TELECOM TRENDS
Focused on Next Generation Network Startups & Emerging Technologies

Reprinted with permission from *Telecom Trends*, March 2004

Arrayed Fiberoptics

Arrayed Fiberoptics was founded "to enable the evolution of fiberoptic components from existing hand-crafted assemblies to modern, reliable, affordable devices." The company has developed and patented a technology for producing a variety of fiberoptic components with better performance, size, reliability, and cost. Arrayed Fiberoptics is a "well-funded pre-IPO company."

Today's fiberoptic components are assembled and packaged one at a time, unable to take advantage of the economies of scale long used by the semiconductor industry. Conventional fiberoptic components require expensive, active alignment between individual single-channel or small array components and their fiber interface. As a result, alignment and packaging often accounts for 80% of the cost of producing fiberoptic components.

Arrayed Fiberoptics has patented a technology to address this problem. The company's Vertical Fiber Integration (VFI) platform seamlessly integrates a precise fiber passive alignment mechanism into microfabricated devices during the fabrication stage, on a full-wafer scale. As a result, the fiber alignment issue is solved before wafer dicing allowing it to offer the same superior insertion loss performance in component arrays as in single-channel components, without individual active alignment.

The key to VFI is a precise vertical light transmission path through the wafer, perpendicular to the wafer plane, which is dramatically different from current waveguide technology. In the case of existing technologies, after the wafer is diced into individual components, each component must then be separately actively aligned to fibers for optimal performance, which is difficult and expensive.

In contrast, VFI components use a stack of wafers; each wafer contains microfabricated optical elements performing optical functions such as collimation, focusing, filtering, deflection, or fiber passive alignment of a light beam as it vertically traverses the wafer stack. One of the wafers in this stack contains patented precision fiber sockets for fiber passive alignment, simultaneously aligning all of the thousands of components on the wafer.

The stack of wafers together form multiple vertically integrated optical circuits. The wafer stack is permanently bonded (providing natural hermetic sealing) using semiconductor wafer bonding techniques, and diced into individual or array components, each one already sealed and fully aligned. Fibers are then passively inserted into the pre-aligned sockets, and attached with strain-relief packaging.

The full wafer alignment and seamless packaging approach results in significant improvements in performance, size, cost, hermeticity, and reliability. Cost reductions of more than 10x are achievable in some applications, according to the company. At the same time, VFI offers high performance, comparable to or exceeding that of more expensive existing individually assembled devices.

Because of the small size and sealed packaging, the components are much less susceptible to environmental factors than many existing components. The patented symmetric fiber mounting approach also minimizes temperature-dependent alignment shift. Lastly, Arrayed Fiberoptics' full-integration reduces the number of parts and interconnects.

VFI is ideal for creating integrated array devices in 1-dimension or 2-dimensions, as well as single-channel devices. VFI enables a variety of low-cost, high-performance single-mode fiberoptic components, both active and passive, in array or single-channel form, such as fiber arrays, epoxy-free fiber arrays, transmitters, receivers, transceivers, VOAs, optical switches, array fiber connectors, collimators and beam-shapers, optical filters, and a variety of other devices.

Arrayed Fiberoptics will team with fiberoptic component vendors to enable them to offer high-performance, high-reliability, low-cost components based on VFI technology. Because Arrayed Fiberoptics' packaging is so much smaller than existing components, vendors can easily integrate VFI into existing components to improve their characteristics, or alternatively use it to create new component designs.

Arrayed Fiberoptics has also introduced its epoxy-free fiber array, designed to be used as a subcomponent for planar lightwave circuits (PLCs), such as arrayed waveguide gratings (AWGs). Currently, the industrial practice for PLC waveguide-to-fiber coupling is simple butt-coupling using epoxy. In this approach, the PLC edges are polished, aligned, and epoxy bonded to a fiber array device, which is typically made by machining V-grooves into the surface of a glass or silicon plate, and placing the fibers in these grooves.

Epoxy bonding has proven to provide quick and simple alignment, low cost, and robust packaging. However, this approach leaves epoxy in the optical path, which causes limitations in power, performance, and reliability due to epoxy degradation. These problems are most acute for AWGs, because they are typically used in long-haul DWDM applications, which require very high power.

These limitations have inspired various attempts to eliminate epoxy from the optical path, typically through the use of additional hardware such as microlenses or external mounting plates. However, due to the complexity and cost of these approaches, they have not been widely adopted.

Arrayed Fiberoptics' epoxy-free fiber arrays (EFFAs) incorporate a patent-pending, integrated epoxy-blocking structure, which preserves the simplicity, low-cost, and robustness of typical fiber butt-coupling, while keeping the optical path epoxy-free. As a result, PLC manufacturers can use their existing packaging designs with very little modification.

The EFFAs can be configured in linear arrays up to 1x64 channels and 2-D arrays, with array pitch as small as 127 um. Even in large arrays, EFFAs provide very precise positioning of fibers, to +/- 0.3 um in both the horizontal and vertical dimensions, which is much higher precision than is available from V-groove technology. EFFAs thus enable higher power and reliability as well as improved device performance due to better alignment precision. Further, unlike V-grooves, EFFAs enable not only linear arrays, but also 2-D arrays.

Typical applications for EFFAs include coupling to PLCs or array devices, such as AWGs, beam splitters, OADMs, optical cross-connect switches, microlens arrays, etc. Arrayed Fiberoptics will team with component vendors to integrate EFFAs into their existing devices for improved characteristics, or alternatively they can be used to create new component designs.

Samples of EFFAs are available now with 250um pitch, and EFFAs with pitch as small as 127 um are currently in development.