



## **White Paper**

# **BinOptics Answers the Photonics Integration Riddle**

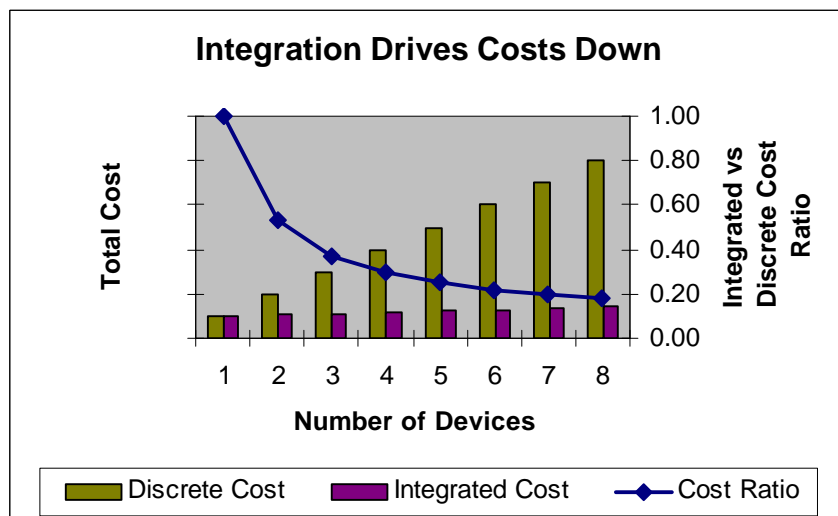
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# BinOptics Answers the Photonics Integration Riddle

Expanding upon more than a decade of research at Cornell University, BinOptics Corporation of Ithaca, NY has developed a way to cost-effectively integrate multiple optical devices onto a single Indium Phosphide (InP) chip. The company has created a novel platform of patented technologies and processes that has the potential to fundamentally change the economics of optical networks, and garner a new generation of optical solutions.

## Optical Integration Drives Cost Reduction

David Doran, director of marketing at BinOptics, says that monolithic integration can reduce optical component costs by up to 80 percent (see adjacent chart). By adding more devices onto a chip you can cut out unnecessary packaging and testing. As an example, let's compare a subsystem composed of four discrete optical components versus a subsystem with one integrated optical component. With the discrete solution, four components are individually manufactured, packaged, and tested; and then built into the subsystem. With the integrated solution, only one monolithically integrated component is manufactured, packaged, and tested. The integrated component solution provides comparable performance at a fraction of the cost.



## Monolithic Integration

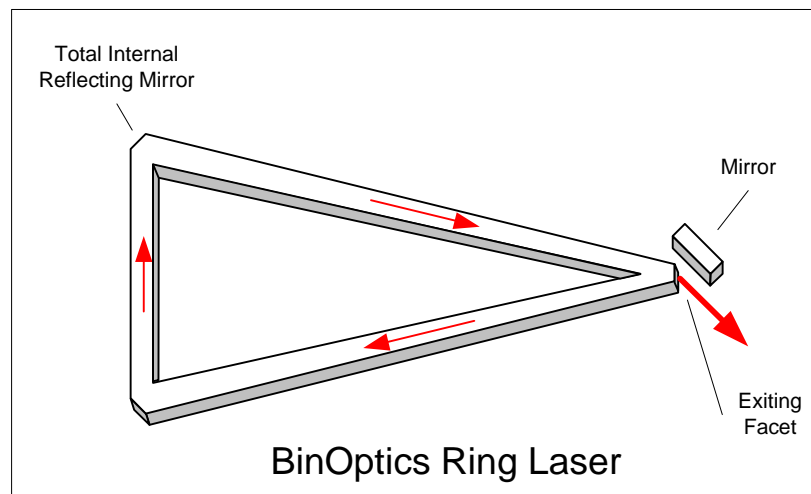
The evolution of electronics, from discrete components to highly integrated chips with millions of functions, is well known. Previous attempts at photonic integration have been disappointing, especially for the most critical active components: lasers, modulators, and photodetectors. BinOptics has developed

two complementary technologies that enable monolithic photonic integration: ring lasers and etched facets.

## Ring Lasers

Semiconductor ring lasers are polygonal cavity devices with total internal reflecting mirrors and a partially reflecting exit facet (see ring laser diagram). Ring lasers inherently demonstrate a single longitudinal mode, a high side mode suppression ratio (SMSR), and high output power. Conventional linear cavity Fabry-Perot lasers emit multiple modes. Distributed feedback (DFB) lasers use gratings to obtain single wavelength output. However, these gratings complicate the manufacturing process significantly and typically require yield-reducing epitaxial regrowth.

BinOptics ring lasers intrinsically support a clockwise and counter-clockwise wave. A strategically placed etched mirror provides the necessary feedback to enhance one of the modes, yielding a single-output device. The result is a high performance laser manufactured without epitaxial regrowth, without facet cleaving, and without facet reflectivity modification.



## Facet Etching

BinOptics' ring laser facets are etched as compared to conventional laser facets that must be cleaved. The mechanical cleaving of facets is an inexact science resulting in inconsistent laser performance and lower yield. Additionally, cleaving breaks the semiconductor crystal and makes monolithic integration past the facet impossible.

Etching creates very high quality facets that are highly repeatable. Etching also allows for the integration of multiple devices on a single chip. Yet, etched devices are separated on the surface of the chip so they have excellent optical and electrical isolation.

## **Device Yield**

In order to successfully integrate even three photonic functions on a chip, the process used must be highly reproducible with almost perfect yield. Do the math: if each device in a three-function component has even a 90 percent yield, the integrated product can be no better than 73 percent. Now try it for a 16-function component. The yield shrinks to less than 20 percent, hardly adequate for a low cost solution.

The processes commonly used to manufacture single wavelength lasers and modulators are far from simple. They require multiple regrowth steps, mechanical cleaving, and deposition of special reflective coatings on the facets. A yield of 30 percent for even a single DFB laser is often considered good. Obviously, integration of multiple DFB lasers on a single chip is not economically viable. BinOptics ring lasers are manufactured using less complex, standard semiconductor processing techniques that deliver similar performance at very high yields.

## **Custom Solutions**

The flexibility of BinOptics integration technology allows the company to offer custom photonic chips through its “Custom Solutions” initiative.

“Customers requiring integration of discrete photonic elements to reduce costs have turned to us to take advantage of our integration platform,” says BinOptics CEO, Alex Behfar. “In many cases, some excellent network solutions are stalled waiting for affordable photonics chips to become available. We are working with our customers to provide low-cost multi-function chips that are specifically designed for their current applications.”

BinOptics’ core business is integrated laser chips for applications such as the soon-to-be ubiquitous 10 Gigabit Ethernet. “After seeing our standard products and the capabilities of the technology, several customers asked about what else we could build,” says Doran.

So BinOptics developed a flexible platform for bringing its design and manufacturing breakthroughs to bear on custom applications. The company has assembled a photonic toolbox of InP-based lasers, photodetectors, modulators, amplifiers, splitter/combiners, and waveguides. Customers can get any configuration of these components to their exact system specifications. The platform approach means that BinOptics has the ability to work initially in low volumes without big non-recurring engineering bills or volume commitments.

## Photonic Toolbox

BinOptics offers customers:

- Ring lasers with output power as high as 20mW, SMSR as high as 45dB, and linewidth as narrow as 2MHz,
- Electro-absorption modulators that have a static extinction ratio as high as 14dB, and
- Wavelength specific semiconductor optical amplifiers with fiber-to-fiber gain as high as 30dB.

The toolbox also includes photodetectors and passive elements such as waveguides and combiners -- all essential to an integrated design.

The functional components in BinOptics' toolbox are impressive, but the big gains come from their integration. The broad range of devices possible in this single platform allows complex optical functions never before possible on such a compact scale. BinOptics can design, simulate, manufacture, test, and deliver unique integrated solutions.

“Integration is the key to advancing optical networking,” says Behfar. “Integration drives cost and size reduction and facilitates new applications.”