Stochastic and Genetic Algorithms Applied to the Modeling and Optimization of Optoelectronic Devices

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Modeling tools have become essential to study and optimize optoelectronic and photonic devices. Methods like Beam Propagation Method (BPM) and hydrodynamic models are now currently used in laboratories.

Exponentially increasing computing power allows us to go one step further in the modeling of optoelectronic devices. Optimization algorithms help us to enhance existing devices and to design more complicated structures.

First we present the optical optimization of a waveguide PIN photodiode on InP substrate in order to get a high responsivity at 1.55µm wavelength and a moderate sensitivity to vertical misalignment. This optimization has been carried out using a 2D-Beam Propagation Method (2D-BPM) coupled to a Stochastic Algorithm. Such a method allowed us to model thousands of devices by randomly choosing numerous epitaxial parameters. An optimized structure was derived from this study. Moreover interesting physical insight was brought by this method.
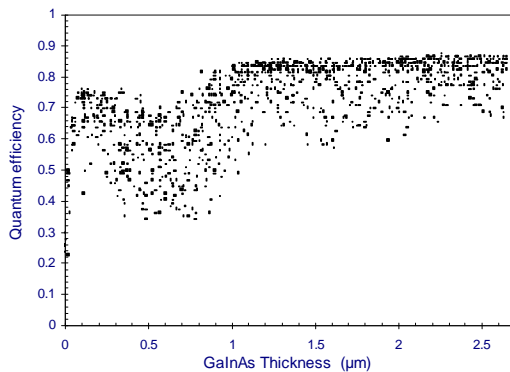
Then we present the design and optimization of optical switches using a 2D-BPM coupled to a Genetic Algorithm. These Algorithms are part of a new computing field called Evolutionary Computation, based on Darwin's theory. They are typically used to compute optima of a fitness function by evolving a population of individual devices using genetic operators. They are particularly well suited for multiparameter and multiobjective optimization. Optical switches were optimized with eight geometrical and physical parameters. We obtained a final structure achieving a good compromise between optical properties and electrical consumption.

Such algorithms allow us to go beyond trial and error method in modeling practice.

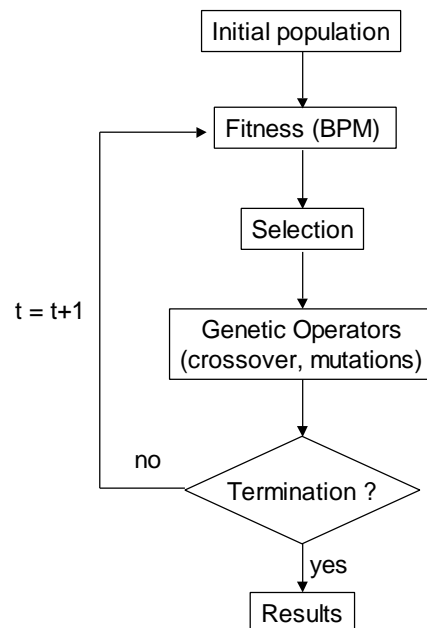*Figure 1 : optimization of a waveguide PIN photodiode by 2D-BPM coupled to a stochastic algorithm. λ =1.55 µm.*

Figure 2 : Genetic Algorithm coupled to 2D-BPM.

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