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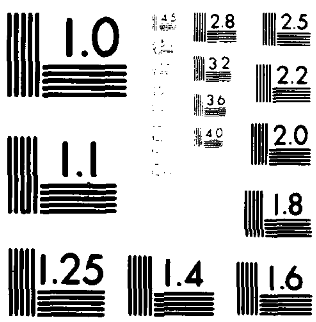

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1. Free Electron Lasers

An exact treatment of the space-charge effect in the single-electron analysis of a free-electron laser is presented to calculate its small-signal gain. With the inclusion of the repulsive force between electrons, it is found that the trajectory of an electron can be solved from a generalized equation which includes a space-charge term. The results show the gain is saturated with decreasing growth rate due to high electron density. The radiation frequency is found to increase with the electron density and approach the value at plasma resonance. The condition $\omega_p L/c = \pi$ clearly defines the boundary between the noninteracting and the collective regime of an electron beam, where ω_p is the plasma frequency, L is the device length, and c is the light velocity in vacuum.

2. Quantitative Calculation of the Electro Optic Effect

With the support of the contract with AFOSR, we have undertaken the task of developing a theoretical model for predicting the electrooptic (EO) coefficient of crystals. The theory uses an extension of the Phillips-Van Vechten model of the optical dielectric constant and accounts for both pure electronic and ionic contributions to the E_o effect.

The first results applied to diatomic (Z_n0, GaAs, etc.) crystals are very encouraging. Agreement of $\pm$ 10% between our prediction and the experimental values is obtained. In the next contract year we will extend this analysis to other classes of crystals including ABC_2 (say $AgGaS_2$).

The availability of a reliable model for the EO effect should prove helpful in the search for new efficient materials, especially for longer infrared wavelengths.

3. Semiconductor Lasers to Optical Fibers

A new project is now underway to grow, epitaxially, low threshold, cw, semiconductor GaAs/GaAℓAs laser with output of apertures which more nearly approximate the dimensions of optical fibers. Presently the mismatch is so large (0.2 x 10 μm for the laser 10 x 10 μm for the fiber) that only a small fraction of the laser output is coupled to the fiber.

Our lasers employed a new method for growing the laser active layer which results in a flared region near the output facet. Preliminary results yielded reasonably (50 ma) low threshold lasers, but it is too early to see if the coupling efficiency is improved.

List of Publications

Resulting from Contract Research

1. C. C. Shih and A. Yariv, "Single-electron analysis of the space-charge effect in free-electron lasers," Physical Review A, 22, no. 6, pp. 2717-2722 (1980).
2. C. C. Shih and A. Yariv, "Quantitative Calculation of Electro-Optic Coefficients of Diatomic Crystals," Physical Review Letters, 44, no. 4, pp. 281-284 (1980).

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An exact treatment of the space charge effect in the single-electron analysis of a free electron laser is presented to calculate its small signal gain. With the support of the contract with AFOSR, we have undertaken the task of developing a theoretical model for predicting the electrooptic (EO) coefficient of crystals. A new project is not underway to grow, epitaxially, low threshold, cw, semi-

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