Co-packaged optical core materials

Article Overview

Co-packaged optical core materials are specialized substrates, photonic and electronic components, and interconnect materials designed to integrate optics and electronics within a single package for high-bandwidth, low-power data transmission.

Overview of Co-Packaged Optics (CPO)

Co-packaged optics (CPO) integrates optical components such as lasers, photodetectors, and photonic integrated circuits (PICs) alongside electronic components like ASICs within the same package. This reduces the distance between optical and electrical elements, improving bandwidth, lowering latency, and reducing power consumption compared to traditional pluggable optics systems (Corning) . CPO is particularly critical for AI and hyperscale data centers, where high-density fiber routing and scalable optical I/O are required .

Key Materials in CPO

o Photonic Integrated Circuits (PICs) PICs are the core optical elements that generate, modulate, and detect light. They are typically fabricated using silicon photonics, indium phosphide, or other semiconductor materials compatible with CMOS processes. PICs must maintain high optical clarity, low insertion loss, and thermal stability to ensure reliable signal transmission .

o Electronic Integrated Circuits (EICs) EICs, including ASICs, control the optical signals and perform high-speed data processing. Materials for EICs are standard semiconductor substrates like silicon, but they must be compatible with the thermal and mechanical requirements of the co-packaged optical environment .

o Substrates and Interposers

o Silicon Interposers: Used for high-density die-to-die (D2D) connections, allowing PICs and EICs to be co-located. They provide precise routing but increase thermal management complexity and cost .

o Organic Substrates: Offer flexibility and lower cost for placing optical engines within the ASIC package. They are suitable for high-bandwidth density but require careful design to manage heat dissipation .

o Optical Coupling Materials Materials such as ion-exchange glass waveguides or femtosecond laser-written waveguides are used to guide light between PICs and fibers. These materials must have low optical loss, high thermal stability, and compatible coefficients of thermal expansion (CTE) with surrounding components .

o Phase-Change Materials (PCMs) PCMs are emerging for non-volatile photonic memory and neuromorphic photonics, enabling integrated storage and computing within the optical core. They help reduce static power consumption and improve energy efficiency in CPO systems .

Material Considerations and Challenges

o Thermal Management: Co-locating high-power EICs and PICs generates heat that must be efficiently dissipated to prevent performance degradation .

o CTE Matching: Materials must have compatible thermal expansion to avoid stress and misalignment between optical and electronic components .
o Dielectric Properties: Substrate and interposer materials must maintain low dielectric loss to preserve signal integrity at high frequencies .
o Reliability: Long-term stability of optical materials, including resistance to photodegradation and mechanical stress, is critical for data center applications .

Future Directions

Research is focusing on higher bandwidth density optical engines, advanced phase-change materials, and improved integration techniques such as 3D stacking of PICs on EICs or co-location on silicon interposers. These innovations aim to overcome thermal, material, and architectural challenges, enabling next-generation AI and hyperscale data center infrastructure . In summary, co-packaged optical core materials encompass PICs, EICs, substrates, interposers, optical waveguides, and emerging phase-change materials, all engineered to optimize bandwidth, power efficiency, and reliability in tightly integrated optical-electronic packages.

Conclusion Co-packaged optics is a promising frontier in advanced packaging that brings much needed gains in

Learn how co-packaged optics is reshaping data center networks by slashing power use and

Meeting market expectations and building confidence in co-packaged optics will require more than performance

Abstract--Co-packaged optics in next-generation datacenters require the assembly of multiple components on the same multi-chip

Co-packaged optics integrates photonic engines directly with switch ASICs and AI accelerators, cutting power draw

Modern computing techniques are pushing the boundaries for high performance requirements. Co-packaged optics (CPO) emerged

Co-Packaged Optics (CPO) Technology for Modern AI Era: A Review Abstract: This paper discusses advanced CPO technologies

Co-packaged optics with Application Specific Integrated Circuits (ASICs) via low-loss electrical channels are

While challenges including heat management and the complexity of maintenance remain, Japanese companies

Co-packaged optical core materials

Co-packaged optics (CPO) is a disruptive approach to increasing the interconnecting bandwidth density and energy

Co-Packaged Optics (CPO) is an advanced integration of optics and silicon on a single packaged substrate

Fiber infrastructures for co-packaged optics can be designed and assembled to achieve high reliability at scale. Failure mechanisms

Co-packaged optics (CPO) technology offers a promising solution by integrating photonic integrated circuits (PICs)

This document provides guidance on the requirements for co-packaged optic assemblies designed for high-radix, network switch

IDTechEx Research Article: The rise of co-packaged optics is transforming modern data centers and high

Discover how co-packaged optics (CPO) is revolutionizing hyperscale data centers. Learn how Corning"s

Web: https://www.morwarreconst.co.za