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Pioneering 3D photonic integrated circuits

OptoCpIrLT™: OPTIMIZED MECHANICAL INTEGRITY TO PERFORM IN INDUSTRIAL WORKING TEMPERATURE ENVIRONMENTS

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OptoCplrLT™ is a novel, monolithic light-turning (out-of-plane) optical component targeting both leading edge silicon photonics application areas and use cases requiring high-performance optical fiber coupling. As optical systems become increasingly embedded in our everyday lives, system architects require a high level of confidence in the reliability of the fundamental building blocks within the complex ecosystem. The mechanical integrity of optical components is one of the key building blocks to enable good Failure in Time (FiT) rates at a system-wide level and it is this aspect of the OptoCplrLT™ we address in the following white paper.

The OptoCplrLT™ design has been optimized for use with transceivers in applications across the industrial temperature range, -40°C to 85°C. Optoscribe has focused on three key features (Figure 1) in the light-turning component to optimize the mechanical integrity of the device and minimize potential points of failure caused by external environmental stressors such as temperature and humidity.

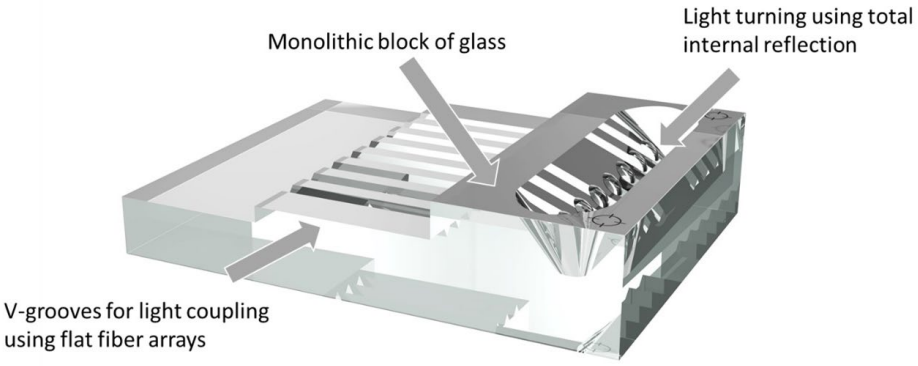

Figure 1: *Key design features to optimize the reliability of OptoCplrLT™*

1) The component:
   a. Fundamentally, the OptoCplrLT™ is a monolithic block of highly stable Borofloat33™ [1]. By designing and manufacturing the device as a single unit and utilizing the optical phenomenon of total internal reflection, a simple solution to a complex optical coupling problem can be delivered at volume.

2) The fiber coupling:
   a. The OptoCplrLT™ has been designed such that the optical fiber arrays used for the transmission of light lie flat for >2 mm with three points of contact with Borofloat33™ along their entire length. This design removes the entire bent fiber sections often implemented on other light turning solutions.

   b. The flat V-grooves also allow the end user an additional degree of flexibility in the type of optical fiber used, opening the potential for novel core sizes and structures to be easily integrated into the optical system.

3) The V-groove:
   a. The geometry of the V-groove has been optimized though modelling and experimental verification to minimize the mechanical stress within the glass. These geometries have been verified through accelerated stress testing.

Tests conducted

Two key tests were conducted on OptoCplrLT™ components based on Telcordia and JEDEC standards to validate the mechanical integrity of the design and manufacturing process.

Temperature cycling

A temperature cycling programme of 100 cycles between -40°C to 85°C with ramping at 10°C / min was conducted on an OptoCplrLT™ design variant. The devices were visually inspected both before and after the testing. On the left of Figure 2 a device after test is shown, no microcracking is evident, both fiducial marks are visible, and all four mirrors are intact. An excerpt of the test data is shown on the right of Figure 2 showing the -40°C to 85°C ramp and temperature dwell.

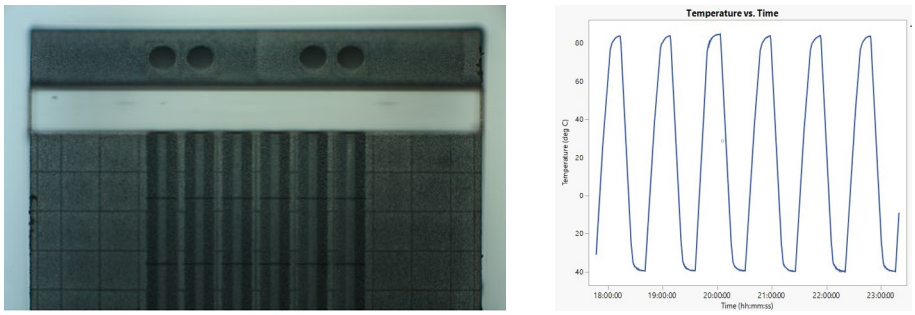

Figure 2: *Left: OptoCplrLT™ after 100 temperature cycles demonstrating good structural integrity Right: excerpt of temperature cycle*

[1] Schott Glass, Borofloat33™ Technical Data Sheet (2019)

Highly accelerated stress testing

Highly accelerated stress testing (HAST) was also conducted on the OptoCplrLT™ component itself and a representative V-groove section. Successful HAST demonstration based on JEDEC standards rapidly gives a good level of confidence in the performance of the devices in high temperature, damp heat environments prior to progressing through the several thousand hours of 85°C / 85% relative humidity (RH) tests required for full Telcordia qualification.

Devices were subjected to a JEDEC test of temperature at 121°C and RH of 100% for 24 hrs. Each device was visually inspected before and after the testing with no microcracking observed on the mirrors or between the V-grooves, all fiducial marks remained visible and all eight mirrors remained intact (Figure 3).

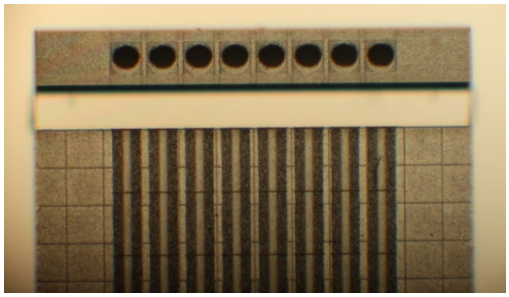

Figure 3: *OptoCplrLT™ after HAST demonstrating good structural integrity*

A set of representative V-groove sections were also subjected to a temperature of 121°C at 100% RH for 24 hrs. Figure 4 is an image of one V-groove array after testing showing no evidence of microcracking on the structures.

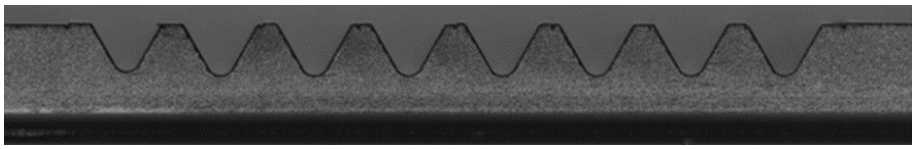

Figure 4: *V-groove array after HAST demonstrating good structural integrity*

The reliability of high-performance optical systems is built from the bottom up with individual component parts playing a crucial role in the overall performance. Optoscribe has demonstrated, using two extreme environmental tests, that the monolithic OptoCplrLT™ product withstands significant environmental stresses supporting its use for leading edge industrial optical applications.

About Optoscribe Ltd

Optoscribe designs and manufactures 3D glass-based optical components for the telecommunications and data communications markets. Using its innovative laser direct-write technology, Optoscribe's bespoke solutions address market challenges such as bandwidth, speed, density and channel count.

Optoscribe's product portfolio includes precision fiber alignment arrays, fiber-to-fiber interconnects, multicore fiber fanouts, photonic lanterns, transceiver photonic integration platforms, SiPh coupling solutions, and Optical Sub-Assemblies.

For more information, visit: www.optoscribe.com

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