

**A Technology Impact to the Competitiveness of  
Fiber Optic Communication Modules  
— MicroOptoElectroMechanical Systems—**

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# Outline

- **Technical Reasons Why FO Components/ Modules Are Expensive**
- **Impact of MOEMS**
- **Drastic Change in Functionality versus Cost**
  - **Two Case Studies**
- **Perspect of Competition Evolution**
- **Concluding Remark**

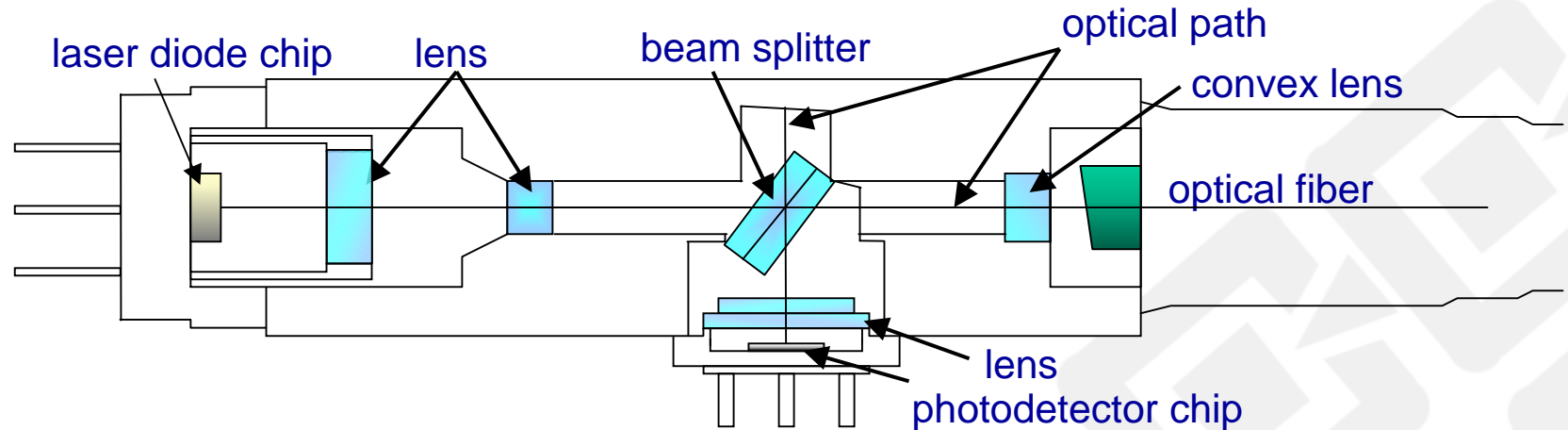


# Technical Reasons Why FO Components/ Modules Are Expensive

- Finish an Optical Precision via Macroscopic Machining
- Carry OE Semiconductors & Optic Circuit Construction on High Priced Packages
- Assemble One Piece by One Piece
- Monolithic Solution set a Low Yield High Price
- Monolithic Solution set a High Demanding Package
- Tough & Complicated Test Program & Standards of Bellcore, ANSI & ITU.
- Non-Technical Reasons



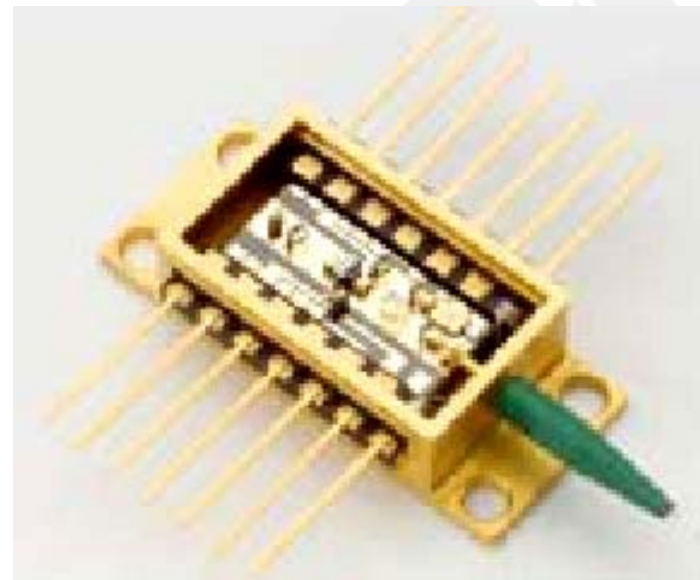
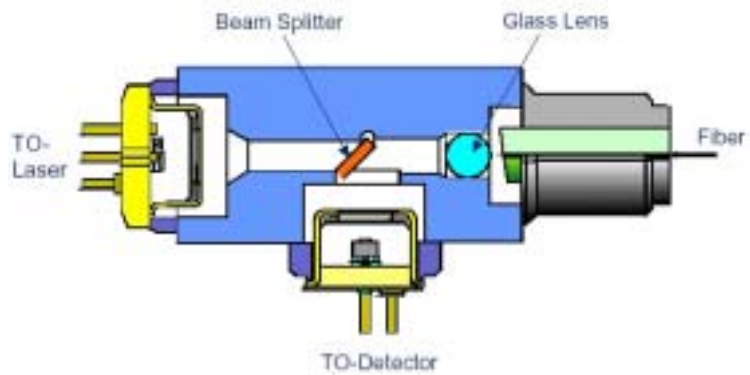
# Bi-directional Transceiver Optical Module by Siemens



## Present Structure

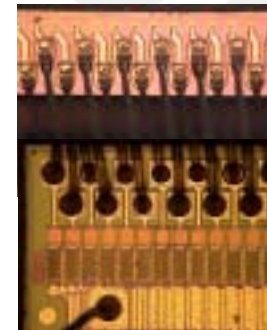
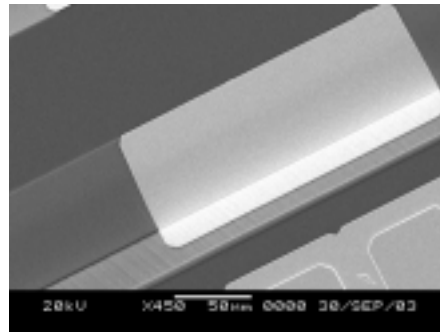
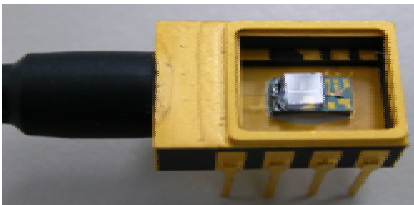
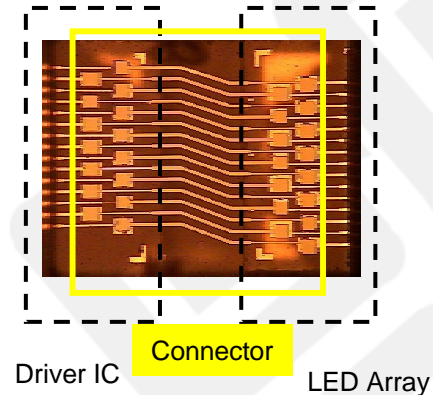
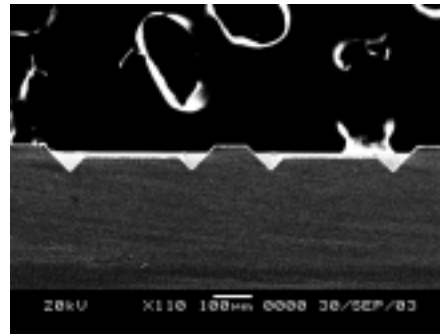
- 1×LD with monitor PD in hermetic package with a flat lens
- 1×PD in hermetic package with a flat lens/AR coating layer
- 1×beam splitter
- 2×collimating/focusing lenses
- overall precision manufactured mass stainless steel mechanical module holder with 2 optical axes & 2 exactly vertical outlet cavities
- active fiber alignment





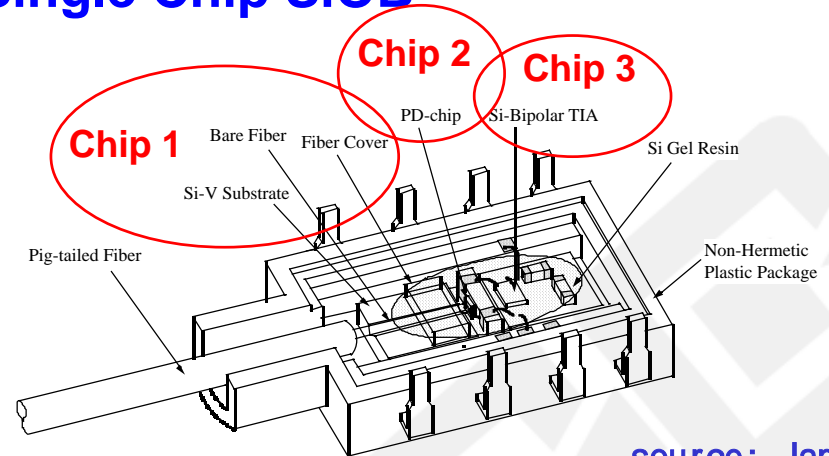
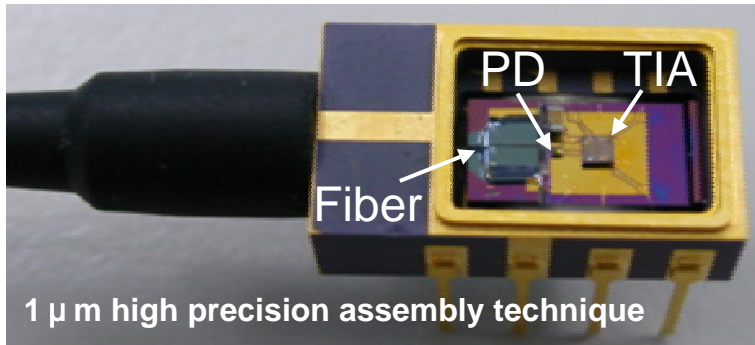
# Impact of MOEMS

- **Silicon Micro Optical Bench (SiOB) :**
  - \*Micro Photolithography \*Micro Machining \*Known Good Die (KGD)
- **Hybrid Microassembly**
  - \*Passive Alignment \*High Precision Flip-chip Bonding
- **Silicon-based Double-side 45 degree Reflector Submount & LED Printhead (LPH)**
  - \*Optic Grade Flatness \*Array Set Flip-Chip Bonding \*High Interconnect Density



# Drastic Change in Functionality v.s. Cost — New Product Case (I)

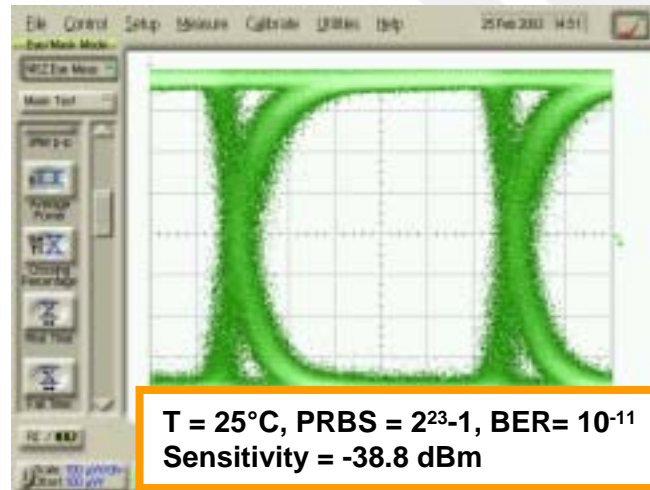
- **Mini-DIL PD-TIA Module – Single Chip SiOB**



source: Japan

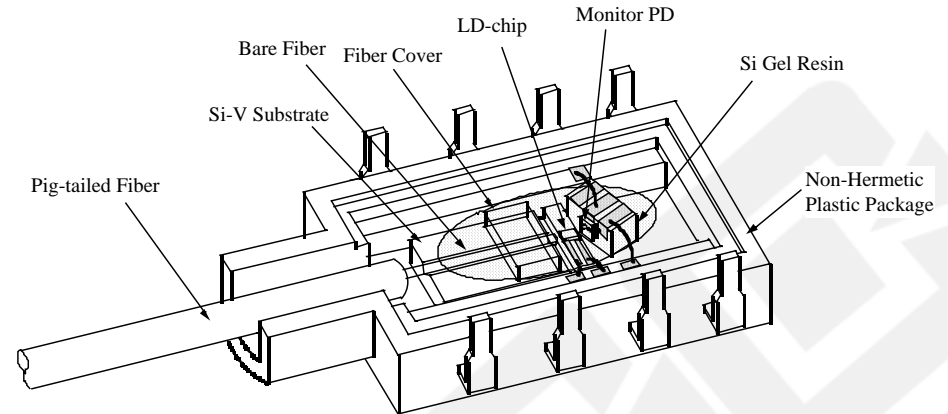
THE OUTLINE OF MINI-DIL PD-TIA MODULE

- **Single Chip SiOB Modular Assembly**
  - high integration
  - high quality
  - high cost competitiveness
- **Passive Alignment of Fiber Assembly**
  - high productivity
  - high alignment precision
  - low cost yet high reliable epoxy fiber fixing



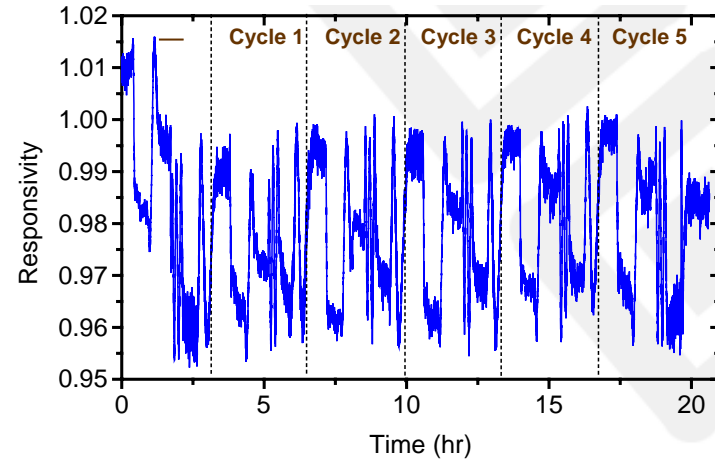
# Drastic Change in Functionality v.s. Cost — New Product Case (I)

- **Mini-DIL LD Module – Single Chip SiOB**



- **Single Chip SiOB Modular Assembly**
  - high integration
  - high quality
  - high cost competitiveness
- **Passive Alignment of Fiber Assembly**
  - high productivity
  - high alignment precision
  - low cost yet high reliable epoxy fiber fixing

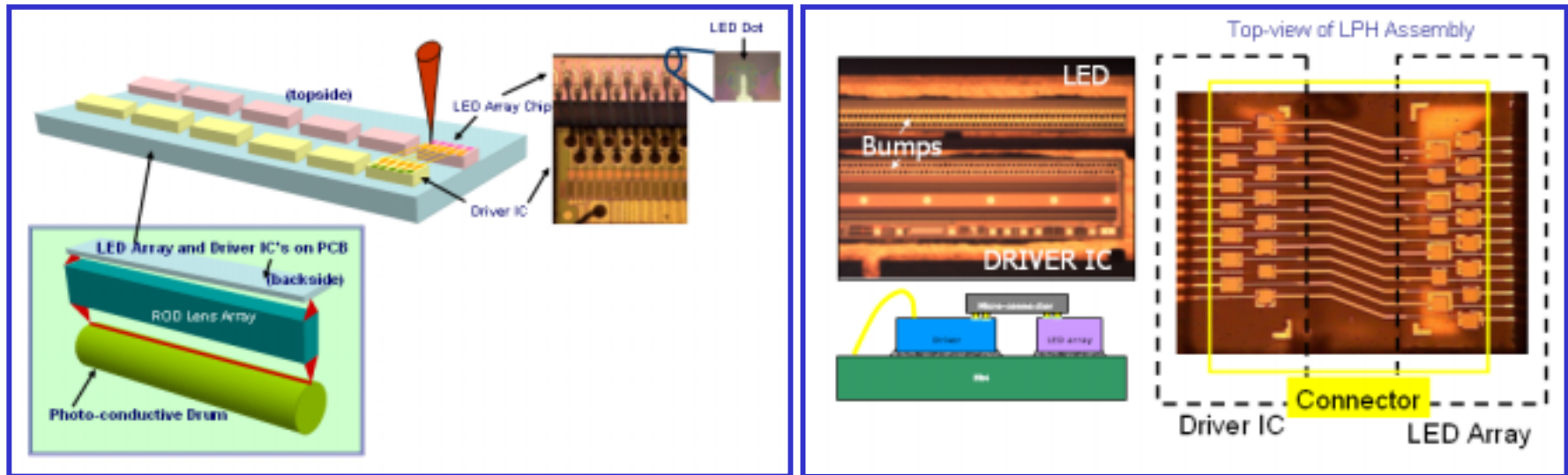
THE OUTLINE OF MINI-DIL LD MODULE





# Drastic Change in Functionality v.s. Cost — New Product Case (II)

- **High Precision Flip Chip Assembly Technique** – High Resolution LED Printhead

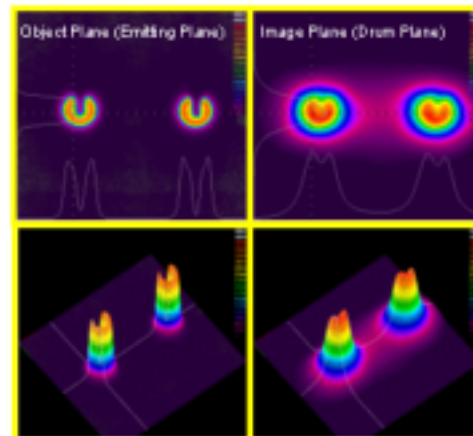


- **High Density Silicon Micro-Connector Array (A4 size, 600 dpi)**

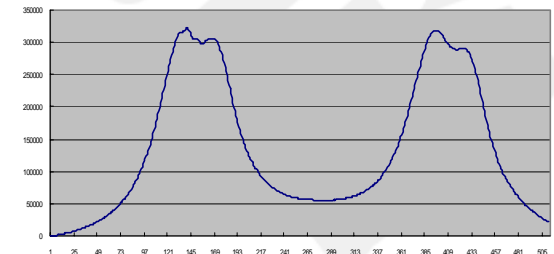
- micro Metal Interconnects: 4,992
- pitch between dots:  $42.3 \mu\text{m}$
- assembly Accuracy:  $5 \mu\text{m}$

- **Cost Advantages**

- eliminating 4,992 Au wire bonds
- chip size 30% shrinkage
- easy to rework



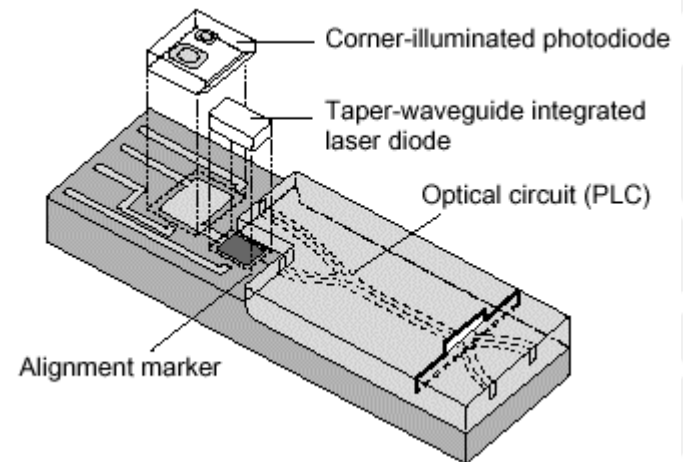
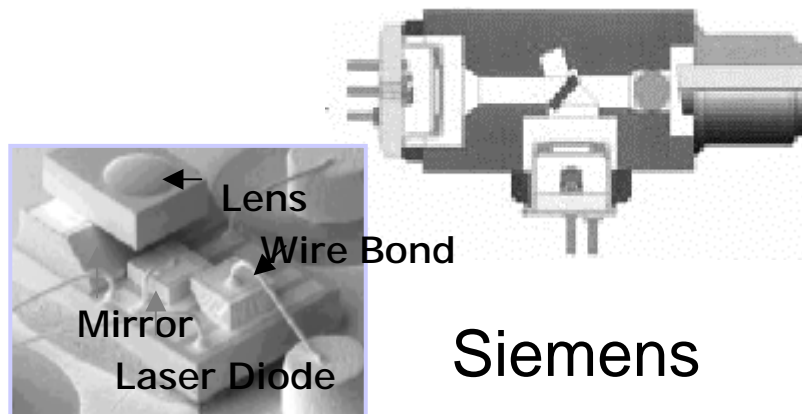
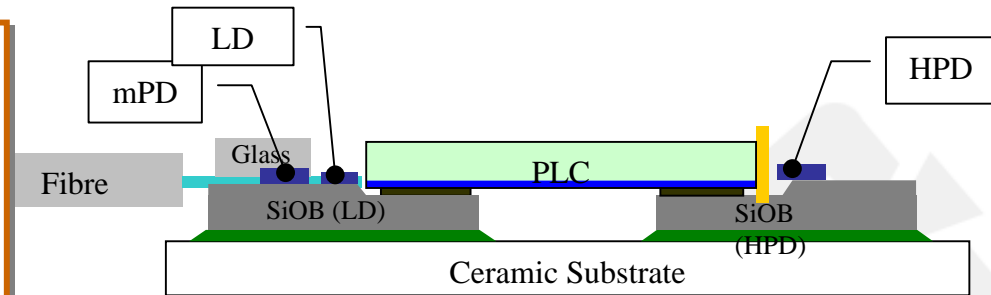
**MTF = 70.7% for 600 dpi**



# Perspect of Competition Evolution

## PLC Based Bi-directional Modules for FTTH

- R&D in Bi-directional Module
  - ✓ Planar Lightwave Circuit (PLC) development
  - ✓ High precision package for PLC
  - ✓ Silicon-based double-side 45° reflector development



# Concluding Remark

1. Fiber optic communication modules, especially for FTTH, is under a huge price pressure, it follows also a hard technology drive.
2. MOEMS or optical MEMS offers an alternative approaches to the objective.
  - By using bare die (KGD) of LD, PD & TIA, it has real state/form factor & cost advantages.
  - By using SiOB, a hybrid microassembly is enabled to make fiber connection & alignment a high productivity & cost-effective solution.
  - A passive alignment & high precision flip-chip mounting is employed.
  - Microlithography & micromachining generate a batch process of production for a tremendous cost-down & reliability improvement.
3. The technology progress made for fiber optic communication is applied to IT as well, such as high resolution LED printhead & multiple-wavelength optical pickup head.

