

Lumerical takes Photonic Inverse Design to the Cloud to Accelerate the Design of CompoundTek's SiPh Grating Couplers

20x Smaller Footprint with
2-Week Design Cycle

The Business Need

CompoundTek is a global foundry services leader in emerging silicon photonic solutions (SiPh) delivering revolutionary semiconductor applications designed to meet critical requirements in high bandwidth and high data transfer solutions. The company's know-how ranges from proprietary fabrication process expertise to design support for end product manufacturing.

In an ongoing effort to offer highly flexible solutions for photonic integrated circuit developers requiring rapid design and manufacture, CompoundTek constantly explores ways to improve its development processes for higher component performance, reduced costs, improved yield, increased engineering productivity, and a shorter design cycle. Facing increased time-to-market demands in a commercializing photonics industry, Lumerical and CompoundTek worked together to explore new ways to improve one of the most complex photonic components, the SiPh grating coupler. In addition to finding ways to shorten the design cycle, the companies emphasized minimizing component size reducing costs to the end user.

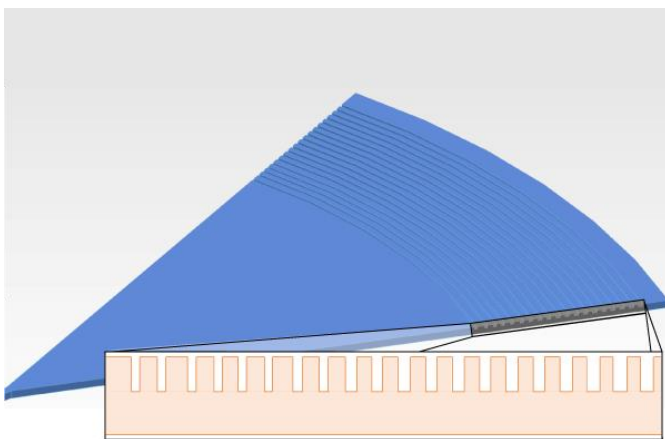


Figure 1: The grating coupler designed using photonic inverse design with a 20X footprint reduction

The SiPh grating coupler is a key functional block for photonic I/O, enabling light to be coupled from fiber to a photonic integrated circuit. Unlike end-fire edge couplers, grating couplers can be located anywhere on chip, simplifying the testing process.

With this flexibility comes the requirement for reduced footprint while maintaining high coupling efficiency. However, with over 100 design parameters, grating couplers are geometrically complex, rendering traditional design and optimization strategies complicated and time consuming.

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Lumerical's Photonic Inverse Design in the Cloud

Lumerical's Photonic Inverse Design (PID) flow was used to design and optimize the new grating couplers in conjunction with Lumerical's industry leading FDTD nanophotonic simulator. Lumerical's PID enables photonic designers to rapidly develop optimized functionality with improved performance, reduced footprint, and more robust manufacturability. PID enables grating coupler designers to automatically and reliably generate optimal designs with hundreds of free parameters to maximize design resolution.

New capabilities introduced with Lumerical's 2020a release improved support for running FDTD and PID on cloud platforms. The release includes features such as job checkpointing, support for Amazon Linux, and online self-activation for FDTD Burst Packs. (see <https://kx.lumerical.com/t/2020a-release-notes/47056>). Other notable PID features such as global optimization allows designers to efficiently explore a broad design space and co-optimize for process and packaging variation resulting in designs robust to manufacturing variability.

With only two weeks of design time, Lumerical's PID flow was run on the Amazon Web Services (AWS) EC2 platform to take advantage of the flexibility, cost-effectiveness, and virtually unlimited scalability it offers. For workloads with variability throughout the design schedule, computing resources can be scaled instantly and without the high upfront IT costs of on-premise platforms. This is especially attractive for the late stages of the design cycle when vastly increased simulation capacity is needed to quickly optimize and validate multiple variants of a design.

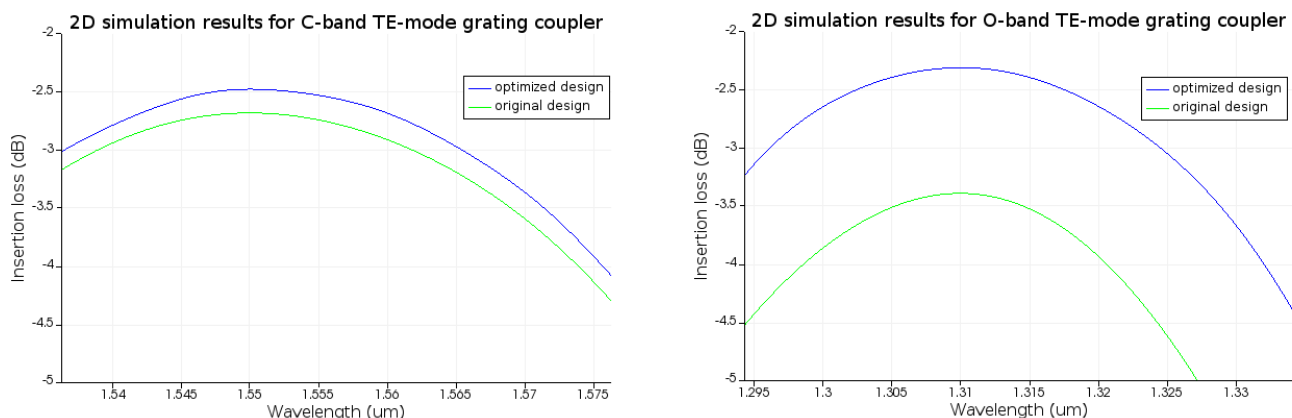
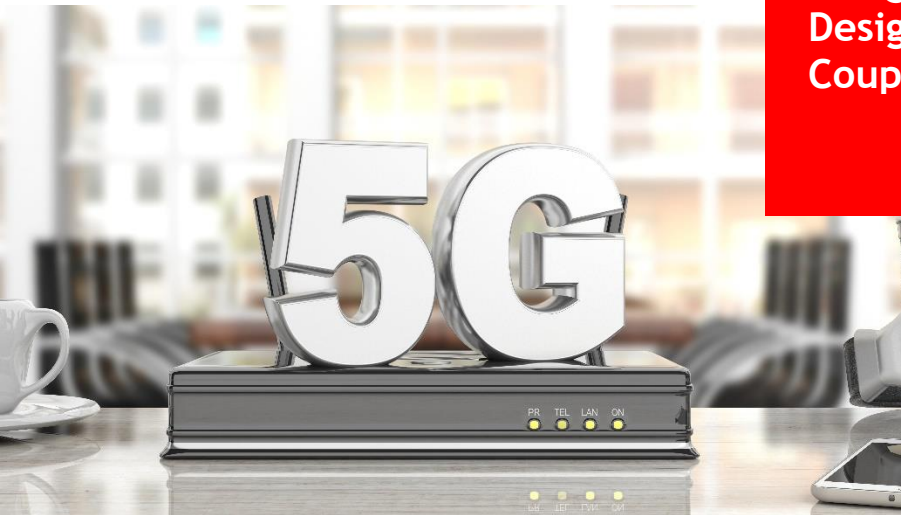


Figure 2: Comparison between the insertion loss of the original and new designs of two types of grating coupler, as simulated in 2D FDTD

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Results

Using Lumerical's PID flow on AWS EC2, new SiPh grating couplers were developed with a footprint 20x smaller than CompoundTek's existing coupler and with predicted improvements in performance. To achieve these results, the PID flow was configured to automatically optimize a parameterized 2D model of the grating coupler in FDTD with over 50 design parameters. The optimization goal was set to minimize insertion loss over the entire band while adhering to minimum feature constraints enforced to ensure manufacturability. Figure 2 compares the FDTD-simulated insertion loss of the optimized design to the original coupler for the TE-mode in the C-band and O-band. For the C-band, predicted performance was comparable to the original design with a loss of -2.5dB at 1550-nm. In the O-band, predicted performance of the optimized coupler improved with a loss of -2.4dB at 1310-nm. Achieving area reductions of this magnitude while improving coupler performance is valuable to CompoundTek's customers because of the potential for reduced manufacturing costs.

By deploying PID on AWS EC2, the time required to generate and optimize the grating coupler designs was limited to two weeks, including the time required to configure and launch the cloud resources. Using the 2D grating coupler example available in Lumerical's application gallery (https://apps.lumerical.com/pic_passive_grating_coupler_2d.html) as a reference design and Lumerical's FDTD Burst Pack licensing, it was possible to start generating candidate designs within hours.

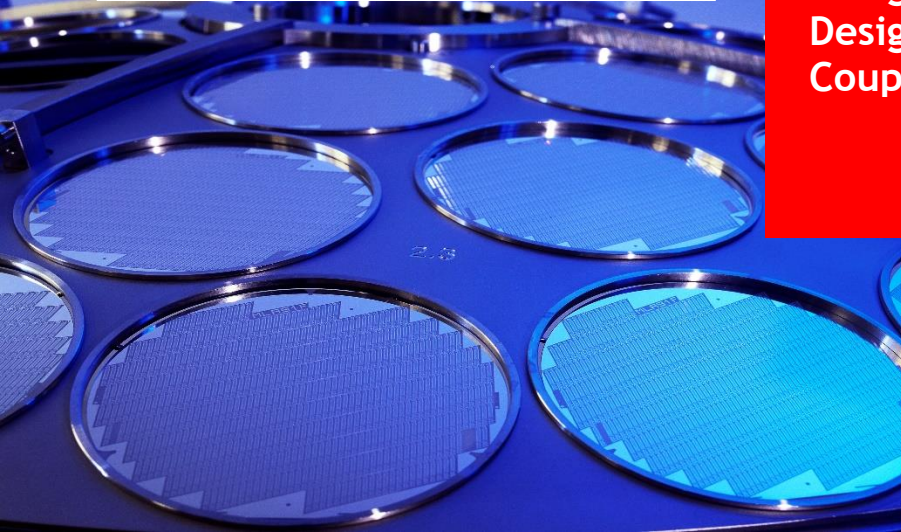
After two weeks, optimal designs for eight manufacturable variants were made available to CompoundTek that are significantly smaller than currently available designs and with better performance across the entire band, with significant gains in the o-band.

The total cost of computing needed to complete the two-week design project was approximately USD\$250, which was achieved by leveraging EC2 spot pricing. By completing the project on AWS, the substantial upfront costs, potential delays, and ongoing maintenance costs associated with deploying and maintaining on-premise computing resources were avoided. When complete, the AWS EC2 instances were simply shut off, such that no further expenses were incurred for idle resources.



SUCCESS STORY

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About CompoundTek Pte. Ltd

Founded and supported by industry veterans and technologists, Singapore-based CompoundTek combines world-class commercial foundry with leading silicon photonics (SiPh) research institutes to provide cutting-edge SiPh technologies that enhance foundry services capabilities. As one of the few offering SiPh solutions internationally, CompoundTek brings to the marketplace revolutionary semiconductor applications designed to meet critical requirements in high bandwidth and high data transfer solutions particularly in emerging connectivity driving Industry 4.0. The company's in-depth know-how includes end-to-end technologies - from proprietary fabrication process expertise to product design support with strategic partners and extended services for end-product manufacturing. CompoundTek's global customers span leading brands and FORTUNE 500 companies in high-growth industries including artificial intelligence, automotive, bio-medical diagnostics, data centre, lidar, smart sensor, telecommunication and quantum optical computing.

Visit www.compoundtek.com for more information.

About Lumerical

Lumerical develops photonic simulation software - tools which enable product designers to understand light, and predict how it behaves within complex structures, circuits, and systems. Since being founded in 2003, Lumerical has grown to license its design tools in over 50 countries and its customers include 13 of the top 15 technology companies in the FORTUNE Global 500 index, and 46 of the top 50 research universities as rated by the Times Higher Education rankings. Lumerical's substantial impact on the photonic design and simulation community means its tools are among the most widely cited in the scientific press, with references in more than 10,000 scientific publications and patents. Lumerical enables its customers to achieve more with light and establish a leading position in the development of transformative technologies employing photonics.

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