Integrated Micro-Optical Systems (IMOS)

Digital Optics Corporation
November 16, 1999
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Market Trends and Drivers

Photonics Integration Trend...
Long-Haul→Metro→Local→Backplane→Chip
1,000's→10,000's→100,000's→1,000,000's→10,000,000's

Enabled By...
Increased Integration (reduce alignment/assembly/test)
True High Volume Processes
Reduced Form Factor
Reduced Cost

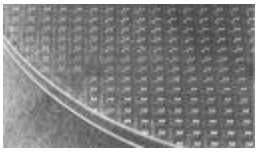
Paradigm Shift

Bulk Components

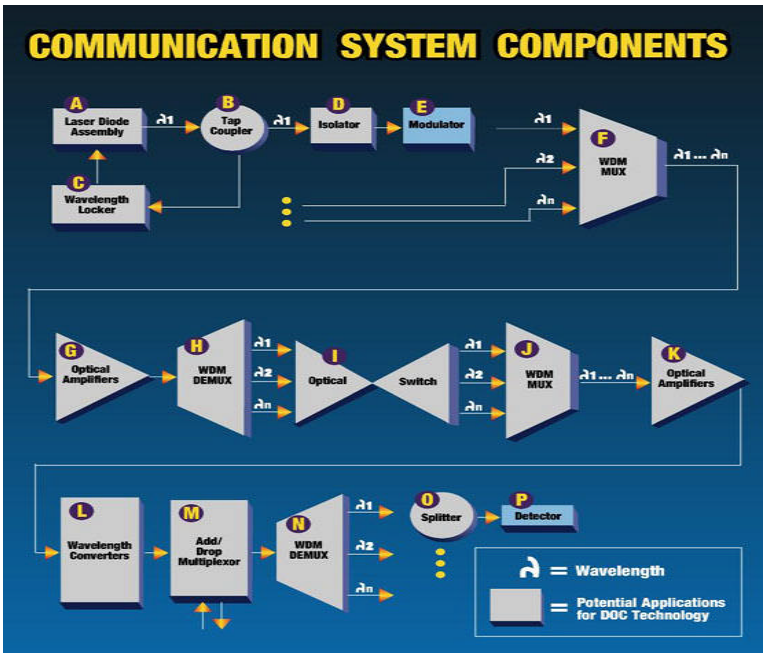
to

Wafer Based Components

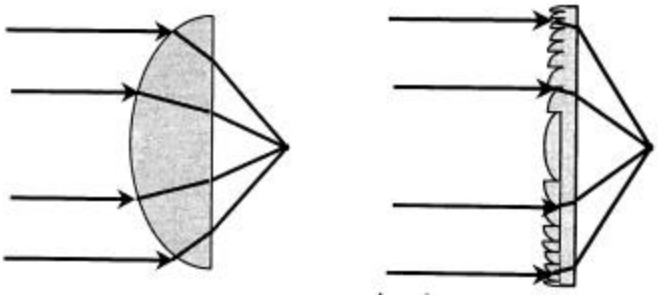
to



Wafer Based Integration

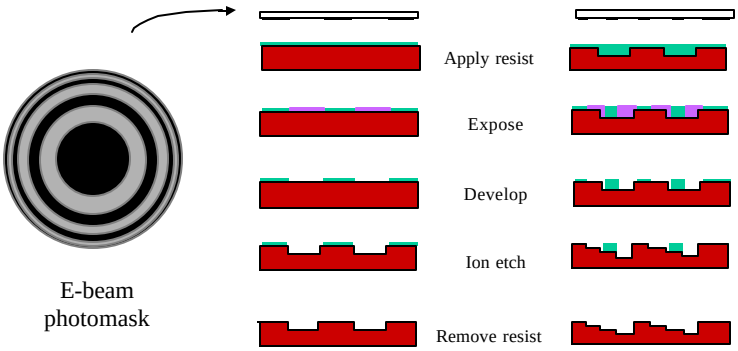


Optics Technology



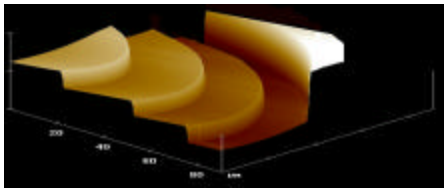
Refractive Diffractive

DOE Fabrication

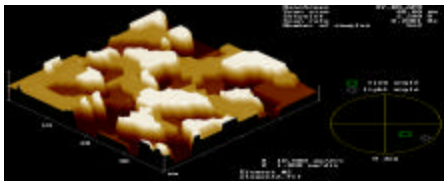


Diffractive Micro-Structures

Diffractive Microlens



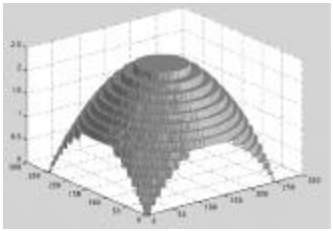
Diffractive Spot Array Generator



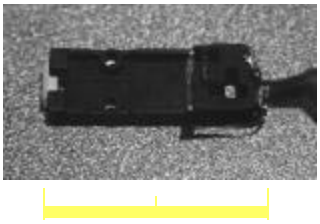
Refractive Lenses

Reflow

Quantized



Integrated Micro-Optical Systems (IMOS)



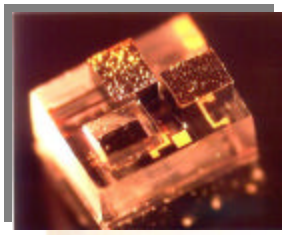
Discrete
Component Solutions

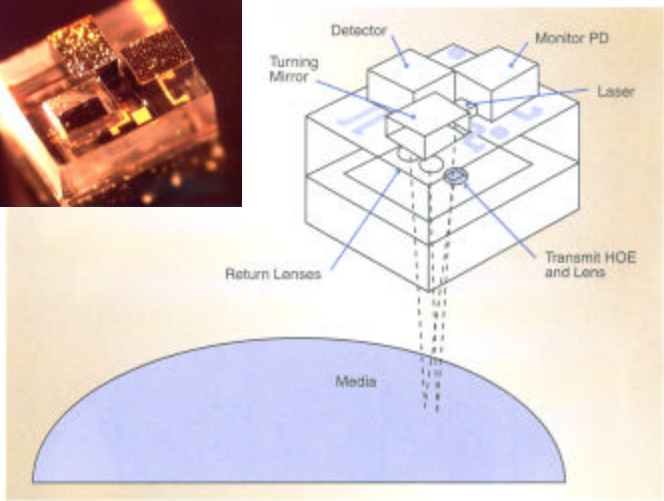
2”

2mm

IMOS Solution

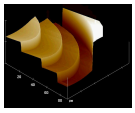
Optical Tracking System





Photonic Solutions

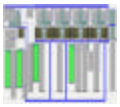
Bulk Components



Diffractives

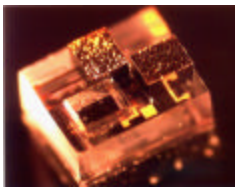
Refractives

Detectors/Sources



IC/Drivers

Integration



Wafer-Based Fabrication

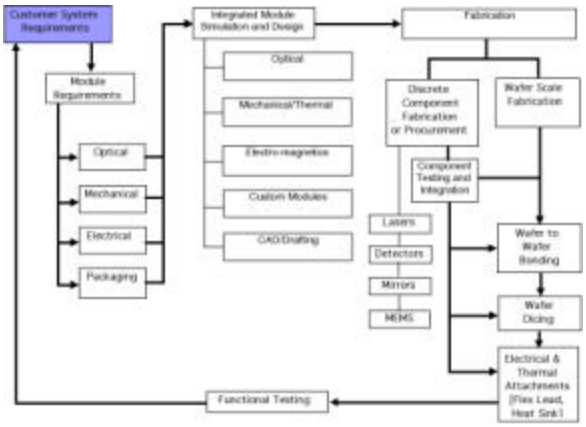
Department of Commerce
National Institute of Standards and Technology
Advanced Technology Program

IMOS Infrastructure for Photonics Manufacturing

$1.656 Million

Nov 1998 - Nov 2000

IMOS Infrastructure



ATP Mission

High Risk - High Payoff

- **Focus on Manufacturing Infrastructure**
- **Substantial Technical Challenges**
- **Credible Commercialization Plan**
- **High Payoff to the U.S.**

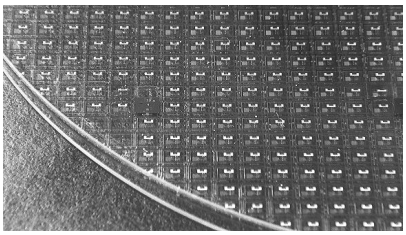
DOC and IMOS

- **Infrastructure for IMOS Design and Fabrication**
- **Design and Fabrication Limitations**
- **Strategic Partnering and Commercialization Exp.**
- **Replacement of Labor Intensive Processes**
- **Spillover benefits to OEM's and Component Suppliers**

ATP-Technical Goals

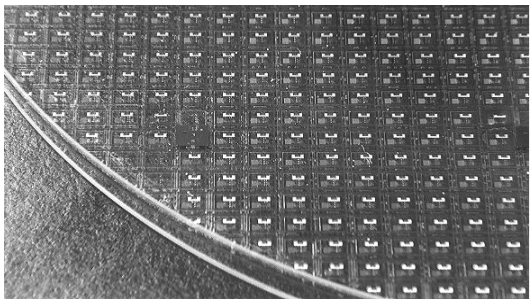
Technical Goals

Integrated CAD System
Component Procurement
Wafer Fabrication of Optics
Component Integration
Wafer to Wafer Bonding
Second Level Packaging
Automated Test Equipment



Hybrid Module

Lithographically generated refractive lenses
Holograms and apertures
Wafer-to-wafer bonding < 2 microns
Back to front alignment < 1micron



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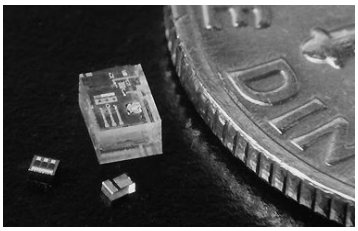
Flip Chip Die Bonding



- Wafer pair die
- Laser
- Monitor detector
- Return signal detector
- Turning mirror

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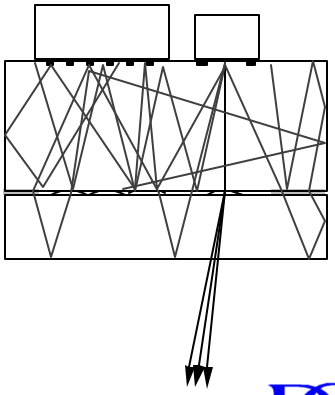
Stray Light

- Modeling difficult
- Diffractive baffles can be built in at no additional cost



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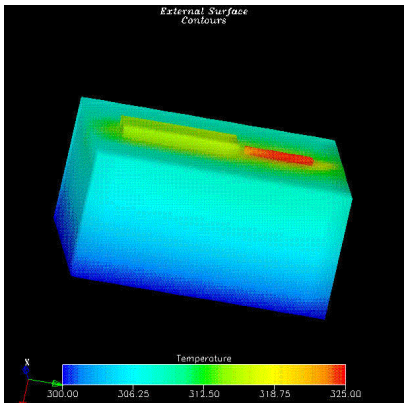
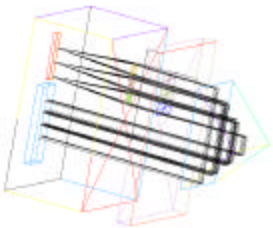
IMOS Value Propositions

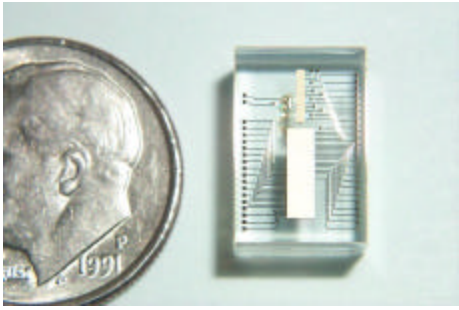
MARKET	IMOS VALUE PROPOSITION
Datacom	• Scalable Manufacturing • Small Form Factor • Quality/Repeatable Manufacturing and Testing • Cost Reductions • Improved Performance • Ease of System Alignment
Sensors	• Economies of Scale • Addresses Form Factor Reductions • Quality/Repeatable Manufacturing and Testing • Cost Reductions • Improved Performance • Ease of System Alignment
Data Storage	• Increased Storage Density – Small Laser Spot • Longer Life of Battery Power Sources • Addresses Computer Form Factor Reductions • Quality/Repeatable Manufacturing and Testing • Cost Improvements • Improved Performance • Ease of System Alignment

IMOS for Sensors - Encoder





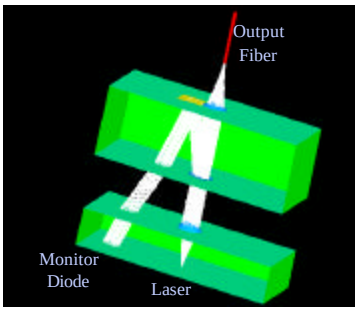
Optical Encoder Module



IMOS for Datacom

Transceivers

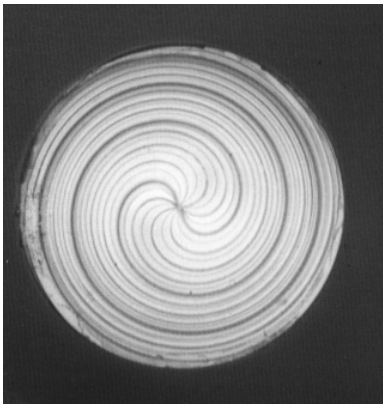
- **Integration of VCSEL's and optics at the wafer scale**
- **Wafer based testing of modules**
- **Specialty optics for fiber coupling**
- **Single or array devices fabricated with a single alignment step**

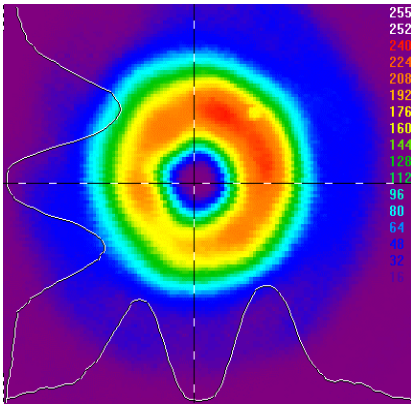


DMD Patchcord

- Gigabit Ethernet, Fiber Channel, Backplane, Parallel Interconnect Markets
- Bandwidth optimized launch into MM fiber
- Solution for Differential Mode Delay (DMD)

DMD Patchcord





Experimental Bandwidth Measurements

DMD Patchcord

- phase matched diffractive lens
- attached with the use of microrods

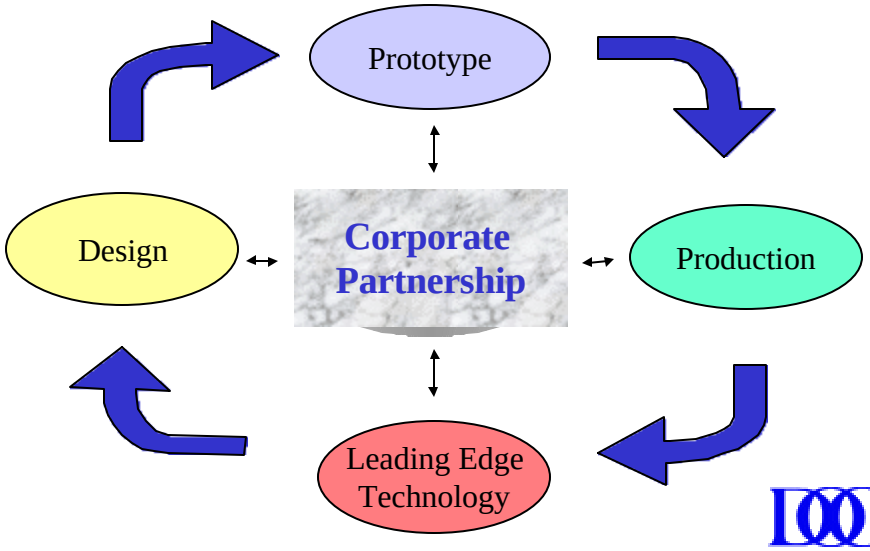
10 fibers by various manufacturers, including worst case fibers (TIA Round Robin)

10 out of 10 fibers higher than 0.5 GHz-km
7 out of 10 fibers higher than 1 GHz-km
best fiber
improved bandwidth from **2.4 to 3.5 GHz-km**

Program Status

- IMOS CAD Modeling online
- Die bonding of VCSEL arrays
- Wafer based integration
- Encoder module demonstrated
- Optical Transceiver array underway

Photonic Solutions



Future Projects

Next Generation of Array Transceivers

- Higher levels of integration
- Wafer based integration and testing
- Two dimensional arrays
- Increased functionality

  e.g. WDM and Conditioned Launch

Summary

- IMOS is the next step in wafer based manufacturing
- Manufacturing must be designed in from the start
- Strategic partnering is essential to the commercialization of IMOS
- ATP funding accelerates the manufacturing infrastructure for IMOS deployment