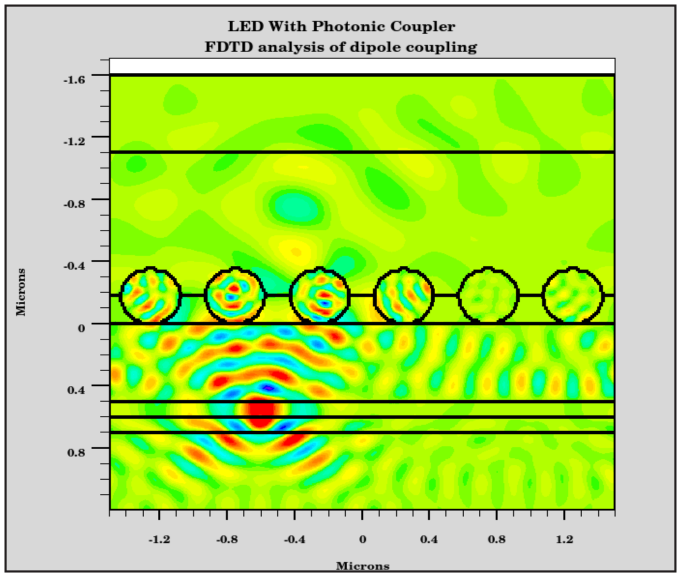
LED

2D LIGHT EMITTING DIODE SIMULATOR

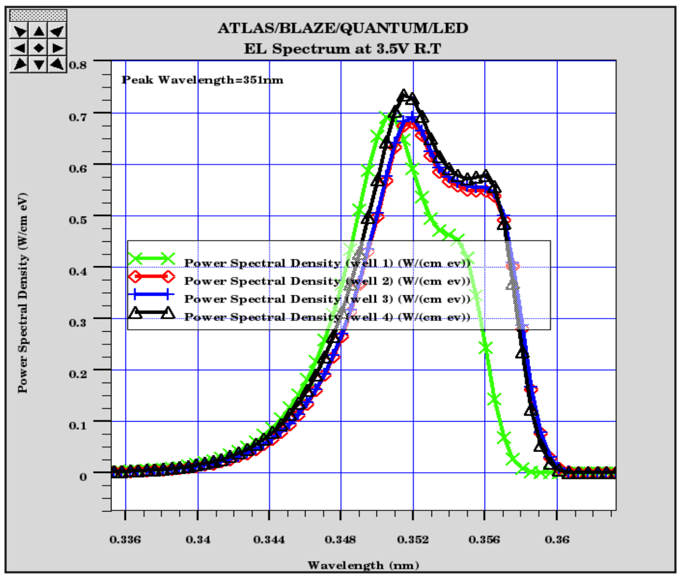
LED is a module used for simulation and analysis of light emitting diodes. LED is integrated in the ATLAS framework with the Blaze simulator and allows simulation of electrical, optical and thermal behavior of light emitting diodes.

Features

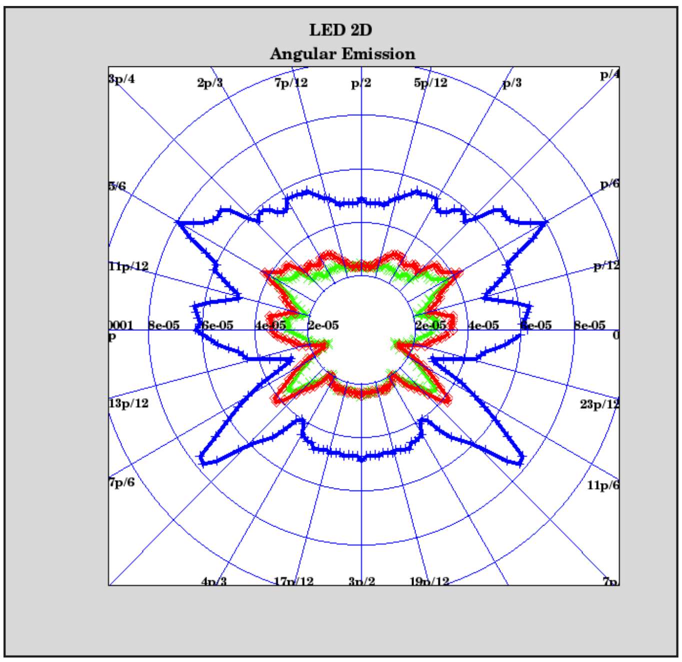
- Uses advanced radiative recombination models in zincblende, wurtzite and organic/polymer materials to give light output intensity response electrical stimulus and spectral emission characteristics
- Radiative emission models account for material composition, strain, polarization and dipole emission effects
- Rigorous reverse ray tracing or finite difference time domain analysis give far field emission characteristics and output coupling efficiency
- Analysis of output coupling enhancement with photonic crystals using finite difference time domain
- Can be used with the Giga simulator to give realistic device behavior in conditions of self-heating
- Can be used with the MixedMode simulator to allow LED characterization in a SPICE circuit environment
- LED is fully integrated into the ATLAS framework and Blaze simulator to give emission characteristics as a function of device composition and electrical stimuli



Application of finite difference time domain method to analyze the LED output coupling for photonic coupling devices such as photonic crystals and gratings.



The emission spectrum derived from quantum well modeling with reverse ray tracing or finite difference time domain modeling give the LED output spectrum as a function of device structure and operating conditions.



Calculated LED output coupling and directionality using reverse ray tracing.

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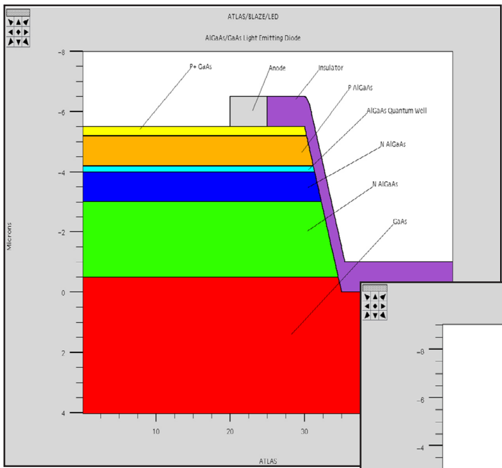
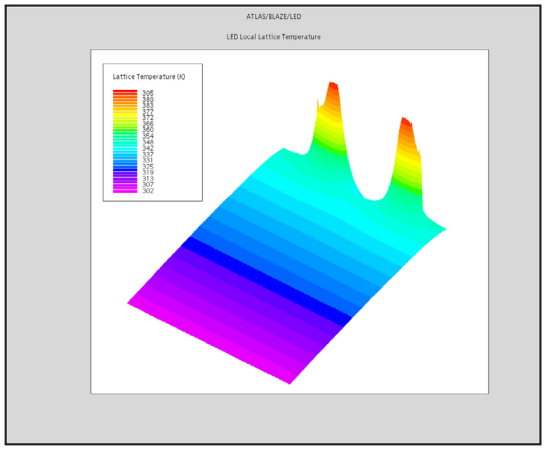
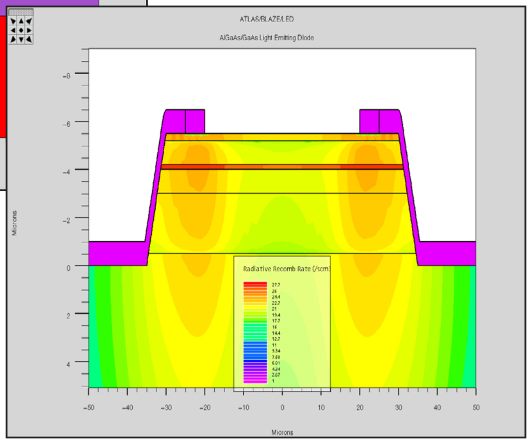


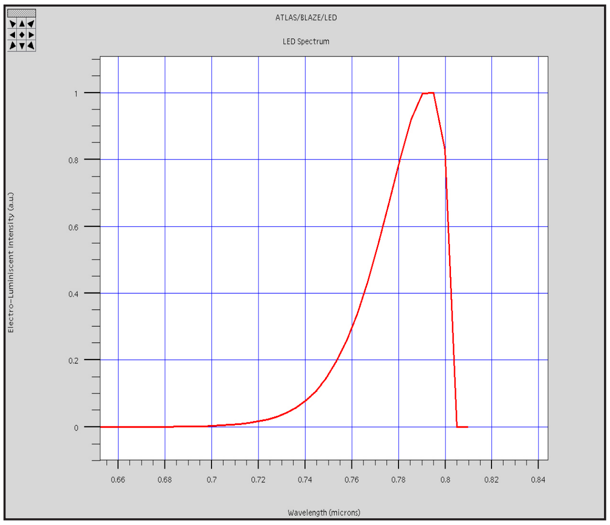
A typical GaAs/AlGaAs LED device structure.



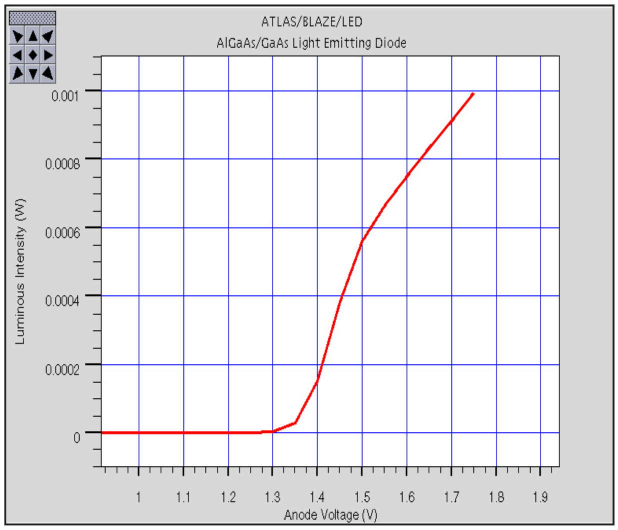
A contour plot of the local temperature in the LED at operating bias.



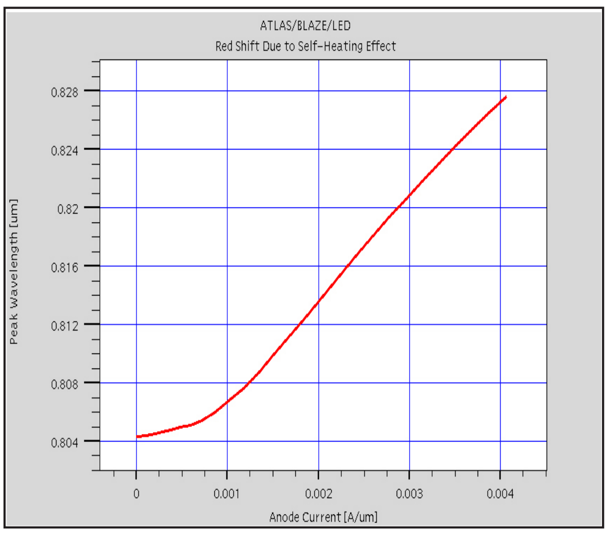
A contour plot of the on-state radiative recombination rate in the LED device.



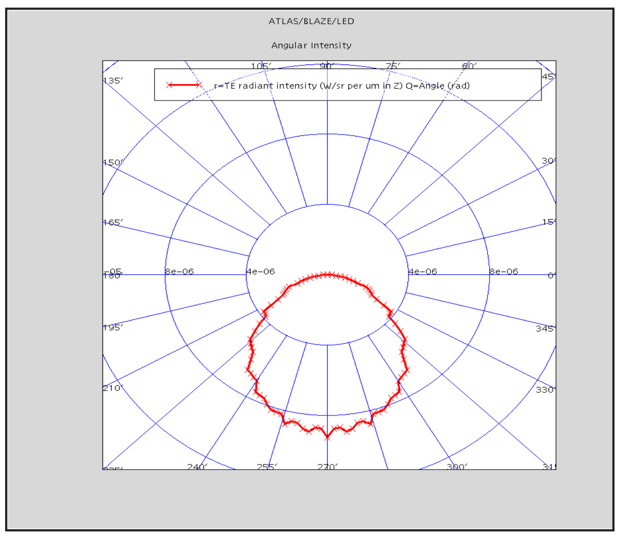
The calculated output spectrum of an LED device.



The calculated optical intensity of the LED as a function of bias voltage.

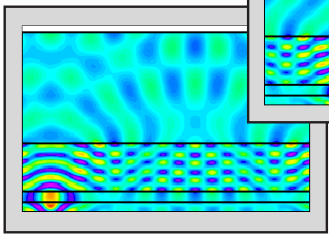
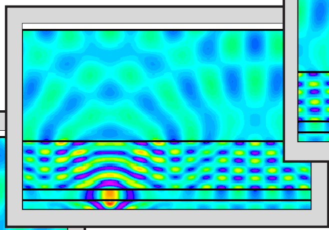
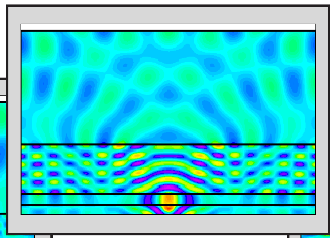
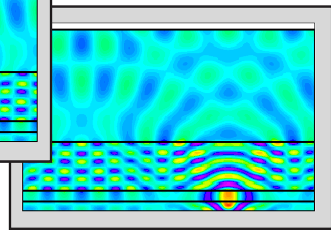
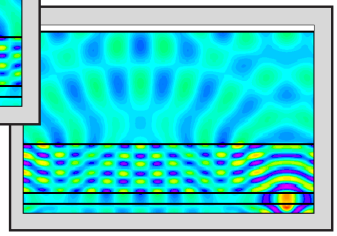


Peak emission wavelength of the LED as a function of input current.

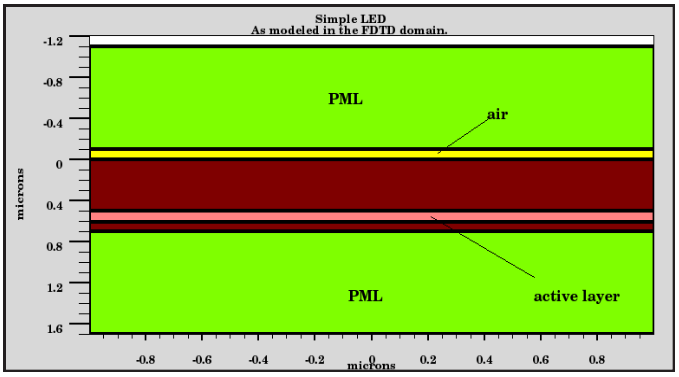


Angular dependence of intensity for the LED as calculated using reverse ray tracing.

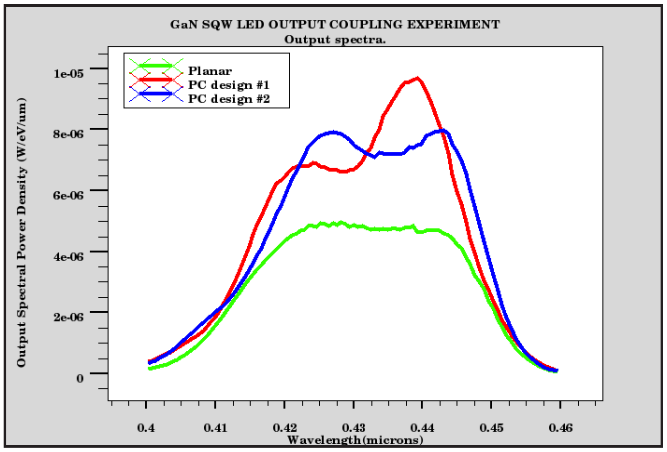
2D Finite Difference Time Domain Anaysis of LED Output Coupling

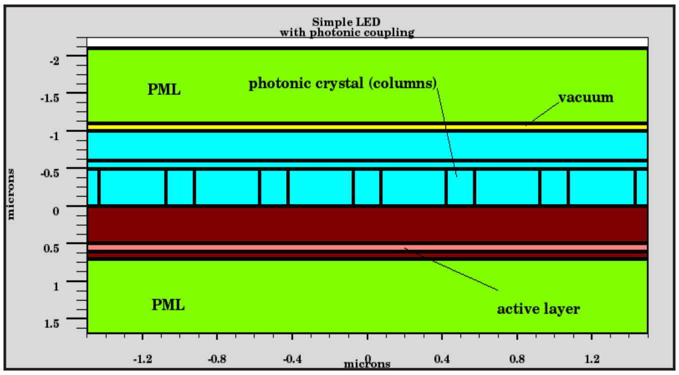
These figures illustrate how the FDTD electric fields are taken at a sequence of dipole locations in the active layer.



The analysis of LED coupling using FDTD begins by placing the LED device in the FDTD domain. In the attached figure we show a simple device located between two PMLs. Photonic coupling devices can be placed in the air above the device.

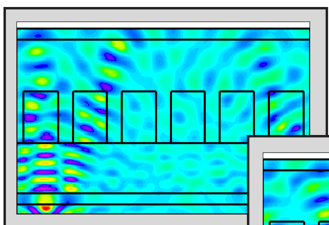
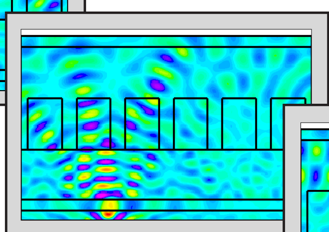
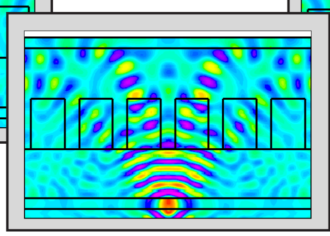
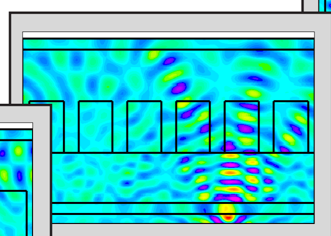
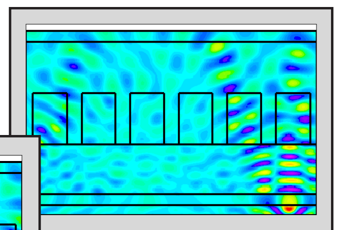


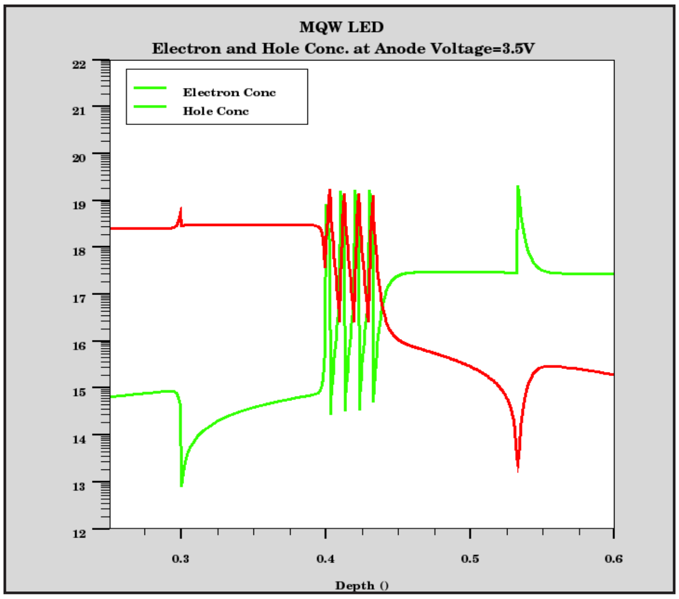
The results from the dipole scans are integrated, weighted with the local spontaneous emission spectrum to obtain characterizations of output coupling as a function of wavelength and geometry as shown in the accompanying figure.



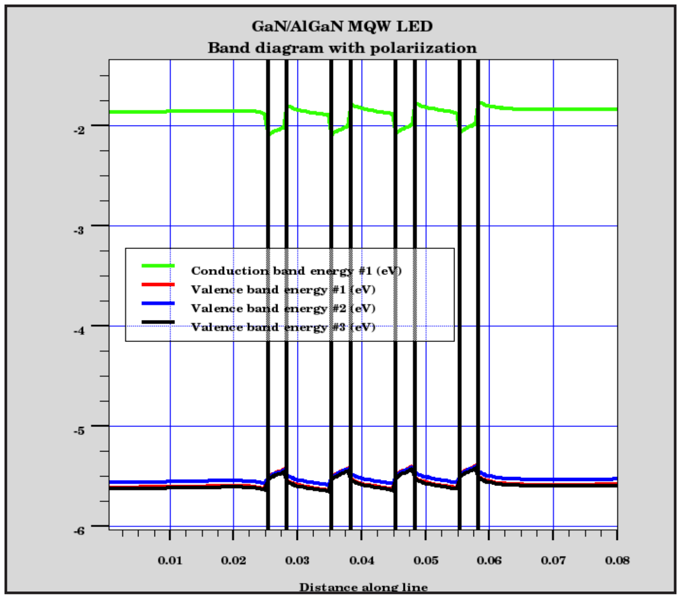
In this figure, a photonic crystal (regular spaced columns) is placed on top of the LED. FDTD analysis can be run on such a strucure to quantify the improvement in coupling of various photonic designs.

This sequence of figures illustrates the effect of a photonic output coupling structure (in this case regular columns) on electric field in spatial analysis of wavelength dependent LED output coupling.

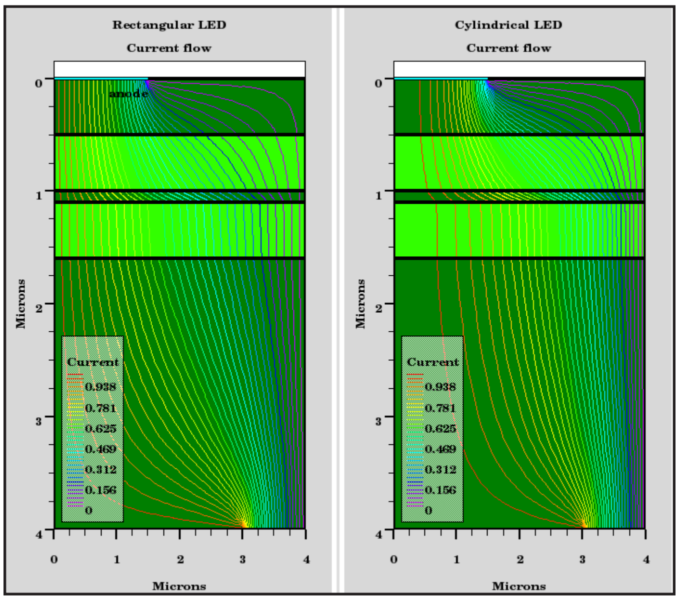








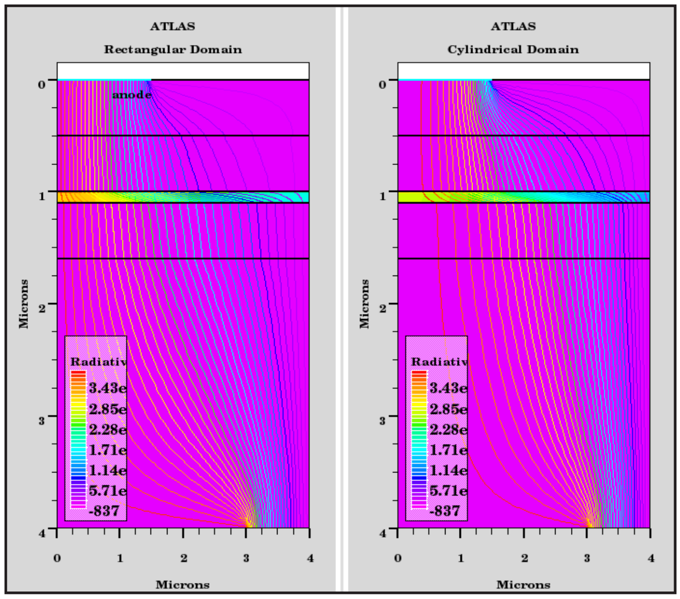
LED simulation allows you to examine internal characteristics such as carrier concentration in multiple quantum well devices.



Using the Quantum module you can analyze emission from quantum wells including the effects of multiple bands (conduction, heavy hole, light hole and split-off) and quantum confined sub-bands.



Here we show the difference in current flow in cylindrical and equivalent rectangular devices.



The accompanying figure shows the radiative rate in the quantum well for the rectangular and cylindrical cases.

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