PICS3D

Photonic Device Modeling in 3D

What is PICS3D

PICS3D (Photonic Integrated Circuit Simulator in 3D) is a state-of-the-art 3D simulator for laser diodes and related active photonic devices. Its primary goal is to provide a 3D simulator for edge and surface emitting laser diodes. It has also been expanded to include models for other components integrated with or related to the laser emitter.

Applications

PICS3D may be used for any type of active or passive waveguide semiconductor devices. It is also suitable for vertical cavity surface emitting lasers (VCSELs). Applicable devices include but are not limited to the following:

APPLICATIONS

- ☑ Fabry-Perot(FP) lasers
- ☑ DFB lasers
- ☑ DBR lasers
- ☑ Multiple sectional devices
- ☑ EAM
- ☑ SOA
- ☑ Waveguide photo-detectors
- ☑ Optically pumped lasers
- ☑ VCSELs
- ☑ External cavity lasers
- ☑ Self-heating effect
- ☑ Higher order grating DFB/DBR lasers

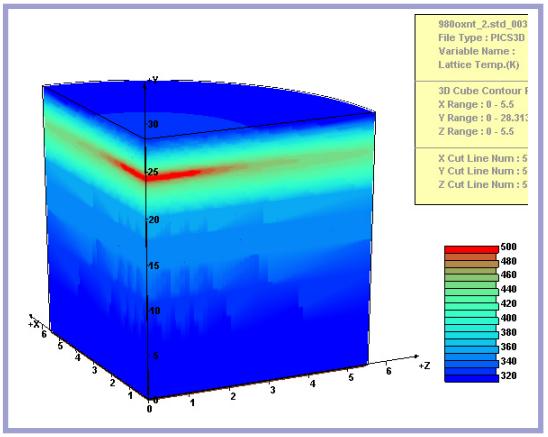
and more...

Introduction to 3D Laser Model

A semiconductor laser is a unique three-dimensional (3D) device, in that both the lateral and longitudinal dimensions are crucial to the operation of the device as a light emitter. The lateral dimension provides the important mechanisms of optical gain, spontaneous and stimulated recombination while the longitudinal dimension provides the amplification of the spontaneous emission and produces the emission characteristics of the device.

PICS3D is capable of performing simulation in time, spectrum as well as in the three spatial dimensions. It gives us a full view of a laser diode in operation at a price: longer computation time. The computation time problem is being reduced with increasing computing power of new generations of computer hardware and updated operating systems.

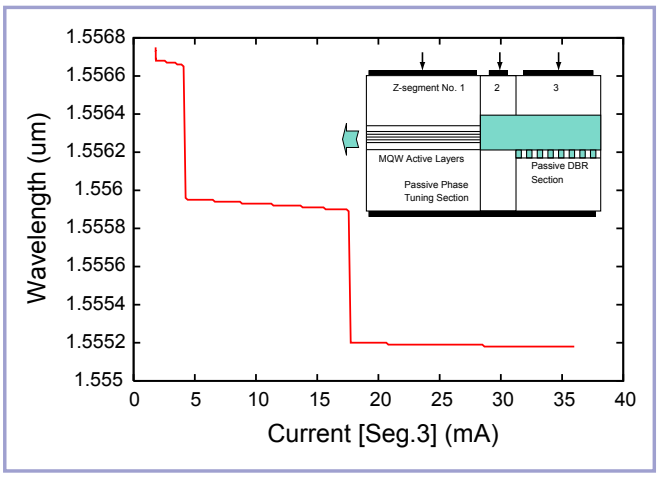
Since the basic physical models and capabilities of PICS3D on the lateral/traverse dimensions are the same as those for LASTIP, we shall only describe our treatment of longitudinal modes and the z-dimension in this product description.



Simulated temperature distribution within a VCSEL with oxide aperture.

Longitudinal Mode Models

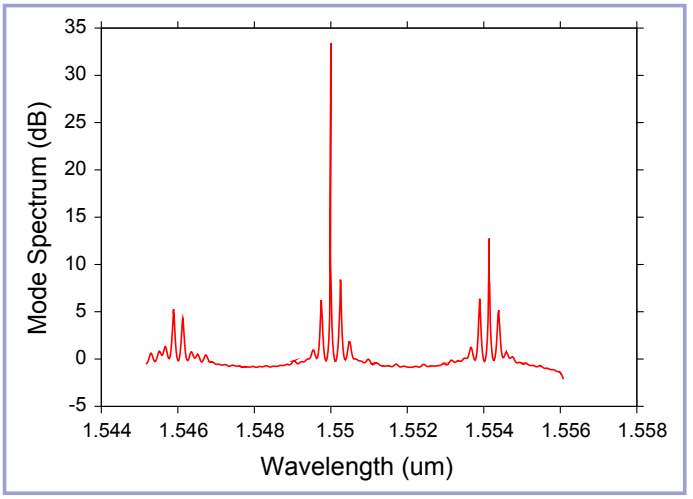
The numerical approach for solving the longitudinal modes is based on a combination of transfer matrix and the complex Green function method. The transfer matrix method divides the longitudinal cavity into subsections and propagates waves from one subsection to the next. The complex Green function method



Tuning characteristics of a 3-section DBR laser simulated by PICS3D.

is a rigorous analytical method that can be used to compute the optical power of a multiple longitudinal mode system accurately. Both coupled-mode theory and multi-layer optics theory can be used for treatment of grating structures in DFB, DBR and VCSEL laser diodes. Optionally, the full 3D BPM model can be used to describe the optics of the active device.

Furthermore, the dynamic equations derived from such an approach allow us to compute the large and small signal responses of the multimode laser diode system.



Emission power spectrum of a sampled grating DBR laser simulated by PICS3D.

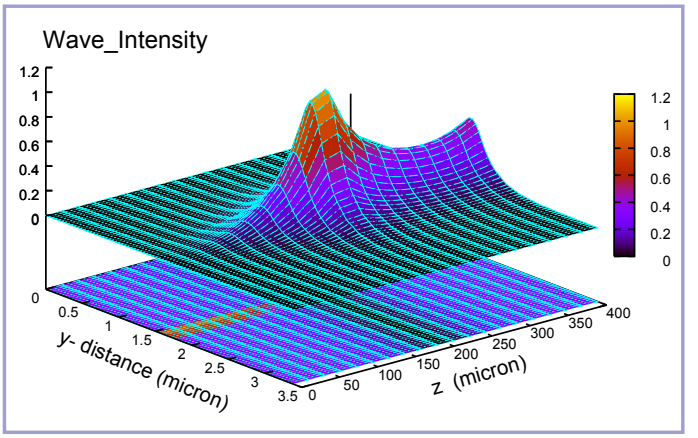
Advanced Techniques for 3D Simulation

To achieve maximum computation speed and efficiency, we have invented a new technology for numerical simulation of laser diodes in 3D. Our new technology divides the tasks of 3D simulation into a combination of 2D and 1Dz (1D in z-direction, the longitudinal direction) simulations (quasi-3D approach). The 2D and 1Dz modules are carefully coordinated so that coupling of physical models in the 2D and 1Dz modules are not lost.

As an option, the 2D module mentioned above may be replaced by a full 3D carrier transport model which allows for a more realistic description of the photonic device. The full 3D option is used at a cost of much increased computation time as compared with the quasi-3D approach.

Supported Platforms	**Windows 2000/XP**

Minimum System Requirements
1GHz Intel Pentium III processor
256MB RAM
300MB available disk space



Simulated traveling optical wave intensity distribution within an InGaAsP MQW DFB laser with 1/4 wave shift in middle section.

PICS3D Output Capabilities

PICS3D has all of the data output capabilities of LASTIP for any specific x-y plane of an edge type laser. In addition, PICS3D is capable of producing the following data.

PICS3D is capable of generating large amount of output data including, but not limited to, the following.

Output capability

Longitudinal distribution

Carrier density — Optical gain
Optical wave intensity — Current distribution
Temperature — Refractive index change
and more...

Bias & time dependent data

Emission power — Frequency change
Sidemode suppression ratio — Line width
and more...

Spectral data

Mode spectrum — FM small signal response
RIN spectrum
and more...

Far-field pattern

Time-dependent solution

All of above at different temperatures

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