Optoelectronic Multi-Chip Module Demonstrator System

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Talk Overview

- We present:
  - A novel technology for chip-to-chip optoelectronic interconnection and packaging
    - “Optoelectronic Multi-Chip Modules”
    - Based on fiber image guides
  - Our current progress on the fabrication and characterization of a demonstrator prototype
    - Implementation of a 64x64 optical crossbar switch
Talk Overview

Outline

- OE-MCM technology
  - Fiber image guide (FIG) technology
  - Using FIGs as an interconnect medium
  - Silicon-on-sapphire CMOS dies
  - OE-MCM fabrication

- Demonstrator system
  - Architecture
  - Interconnection topology
  - Chip layout
  - Experimental results
Fiber Image Guides

- Dense array of small-core fibers arranged in a lattice
  - Fiber diameter 5-20 um, pitch 15um, 10,000 - 15,000 core/mm²
  - (imaging)
Optical Interconnect

- Optical links
  - Based on rigid fiber image guide segments
  - Acts as transmission medium and structure of MCM
  - Cut image guide at different angles to create horizontal connections between sides of MCM structure
  - Stack image guide segments to create different signaling topologies through MCM
OE Component Design

- Design logic on CMOS with transparent substrate (UTSi)
- Bump-bond SoS die to PCB (electronic I/O)
- Bump-bond VCSEL/detector chips to SoS die
- Bond SoS die to sides of image guide glass
OE-MCM Demonstrator System

- 3-chip OE-MCM implementing a 64x64 crossbar switch
- Each chip implements eight independent 8x8 switches
- Fiber ribbon cable (8x8) carries optical data in/out of MCM
- Switch is electronically configured
  - 2 level configuration memory

3-stage switch architecture
OE-MCM Demonstrator System

Switching logic and switch configuration memory

Chip layout

Alignment marks

4 x 5.5 mm
OE-MCM Demonstrator System

Bottom view of chip showing detectors

Bottom view of chip showing VCSEL array
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Bottom of SoS chip bump-bonded to PCB

Top of chip showing receiver/VCSEL arrays (through PCB cavity)
OE-MCM Demonstrator System

- Image guide offset is required
  - VCSEL/detector arrays not symmetrical relative to chip axis
OE-MCM Demonstrator System

Switch MCM connection topology

Switch chip mounted on fiber bundle structure
OE-MCM Demonstrator System

Switch MCM electrical tester

- Switch is electronically configured through ribbon cables
- Large heat sinks are used to dissipate heat from chip and voltage regulators
- SMA cables used for testing
OE-MCM Demonstrator System

- Current results:
  - Optical I/O coupled to optic
  - Single chip/single channel tested at 500MHz
  - Bandwidth limitation due to testing system
  - Expected throughput: 1-2 GHz/channel

500 MHz eye diagram