. We consider the dielectric function and conductivity of the waveguide core and cladding layers within the DrudeLorentz approximation. We show that the entire spectrum of a QCL cavity consists of three kinds of eigenmodes: volume, surface, and Langmuir modes. We perform an analytical analysis and numerical calculations of FCA and polarization ratio for each type of the eigenmodes within a wide frequency range from the microwave up to the ultraviolet spectrum. We make a comparative analysis of FCA in the cladding layers and waveguide core. We specify frequency intervals where absorption in the core or in the cladding layers is dominant. Identification of the most favorable modes for lasing is carried out for each part of the spectrum. So, we identify that the main Langmuir mode is the most favorable mode for the lasing at the long-wave edge of the terahertz (THz) region: (i) it has no frequency cutoff and can be excited at arbitrarily low frequency, (ii) it is nearly transversal that is very favorable for the QCL operation, and (iii) it is almost totally confined within the waveguide core. The model analyzed is directly related to one-dimensional photonic crystals and metamaterials consisting of alternating anisotropic layers.
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地址: [Bogdanov, Andrey; Suris, Robert] RAS, Ioffe Phys Tech Inst, St Petersburg, Russia
[Bogdanov, Andrey; Suris, Robert] St Petersburg Acad Univ, RAS, St Petersburg, Russia
[Bogdanov, Andrey; Suris, Robert] St Petersburg State Polytech Univ, St Petersburg, Russia
通讯作者地址: Bogdanov, A (通讯作者),RAS, Ioffe Phys Tech Inst, St Petersburg, Russia
电子邮件地址: bogdanftf@mail.ru
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