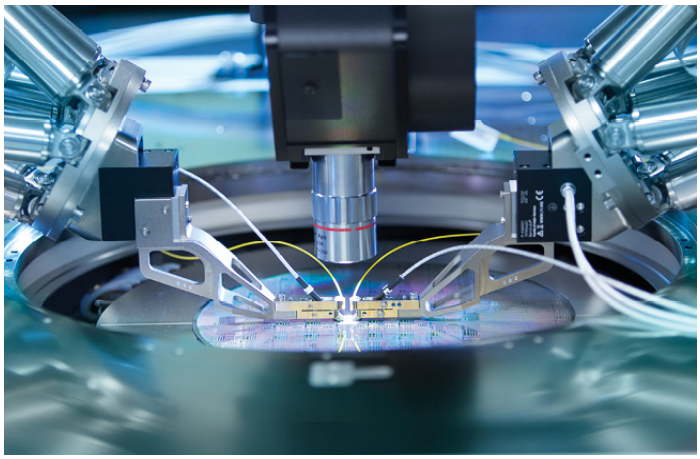
Technical Brief:

Moving Silicon Photonics Out of the Lab and Into the Fab

The semiconductor industry is at the gateway of a technology shift in the form of silicon photonics (SiPh), which holds the potential for spectacular gains in speed, power efficiency and density. The first wave of the SiPh revolution stands poised to roll over data centers around the world with optical interconnects that breach the barriers set by copper wire. End user benefits might include an HD movie or 100 hours of music downloaded in a single second. Bandwidths of a terabit per second now come within practical reach. FormFactor is already playing a significant role in the implementation of silicon photonics technology. This major inflection point provides a good illustration of how we participate in solving the challenges of wafer test long before a new technology goes into mass production.

Silicon Photonics Comes of Age

In essence, silicon photonics merges two technologies—integrated circuits and optical communications, which have evolved along parallel but separate paths. Each offers distinct advantages. Silicon-based IC fabrication now integrates literally billions of transistors onto a single substrate. Laser-based optical communications produce very high bandwidths and low-loss signal transmission over long distances. When combined via SiPh, they offer new possibilities in transmission speed, scalability, energy efficiency and cost reduction. Over time, SiPh will scale down from data center applications to interconnects on individual chips. Eventually, hundreds of cores on a single IC could be interconnected through an on-chip optical mesh.



When optical fibers must be precisely aligned to couple light in and out of a wafer without physical contact

SiPh permits both logical and optical components to coexist on the same wafer. Optical devices such as lasers, waveguide structures, detectors, multiplexers and others could interface directly with classic logic components or can be combined as separate ICs through advanced 2.5D and 3D integration techniques. This new level of integration permits the fabrication of hybrid devices that can be mass produced and interconnected via optical fiber cabling at very low cost while yielding substantial performance gains.

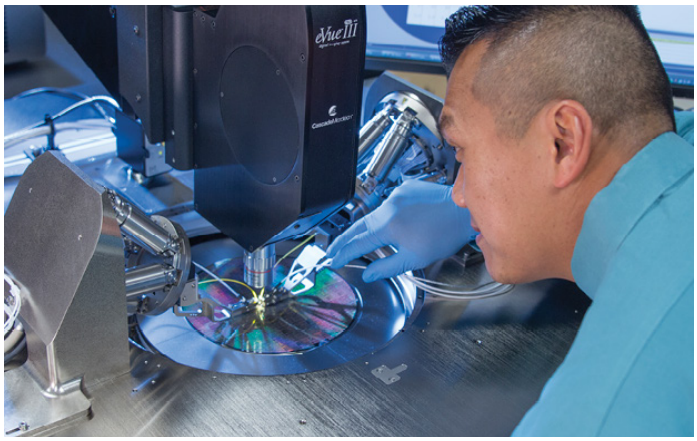
Moving to a New Paradigm in Wafer Test

Typically, SiPh includes on-chip I/O devices in the form of etched diffraction gratings, which route the light from off-chip optical fibers to waveguides within the chip, where operations such as filtering and conversion to digital data streams are performed.

This addition of optical I/O, along with electrical, adds an entirely new dimension to wafer test methodologies. The need to capture and insert modulated beams of light requires the development of novel probing strategies that accommodate a new set of mechanical requirements. The classic problem of maintaining accurate physical probe

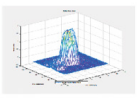
contact with pads on the wafer surface gives way to a new paradigm when optical fibers must be precisely aligned to couple light in and out of a wafer without physical contact.

FormFactor understands the critical importance of refining and perfecting SiPh probe technology. The research at this phase of development will ultimately provide the foundation for wafer-level production test. And as SiPh technologies expand beyond the data center into a growing number of new applications, the costs associated with testing millions of devices will become a critical factor in realizing the full economic potential of SiPh.



Keysight N7700A
Photonic Application Suite

Cascade CM300xi



FormFactor
SiPh-Tools

FormFactor Optical
Scanning Software

Alliances Hold the Key to SiPh Test Solutions

FormFactor takes a holistic view toward developing successful approaches to SiPh wafer test devices. We have forged partnerships with other key suppliers of test technology that play on each contributor's individual strengths. In this particular application, we actively interface with Keysight Technologies for measurement instrumentation. FormFactor leverages considerable expertise through an innovative team as well as collaborating with the right partners to deliver effective solutions.

SiPh-Tools Software is Key to the Integrated Solution

We harness the platform's inherent capabilities and extend them through a new software package, SiPh-Tools, to provide a system-level solution for SiPh wafer test. SiPh-Tools interfaces with third-party probe control software to accurately place optical fibers with sub-micron level precision. On the instrumentation side, we facilitate the interaction with Keysight's Photonics Applications Suite, which controls the actual measurement functions, such as laser beam generation and optical power detection, along with standard electrical measurements.

This type of multi-partner effort is already producing a deep knowledge base, the kind that will move silicon photonics out of the lab and into the fab as customers demand solutions that help them accelerate their products to market and profitability.

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