PICS 3D – Evaluation (by Sudharsanan S – started on October 14th,2010)

Day 1 – Notes from the manual

PICS3D uses finite element analysis (FEM) to study various Photonic Integrated Circuit (PIC) components.
It uses k.p theory => we can model strained QWs. We can model ternary/quaternary compounds including nitrides.

Applications of the software:

1. Fabry-Perot (FP) lasers.
2. Distributed Feedback (DFB) lasers.
3. Distributed Bragg Reflector (DBR) lasers.
4. Semiconductor Optical Amplifiers (SOA).
5. Waveguide photodetectors.
6. Vertical Cavity Surface Emitting Lasers (VCSELs).
7. External cavity lasers.
8. Fiber grating lasers.
9. Electrode absorption modulators (EAM).
10. Multi-section/Multi-electrode DFB or DBR lasers.
11. Multi-section photonic integrated circuit combining more than one of the above devices.

Capabilities:

1) Light versus current (L-I) characteristics.
2) 3D potential, electric field and current distributions.
3) 3D distributions of electron and hole concentrations.
4) Band diagrams under various bias conditions.
5) Quantum well sub-band structure with valence mixing model.
6) 3D distributions of occupancy and concentration of deep level traps in a semiconductor.
7) 3D optical field distribution.
8) 3D local optical gain distribution.
9) Full multiple mode emission spectra at different power levels.
10) Lasing wavelength, output power and longitudinal photon density distribution as a function of bias current.
11) Characteristics of DFB lasers with spatial and spectral hole burning effects.
12) Full multi-mode simulation of DFB lasers.
13) Relative Intensity Noise (RIN), Frequency Noise (FM) and spectral line-width under different bias conditions.
14) Static tuning and dynamic modulation characteristics of single- and multi-electrode DFB or DBR lasers.
15) Second harmonic distortion in a laser system under direct current modulation.

The 3 basic file types: (need to be set up by the user)
*.layer – input device structure/generate mesh, (generates *.geo, *.doping and *.mater files)
*.sol – solve the equations (material properties, control bias)
*.plt – plot the results using GNUPLOT.

Others
*.geo – device geometry and initial mesh location.
*.doping – doping info (to be included in *.sol file)
*.mater – material info (to be included in *.sol file)
*.mplt – plot mesh generated from *.geo file.
*.gain – use to preview optical gain spectrum, spontaneous emission spectrum, quantum well sub-bands.
*.out_00xx – numerical output data (used by *.plt file to plot)
*.std_00xx – numerical output data (used by Crosslight view program to plot 3D figures)

Day 2&3 – Vettithanama pozhuthai kazhittal.

Day 4

Some important syntax:
A statement is a mathematical expression (assignment statements, conditions etc.)
1) && - to split a statement into 2 lines, in the code.
2) $ - implies comments.
3) Caution: Parameter type (double, floating point, character etc.) is important, unlike MATLAB.
4) Each line can have a maximum of 80 characters.
5) Characters used for grouping data (/matrices) are '(', ')', '{', '}', '[', ']', ','.

Day 5
GUI tools apart from command line programs
1) SimuPics3D - A simple text editor for the input files. However, it also integrates various device setup utilities and graphic input/output programs and can launch the main solver. It includes a "Wizard" to assist with use of various commands. This should be the starting point of any simulation.
2) LayerBuilder - which generates layers of material used to build a device. Reads and creates *.layer files to define simple device structures.
3) GeoEditor - which allows the user to draw complex devices with irregular shapes that are compatible with the *.geo input file format. It should be used instead of LayerBuilder when the device structure does not follow the typical layer/column pattern found in most devices.
4) CrosslightView - A 3D color graphic display tool using the OpenGL technology. It is compatible with the *.std file format.