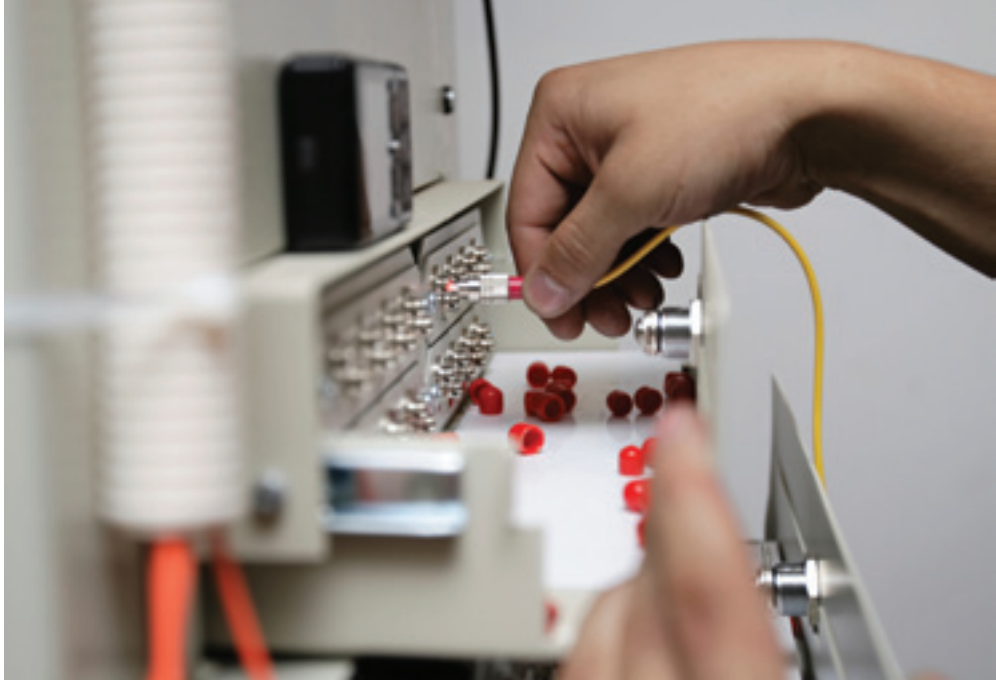

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Opportunities and Trends in **Optoelectronic Manufacturing**

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A recent workshop organized by the Optoelectronics Industry Development Association (OIDA) highlighted key challenges and opportunities facing photonics manufacturers today.

The photonics and optoelectronics industry underwent dramatic changes following the telecom bubble collapse about a decade ago. Many companies struggled to survive, while others filed for bankruptcy. According to a report by the CATO Institute, close to 500,000 jobs were lost when the telecom bubble collapsed. A vast majority of the jobs lost in photonic manufacturing were in photonic packaging and assembly. Businesses that managed to stay afloat were subject to severe pricing pressures.

While end-user demand for bandwidth continues unabated, the gross margins for the photonics industry continue to pose business challenges—particularly in the communications sector. To remain competitive, the industry has responded by off-shoring the packaging and assembly of optoelectronic components to locations where the labor cost is lower.

The U.S. government has recently announced a string of manufacturing initiatives to facilitate development of advanced manufacturing technologies and to provide the impetus for job growth.

These new initiatives have the potential to translate into opportunities for the photonics community. For this reason, the Optoelectronics Industry Development Association (OIDA) organized a workshop earlier this year entitled, "Opportunities and Trends in Optoelectronic Manufacturing." It was collocated in Los Angeles with the 2012 Optical Fiber Communications conference. The primary goal of this one-day event was to reflect upon the current state of photonics manufacturing and to discuss how to foster its development through government grants or public-private partnerships. Speakers represented all segments of the photonics industry, including large, medium and small companies, the government, academia and the financial community.

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The presentations and discussions were primarily focused on the communications sector, spanning the gamut from long-haul to personal communications. The technology discussions were specific to the photonic components that power our telecommunications infrastructure.

Challenges

Many of the speakers touched upon the challenges facing the photonics component industry, which include the following.

Gross margins are low. Gross margins of roughly 30 percent are not sufficient to sustain and grow a manufacturing business. The evolution of new multi-source agreements (MSAs) is further squeezing these margins. While MSAs provide a larger addressable market for component manufacturers and enable a larger supplier base for systems vendors, the cost advantage is stacked heavily in favor of systems vendors; component vendors are under significant pressure to deliver products at better price points. This forces component suppliers to focus on staying cost-competitive and relegates technology differentiation and innovation to secondary status.

The industry remains fragmented. Chip-level design, processing and packaging continue to be of a proprietary

nature, and the large component suppliers tend to be vertically integrated. This makes the existing suppliers reluctant to change their design, process or packaging methodologies. The business model for the industry is also a barrier to new entrants who lack access to necessary capital-intensive infrastructure.

Companies are reluctant to make new large-scale capital investments. The vast majority of major investments were made before the collapse of the telecom bubble. The current gross-margin challenges have made companies hesitant to make new large-scale investments.

Despite these challenges, the pace of innovation has not slowed. Tremendous progress has been made in technologies that enable significant integrated chip density and data capacity.

Paradigm shifts

The workshop also highlighted key industry trends.

Photonic integrated circuits (PICs) are on the rise. Commercial systems based on indium phosphide PICs are now commonplace in many optical networks. Engineers have demonstrated telecom-grade reliability in these PICs, and the component count and complexity have increased over time.

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There is a resurgence of interest in coherent systems, thanks to technologies such as advanced digital signal processing chip sets, higher constellation modulation, etc. This technology, which was originally investigated in the 1970s, can now deliver such staggering capacities as 100 Gb/s per optical channel.

As consumers demand more bandwidth, clearly photonic technologies will become more pervasive in our network infrastructure. In future very-short-distance networks, it is conceivable that a single optical fiber could be deployed per user. The photonic technologies found in today's short-distance applications such as data centers were originally developed for telecom applications. However, such technologies are not cost-competitive for consumer and other future applications. Thus, we need to realize a new manufacturing paradigm to attain cost-competitive higher-bandwidth networks in the future.

Opportunities

With challenge comes opportunity, and the workshop speakers and attendees identified several possible growth prospects.

Chip technologies. Develop design rules across all material platforms for chip technology, create design tools and standardize design libraries to conform to these design rules. Decouple design from fabrication. The electronic IC industry has been very successful in accomplishing this. The photonics industry can benefit from the learning trajectory followed by the electronic IC industry. In the future, this manufacturing paradigm could spawn a host of innovative fabless companies as well as create opportunities for existing companies.

Packaging and assembly. Standardize chip interfaces to facilitate standardized packaging and assembly. Manufacturing tools can be developed to automate packaging and assembly. Standardization of chip and package interfaces would also facilitate testing at a lower cost.

Materials technology. Create technologies that allow integration of disparate materials on a common platform. With electronic ICs, circuits are designed and fabricated on unique substrates (Si, GaAs, etc.). In photonics, however, the best-in-breed performance of different photonic functions (lasing, modulation, photo-detection, etc.) may all require various materials technologies to achieve the necessary functionality.

The collective benefits of disparate materials technologies can only be realized on a shared substrate platform if the materials can be delineated on a common substrate.

We can only seize these opportunities and shift paradigms by creating an industrial ecosystem that fosters innovation in photonic manufacturing. Given the challenges that photonic components companies are experiencing, such a vision can only be realized with significant government funding and through public-private partnerships.

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About OIDA

Founded in 1991, the Optoelectronics Industry Development Association (OIDA) is a Washington D.C.-based, not-for-profit organization that serves and represents the optoelectronics community. It is a division of the Optical Society (OSA).

OIDA members include the leading providers of optoelectronic components and systems enabled by optoelectronics, as well as universities and research institutions. The association provides roadmaps, reports and market data for the optoelectronics industry. It serves as the voice of industry to government and academia; acts as a liaison with other optoelectronic industry associations worldwide; and provides a network for the exchange of ideas and information within the community.

[References and Resources]

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