Optimization of Silicon Photonic Components using Multi-Fidelity Simulations and Co-Kriging

Pierre WAHL[1,6], Ivo COUCKUYT[2], Christian KREMERS[3], Frank DEMMING[3]
Tom DHAENE[2], Wim BOGAERTS[1,4,5*]
[1]Luceda Photonics, Dendermonde, Belgium
[2]Surrogate Modelling Group, Ghent University-iMinds, Dept. of Information Technology, G. Crommenlaan 8 Blok C0 bus 201, 9050 Ghent, Belgium
[3]CST-Computer Simulation Technology AG, Bad Nauheimer Strasse 19, 64289 Darmstadt, Germany.
[4]Photonics Research Group, Ghent University-Imec, Technologiepark 15, 9052 Ghent, Belgium
[5]Center for Nano- and Biophotonics, Ghent University, Belgium
[6]Brussels Photonics Team B-PHOT, Department of Applied Physics and Photonics, Vrije Universiteit Brussel, Brussels, Belgium
* Wim.Bogaerts@ugent.be

Silicon photonic devices can be very compact because of the high refractive index contrast. But this also makes them very sensitive to geometry variations, and hard to model [1]. Typically, a fully vectorial, 3D solution of Maxwell's equations is the only reliable simulation technique, be it with *eigenmode expansion* (EME) or *finite-difference-time-domain* (FDTD). Finding an optimum geometry of a parametric component is therefore computationally very expensive, and it is important to keep the number of these 'expensive' simulation as small as possible. *Efficient global optimization* (EGO) uses *Kriging* to reduce the number of simulations by adaptively selecting the simulation point with the largest likelyhood of producing a better component. However, individual simulations are still expensive.

In this work, we combine expensive, high-precision 3D-FDTD simulations with much cheaper, lower-precision 2D EME simulations to accelerate the optimization. This *Co-Kriging* technique uses the cheap simulations to learn the trends of the component behavior, which are calibrated with the expensive simulations [2]. The cheap simulations allow a quick building of the landscape of multi-dimensional parameter space, which minimized the use of the expensive simulations.

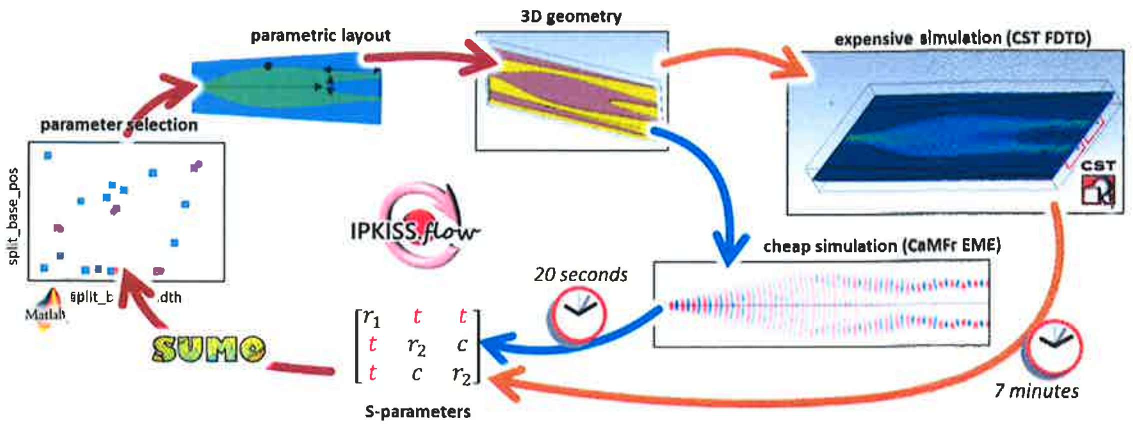

Fig. 2. Optimization of a photonic component using cheap and expensive simulations.

ECIO + OWTNM SESSION

SIMULATIONS/MODELLING

CHAIR: Andrea MELONI, Politecnico di Milano, Italy

ECIO|O-43 20.05.2016 11:00–11:15

Analysis of Quantum Dot Single Section FP Lasers for comb spectra generation

Mariangela GIOANNINI, Paolo BARDELLA, Ivo MONTROSSET
Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Italy

We report a numerical model for the simulation of optical comb spectra generation using single section FP quantum dot lasers. We discuss the role of the most relevant QD parameters such as the large gain compression factor (ε-parameter), the homogeneous and inhomogeneous broadening of the gain spectrum and the carrier relaxation time from excited state to ground state.

ECIO|O-44 20.05.2016 11:15–11:30

Rate-Equation Analysis for an Integrated Coupled-Cavity Laser with MMI Anti-Phase Coupler

Daan LENSTRA
Eindhoven University of Technology, The Netherlands

In this paper a dynamical theory is reported for the coupled-cavity laser (CCL) with a multi-mode interference (MMI) coupler, which provides an excellent description of the locking and other operational aspects of the laser realized by D'Agostino et al. in 2015.

ECIO|O-45 20.05.2016 11:30–11:45

Angled 3D Glass-to-SiPh adiabatic coupler

Giannis POULOPOULOS[1], Dimitrios KALAVROUZIOTIS[1], John R. MACDONALD[2], Paul MITCHELL[2], Nicholas PSAILA[2], Joek TUIN[3], Rutger SMINK[3], Sander DORRESTEIN[3], Michiel VAN RIJNBACH[3], Jeroen DUIS[3], Hercules AVRAMOPOULOS[1]
[1]National Technical University of Athens, Greece; [2]Optoscribe Ltd, UK; [3]TE Connectivity, The Netherlands

We propose and simulate, an adiabatic coupling scheme between a 2 degrees angled 3D glass waveguide and a SiPh chip. The numerical investigation relied on 3D EigenMode Expansion simulations revealing 98% overall glass-to-silicon coupling efficiency and 120 um coupling length. The coupler exhibits adequate tolerance to lateral misalignments enabling the use of passive alignment assembly equipment.

ECIO|O-46 20.05.2016 11:45–12:00

Optimization of Silicon Photonic Components using Multi-Fidelity Simulations and Co-Kriging

Pierre WAHL[1,6], Ivo COUCKUYT[2], Christian KREMERS[3], Frank DEMMING[3], Tom DHAENE[2], Wim BOGAERTS[1,4,5]
[1]Luceda Photonics, Dendermonde, Belgium; [2]Surrogate Modelling Group, Ghent University-iMinds, Dept. of Information Technology, Belgium; [3]CST-Computer Simulation Technology AG, Germany; [4]Photonics Research Group, Ghent University-Imec, Belgium; [5]Center for Nano- and Biophotonics, Ghent University, Belgium; [6]Brussels Photonics Team B-PHOT, Department of Applied Physics and Photonics, Vrije Universiteit Brussel, Belgium

We present an efficient global optimization (EGO) for high-contrast optical components based on adaptive sampling and the combination of cheap and expensive simulations (co-Kriging). We demonstrate this technique on a 1 x 2 splitter with 5 design parameters, which we optimize using 2D eigenmode expansion and 3D FDTD. The total process uses 238 cheap and only 12 expensive simulations.

ECIO|O-47 20.05.2016 12:00–12:15

Feedback-Insensitive Integrated Laser

Perry VAN SCHAIJK, Daan LENSTRA, Erwin BENTE
Eindhoven University of Technology, The Netherlands

Semiconductor lasers are highly susceptible to external optical feedback. Since the optical isolators used to prevent this effect cannot be integrated, we propose to fabricate an integrated feedback-insensitive laser. Two designs for integrated ring lasers are studied in detail. Theoretical analysis based on rate equations, simulation results and preliminary measurement results will be presented.

OWTNM|O-01 20.05.2016 12:15–12:30

Design of an optical nanoantenna with focusing sub-wavelength grating couplers and metallic reflector

Alonso MILLAN MEJIA, Yuqing JIAO, Jos VAN DER TOL, Meint SMIT
Photonic Integration Group, Eindhoven University of Technology, The Netherlands

In our 300 nm thick InP membrane, the best grating we got has 5 periods with a pitch of $\Lambda = 880$ nm with a filling factor of 0.52. The subwavelength ridge is 100 nm. The efficiency obtained at 1.55 μm is 59% of upcoming light and 8% reflections. The far-field emission is centred about 13° from the zenith.

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