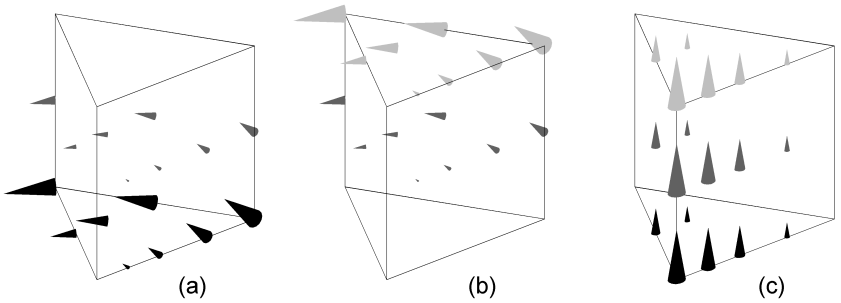
Peter Nyakas: Three-Dimensional VCSEL Simulation Using Vector Finite Elements

Motivation: only mode expansion methods had been used successfully for real 3-D optical simulation of VCSELs.

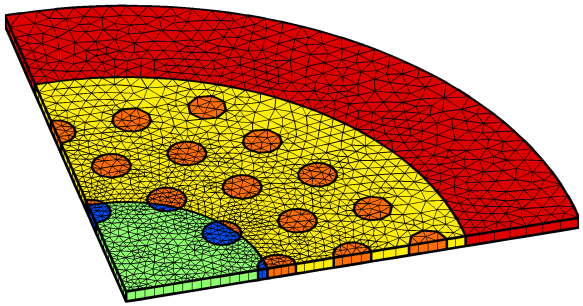
- coupled mode theory
- plane-wave admittance method



vector basis functions

Finite Element Method has been realized for the first time for polarization-resolved simulation of arbitrary VCSELs (noncircular mesas, photonic crystal patterns).

$$F(\mathbf{E}) = \frac{1}{2}\int_V \left[(\nabla \times \mathbf{E})\mathbf{\Lambda}^{-1}(\nabla \times \mathbf{E}) - \frac{\omega^2}{c^2}\mathbf{E}\varepsilon_r\mathbf{\Lambda}\mathbf{E} \right] dV$$



discretization with prism elements

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Selected Results:

- wide-angle diffraction around elliptical oxide aperture
  - electric field components for elliptical aperture VCSEL
  - simulation of photonic crystal and oxide aperture