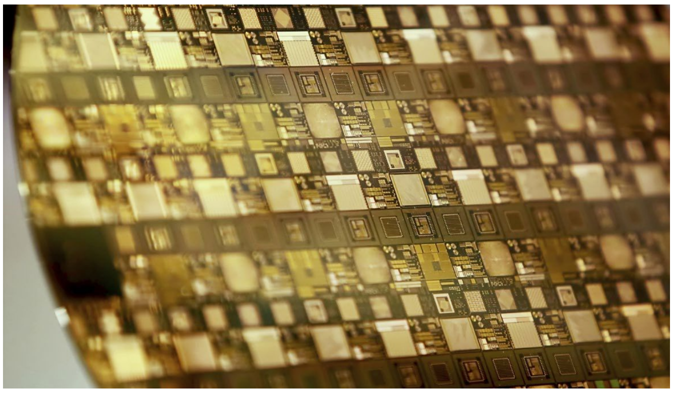
mesomatic fiberoptics

Testing and Quality

Silicon Photonics and PICs



Silicon Photonics and PICs are upcoming technologies with great potential in many different sectors. Global network and data center traffic will continue to grow rapidly in the future. Bandwidth, costs and energy consumption are the challenges that require new technologies. LIDAR (Light Detection and Ranging) is also a promising application as well as optical sensors. Special measurement technology is needed to assess the quality and efficiency of these new products and production processes. This is used both in R&D and in production.

What is important?

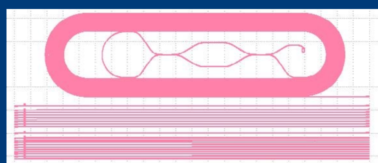
To evaluate a photonic component of this size, several measurands are essential. Position and type of any imperfection, influence of the specimen on the polarization of the light and wavelength and polarization dependent loss are important parameters.

In the following, measurement methods, measurement analyses and the appropriate measuring devices will be presented. Depending on the application, devices can be combined or used individually. Some devices offer a variety of functions, others are specialized for one application.

Applications

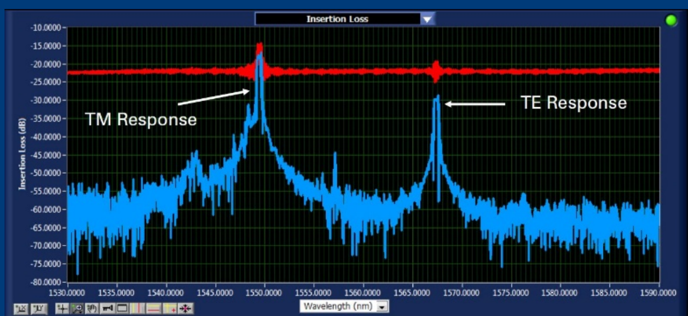
- Manufacturing test
- Quality control
- Diagnose production issues
- Characterize and analyze designs
- Validate models and improve simulations
- Passive optical components and modules - filters, PLCs, AWGs, MUX/DEMUX, splitters, gratings, WSS, ROADMs

Example: Characterization of Planar Waveguides with Luna High Resolution Reflectometer OBR



Planar optical waveguides, a key building block of silicon photonic platforms, present several unique measurement challenges, including greater losses per unit length and high polarization dependency.
Luna's swept laser interferometric technology is able to scan the device and trace reflectivity along the length of the waveguide with sub-mm detail and fully characterize the optical path. For this example waveguide grating, the time domain trace allows easy identification of the facet and grating reflections.
Using the Luna analysis software, you can select only the grating reflection and easily observe the different TM and TE polarization effects in the spectral response. Otherwise, the overall spectral response (shown in red trace on bottom plot) is dominated by the large facet reflections.

The time domain response clearly shows the large facet reflections and grating reflection of the silicon photonic waveguide.



The spectral analysis of only the grating reflection (blue trace), selected via the time domain response, easily identifies the grating peaks. The overall response of the waveguide is shown by the red trace.

LUNA OBRs: advanced Test Suite for Silicon Photonics and PICs

Luna's unique test systems, based on optical frequency-domain reflectometry (OFDR), deliver accuracy and speed for testing modern integrated optical components.

"See Inside" Components with 10 µm Resolution

Luna's ultra-high resolution reflectometers offer backscatter-level sensitivity for unprecedented distributed loss analysis of passive components.

Complete Component Characterization with Single Instrument

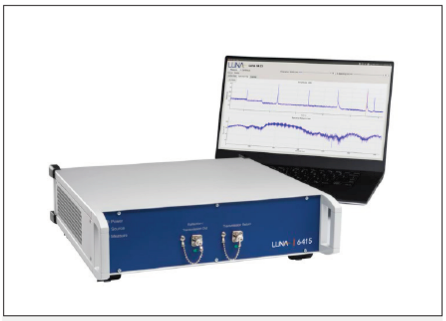
Luna's Optical Vector Analyzer (OVA) measures a passive component's linear transfer function (Jones Matrix) with a single scan, yielding insertion loss (IL), group delay (GD), chromatic dispersion (CD), polarization mode dispersion (PMD), polarization dependent loss (PDL), and other critical parameters.

Optical Vector Analyzer
OVA 5000

- **Complete characterization** of waveguide devices
- **Full polarization analysis** without need for polarization controller or aligned PM fiber
- **Instantaneous measurement** of IL, RL, PDL, PMD, TE/TM states, waveguide scatter, and more in a single fast scab

Optical Backscatter Reflectometer
OBR 4600

- **Unprecedented visibility** into the details of silicon photonics, PICs and fiber optic components
- **10 µm resolution; -140 dB sensitivity**
- **Waveguide scattering** and loss easily measured and analyzed
- **Skew measurements** with sub-picosecond resolution

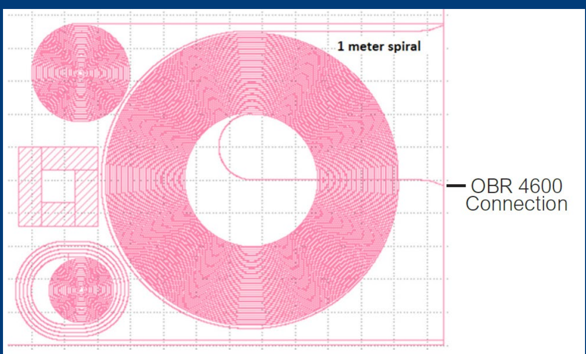


Lightwave Component Analyzer
Luna 6415

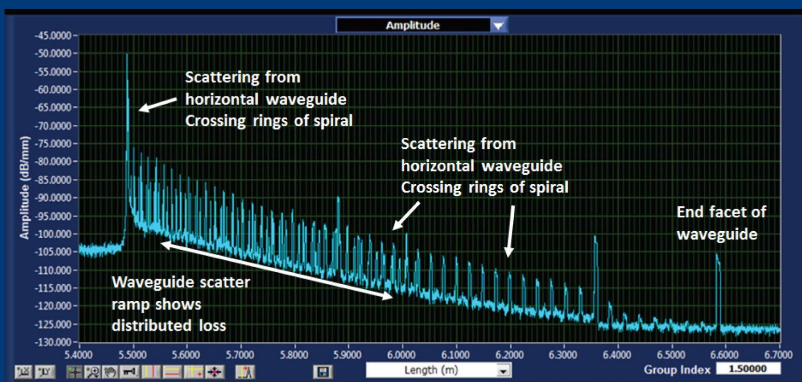
- **High speed analyzer** for production test and quality control
- **Reflectometer and transmission** analyzer combined in single instrument
- **Measure distributed loss** versus length with very high resolution
- **Spectral analysis** of transmission and reflection paths

Example: A Spiral Delay Line Fabricated on a Silicon Platform - An Analysis Using Luna's OBR 4600

The Si photonics spiral delay chip compacts a 1 meter optical path length into an approximately 1 cm^2 area. The OBR 4600 can be optically coupled to the end of the spiral waveguide and the full 1 meter path length scanned. In the data shown above, the reflection at the chip input facet is at 5.486 meters and the reflection from the end facet is shown at 6.586 meters. The distributed loss across the entire device can be measured and is approximately 30 dB/m. The data taken in a single scan contains a remarkable level of detail with reflective events due to waveguide crossing of the spiral clearly shown with just 50 micron separation. Data from a single scan be reprocessed in different ways to support a variety of analysis.



Spiral Delay Chip - Schematic



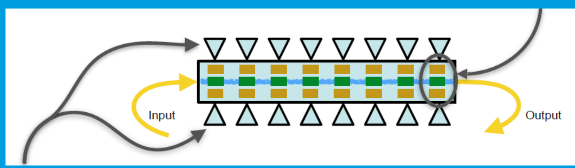
Polarization of Light

In many applications, the polarization of light is an important parameter. On the other hand, waveguides based on silicon photonics can influence the polarization. With the equipment shown below, you have full control on the polarization at the input and can measure the influence of the component on it at the output.

Luna Polarization Control Platform based on Lithium Niobate Technology

NRT-2500 - 7 Polarization control functions in 1 instrument:
Paddles, Acquirer, Tracker, Scrambler, Randomizer, Depolarizer, Spinner

$LiNbO_3$ waveguide with 8 electro-optic waveplates formed from a 3-electrode group



- Two electrodes drive each (1) extremely fast, (2) endlessly rotatable waveplate angle, and (3) variable waveplate birefringence
- Highly repeatable
- Reliable: solid state design with no moving parts or stressed fiber
- High speed with sub-microseconds switching speed
- Endless rotation with no resets

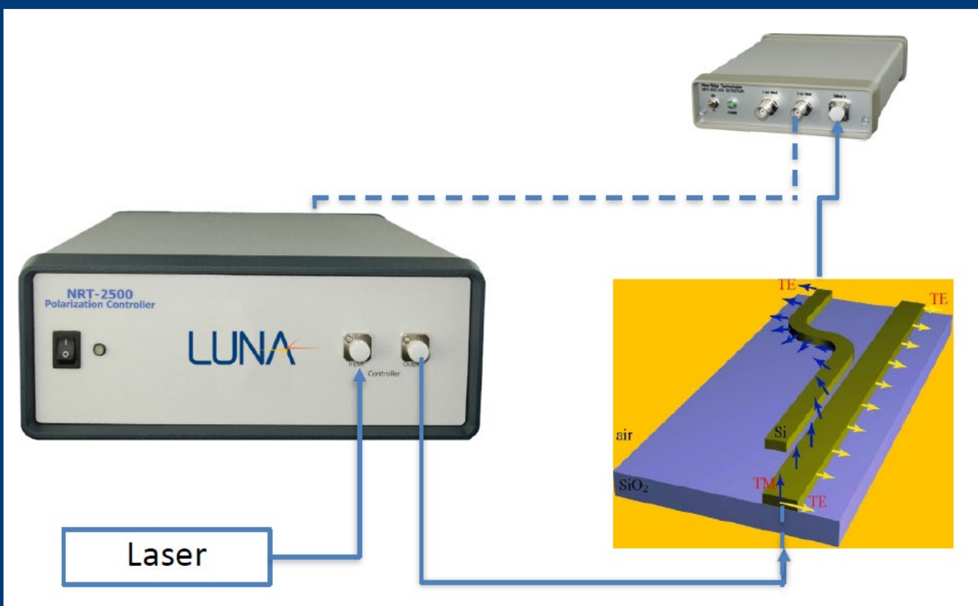
Polarimeter POD-201

The POD-201 is an in-line fiber-coupled polarimeter that simultaneously measures the four Stokes parameters to yield the instantaneous state of polarization (SOP) and degree of polarization (DOP) of input light.

Example: Polarization Alignment for Silicon Photonics Characterization

NRT-2500 Acquirer mode is the automated ‘smart’ Paddles mode

Drives the SOP to maximize or minimize feedback for TE/TM polarization alignment



Wavelength and polarization dependent loss

Within the important wavelength range of 1520.086 to 1630 nm measuring the insertion loss (IL), polarization dependent loss (PDL), return loss (RL) directivity as a function of wavelength is an important part of quality control in both research and development (R&D) and production environments.

VIAVI MAP Swept Wavelength System

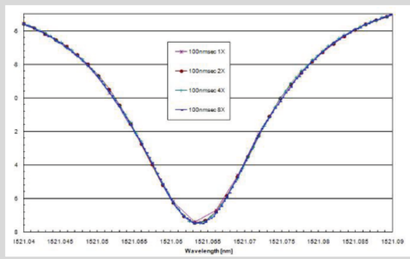
The new mSWS-A2 raises the bar on test speed, accuracy, and resolution, all while maintaining its patented distributed architecture to deliver the lowest-cost testing in the industry.

Calculable parameters relative to the measured peak:

- Loss at peak
- Center wavelength, from x dB threshold
- Loss at center wavelength
- Bandwidth at x dB threshold
- Crosstalk, left/right, and cumulative
- Flatness

This integrated measuring system with a laser, an integrated source optic module (SOM) and the detector module allows a very precise correlation of wavelength and measured value during the scanning through the wavelength range.

With a 4-state polarization controller located within the SOM, PDL and average loss can be measured quickly as a function of wavelength. It can measure four polarization states at 0°, 90°, –45°, and circular polarization and uses the Mueller matrix analysis to accurately determine PDL at all wavelengths scanned.



Example of ultra-high resolution where all data was collected at 100 nm/s sweep speed

Links to the products:

Luna OBR
Luna Polarization Control Platform
Viavi Swept Wavelength System

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