REDEFINING THE LIMITS

Assembly & Test

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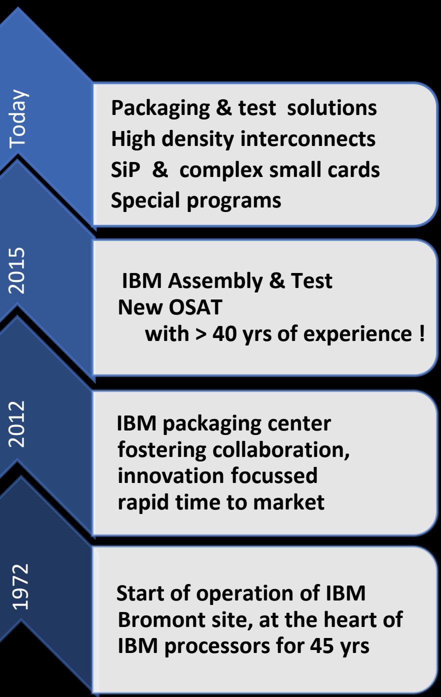
North American Assembly and Test Provider



- Advanced Flip Chip Packaging & Photonics
- Any wafer source
- "Masters of Complexity"
- Outstanding characterization capabilities
- Design for manufacturing
- Better Time to market

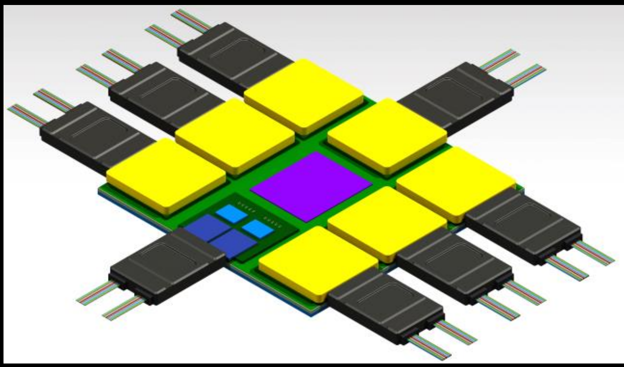
RF
SIP
Custom
IBM
Z
5G
400 M $
Mainframes
Datacom

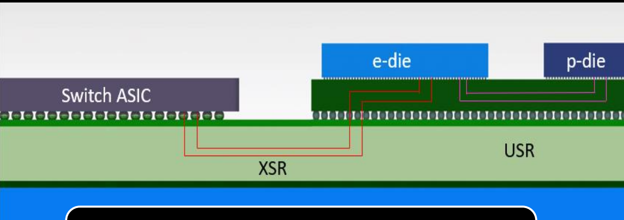
Co-Packaging – Advanced integration

Design for manufacturing & Test

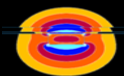
REDEFINING THE LIMITS

Disaggregation → Package integration
Heterogenous integration of various node function in SiP

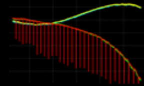


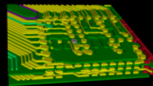


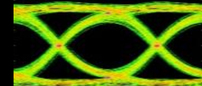
Packaging is critical for success
Co-design with packaging in mind

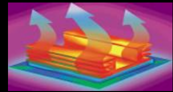

Simulation

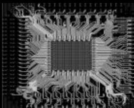
Optical Performance


Measure & Test

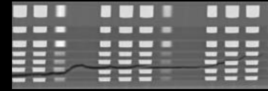

Design


Electrical Performance


Thermal Management


Substrate

Reliability


CPI

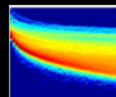
Manufacturability

Industry 4.0

Cost / yield

Miniaturization

Modeling

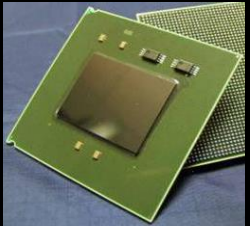

Predictive manufacturing

Heat spreaders not shown for clarity reasons

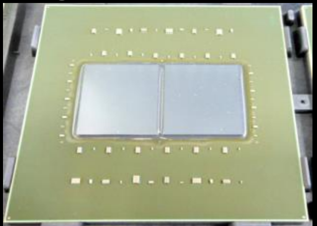
IBM Bromont – Advanced Packaging

Heterogenous integration of various node function in SiP

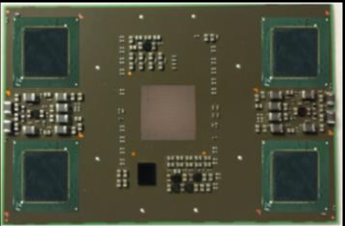
Large MCM



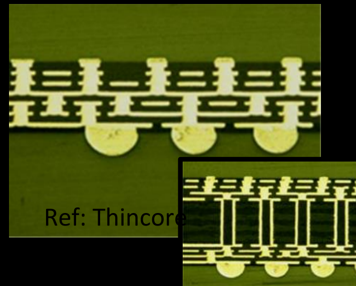
Large SCM/DCM



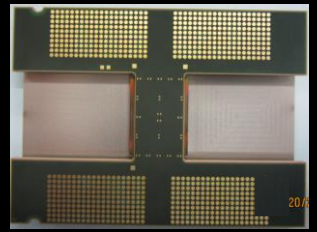
MCM - HI / SiP



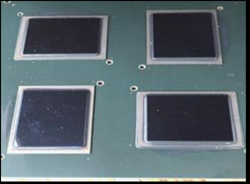
Coreless



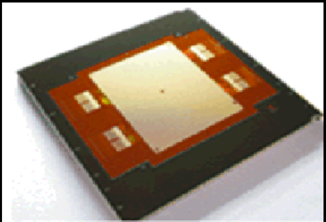
Custom

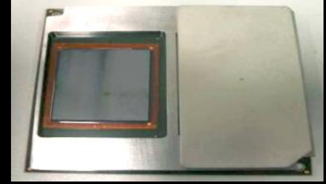


CSP

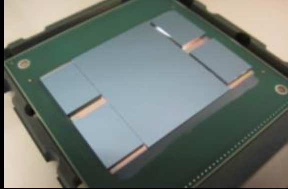


2.1D/2.3D

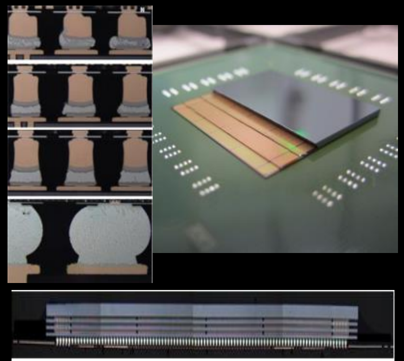




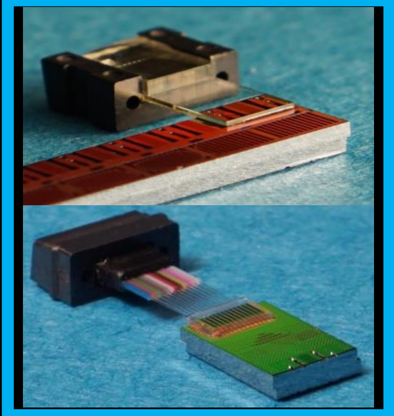
2.5D



3D



Photonics



Silicon Photonic Packaging Vision

Manual / Low volume

- Active alignment
- One connection at a time
- Custom design

Lower packaging cost increased scalability

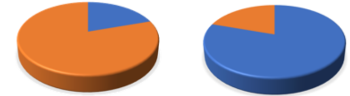
Automated / Low volume

- Self alignment
- Multiple connections at a time
- Standard design

Legacy

Cost Structure

Integrated Photonics | Microelectronics



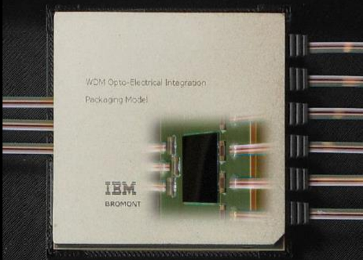
Packaging / Test | Device

IBM Bromont

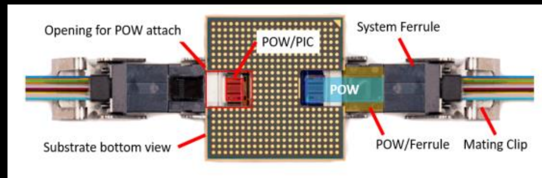
Leverage Microelectronic Packaging Infrastructure / Knowhow

Photonic co-packaging demonstrator

High Fiber Counts Application

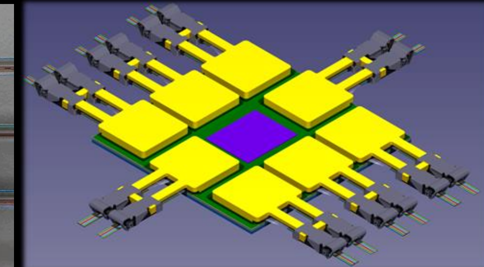


High Density Optical Port Counts Application



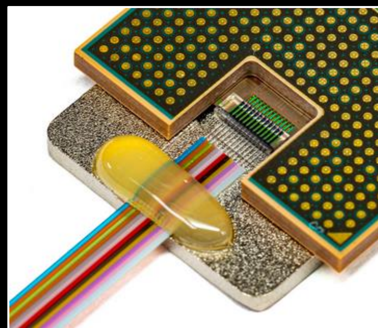
Integrated Connector

Clip installed during fiber cable plug in

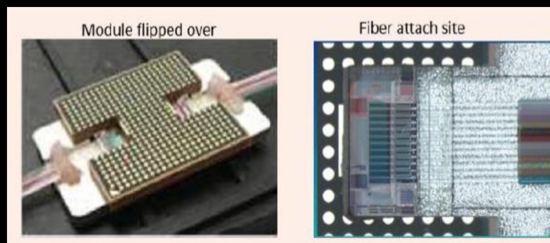


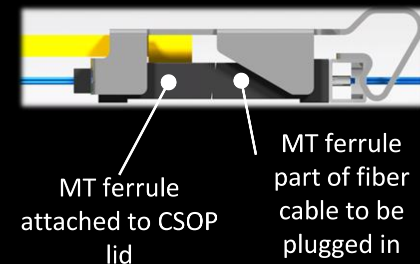
Solder Reflowable Silicon Photonics Fiber assembly

Strain Relief of fiber assembly pigtail



Full Optical Switch

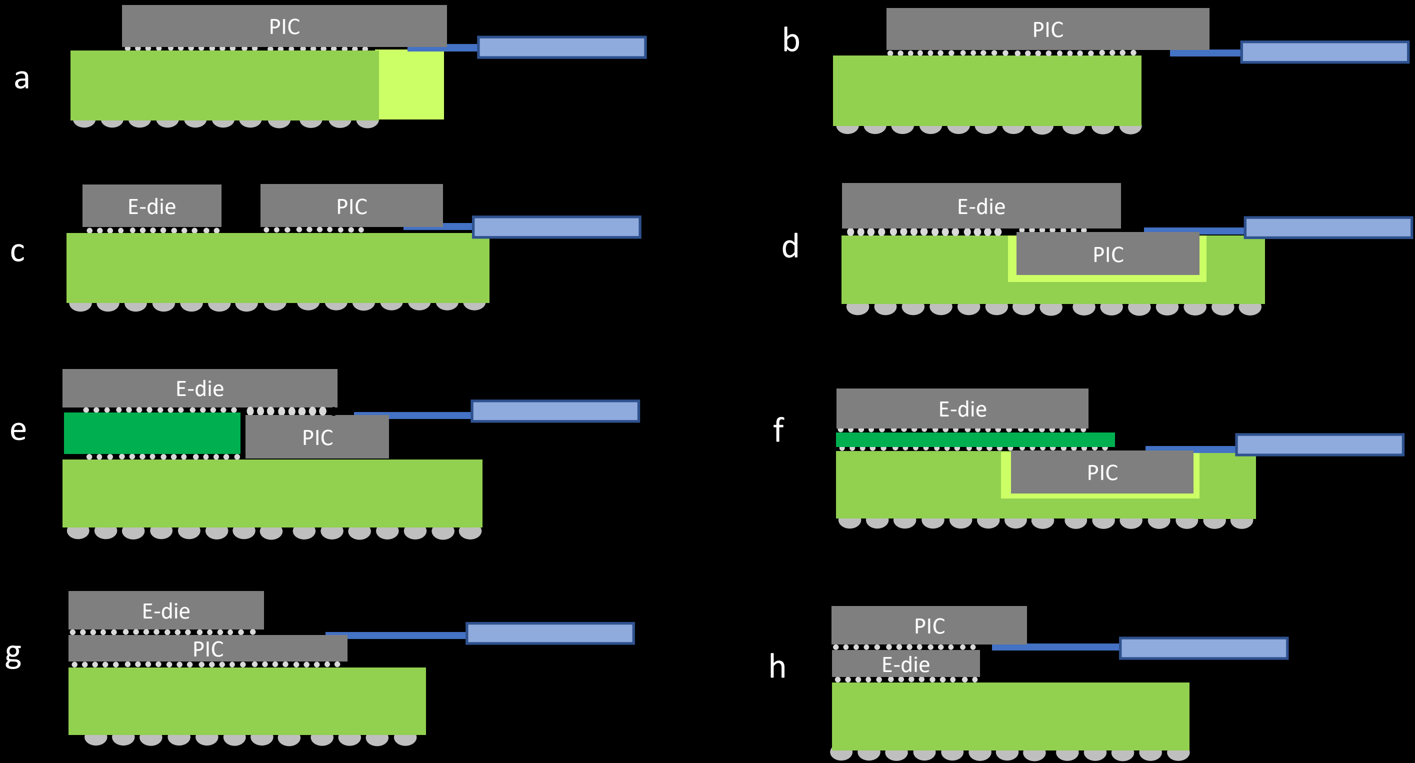




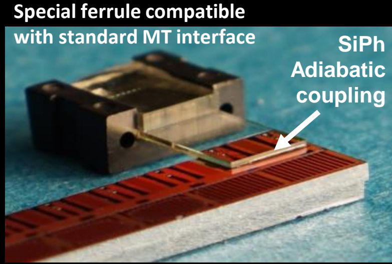
MT ferrule attached to CSOP lid

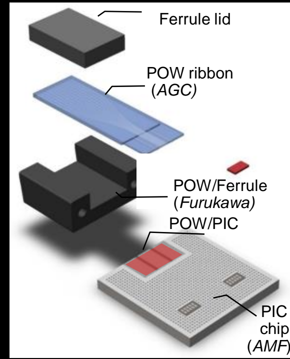
MT ferrule part of fiber cable to be plugged in

Co-Packaging in Advanced integration



Compliant Polymer interface – Dense Single mode coupler

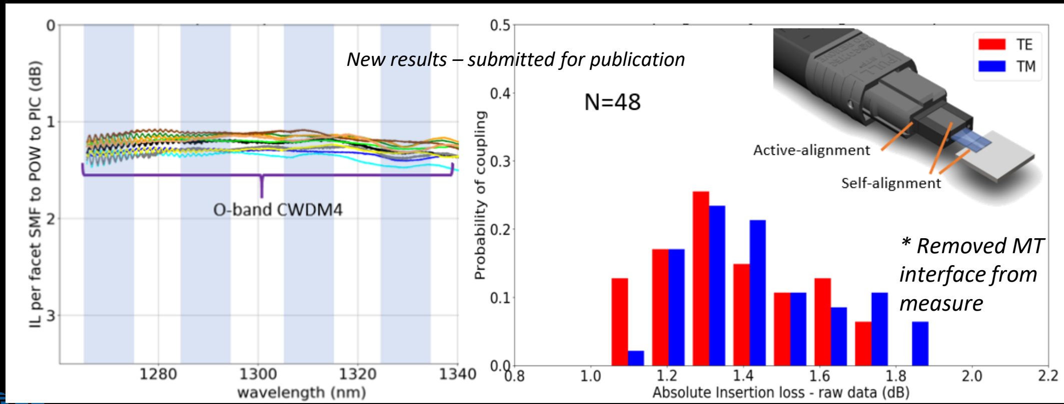


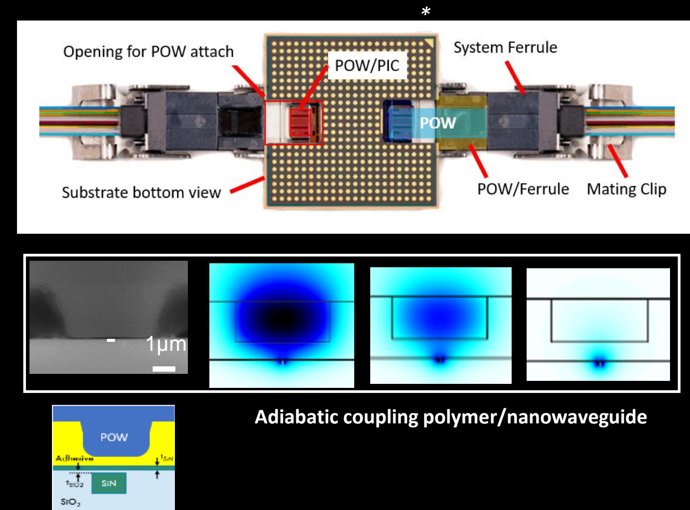


Parallel channel array (dense 50µm pitch – 12ch TV)
O, S, C, L bands compatible
Couples both polarizations (TE / TM)
Assembly using high throughput pick n place tools

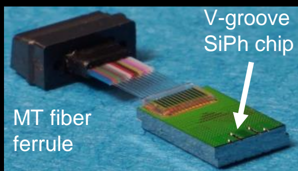
- Denser pitch (up to 25µm) at chip interface
- No need for deep grooves (wet etch process)
- Mode converter structure is simple
- Compliant material for CPI risk mitigation

Advances in Interfacing Optical Fibers to Nanophotonic waveguides via Mechanically Compliant Polymer Waveguides
IEEE Journal of Selected Topics in Quantum Electronics - 06 January 2020





Fiber Array – Single mode solder reflowable coupler



IBM design chip build at GF

- Parallel channel array (12ch TV)
- O, S, C, L bands compatible
- Couples both polarizations (TE / TM)
- High throughput pick n place tools
- Solder reflow compatible (260 C)

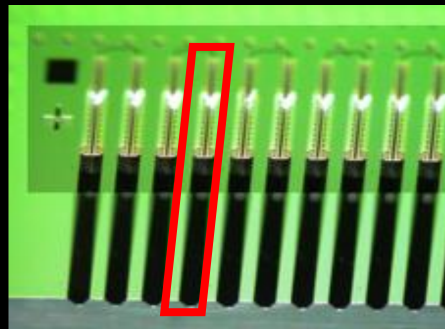
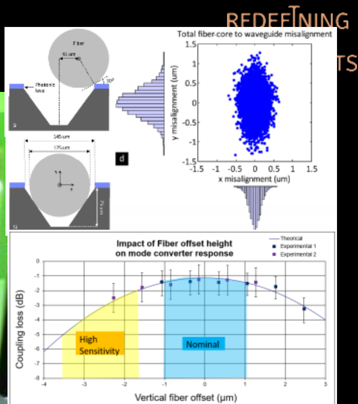
Integrated Metamaterial Interfaces for Self-Aligned Fiber-to-Chip Coupling in Volume Manufacturing

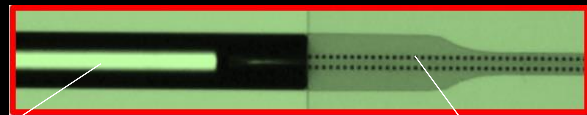
IEEE Journal of Selected Topics in Quantum Electronics

Volume: 25 , Issue: 3 , May-June 2019

Key to Success:

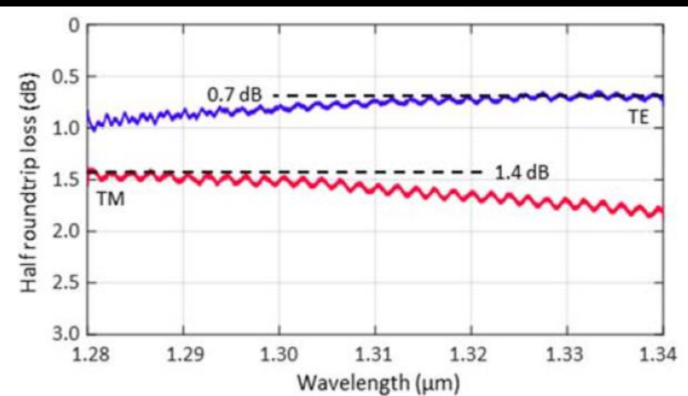
Adhesive partitioning

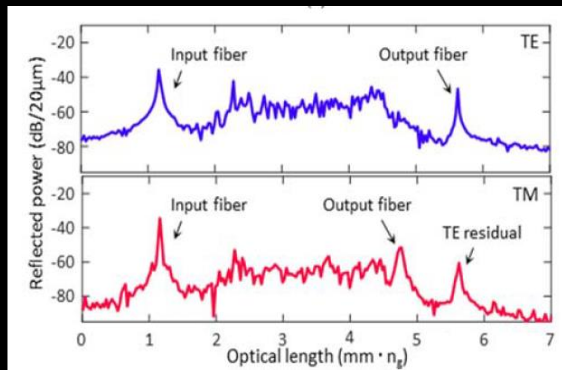



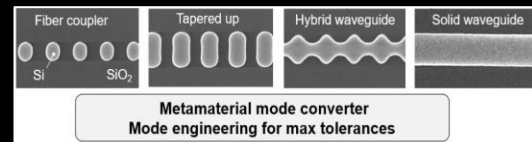


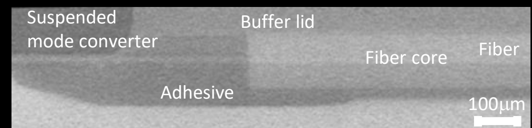
Structural adhesive for fiber
- Mechanical stability/robustness
- Fast UV tack (< 5 sec)

Optical adhesive for suspended region:
- Optical performance
- Reduce stress on fragile membrane



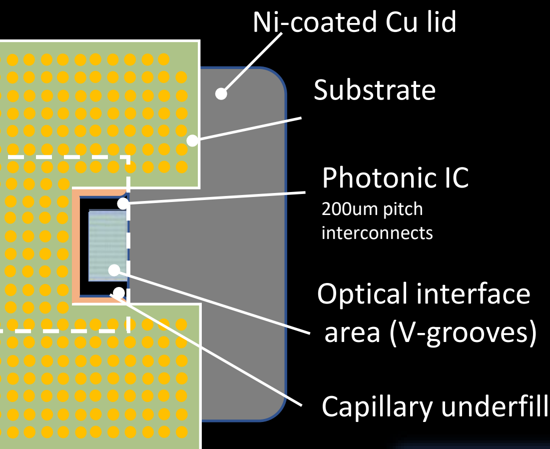






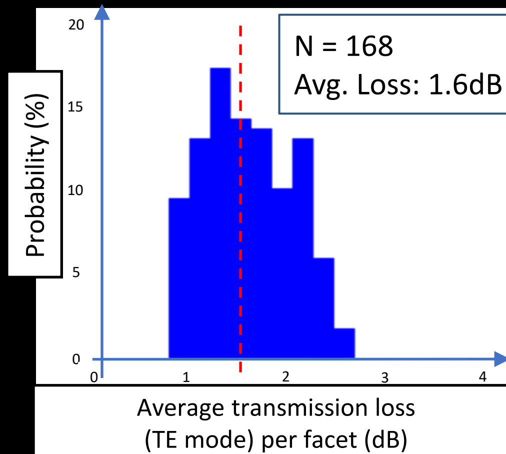
Fiber ribbon assembly in V-grooves (X-ray tomo)

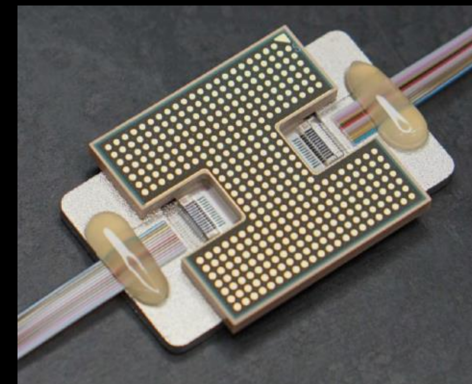
Photonic Flip-Chip assembly example



Bottom view substrate side of the module

Repeatability





Formic acid furnace

R&D formic acid oven also available

Formic acid flip-chip bonding

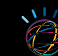
Fluxless solution required to maintain grooves/facet cleanliness and SWG integrity

Fluxless formic acid reflow with temporary adhesive material (tacking fluid)

No voiding / cracking of the IMC & solder

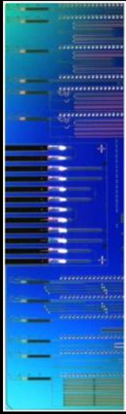
Formic acid reflow available at IBM Bromont

IBM presentation

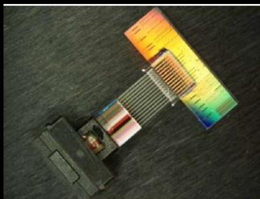


Fiber Array – Reliability Demonstration

High sensitivity hardware

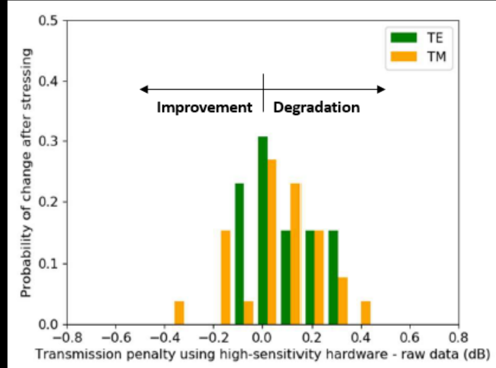


PIC

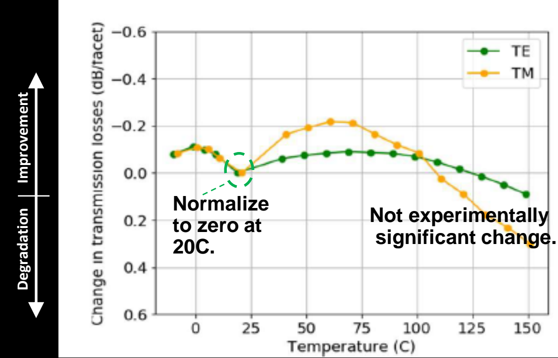


Assembly

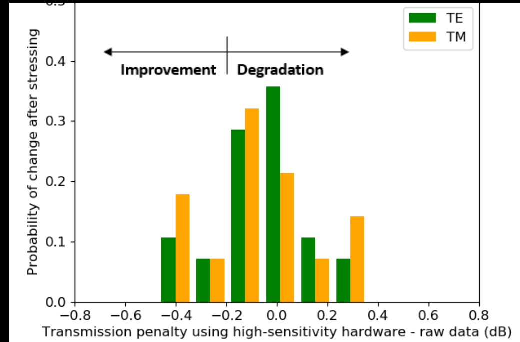
Solder reflow (5x) 1min@250C



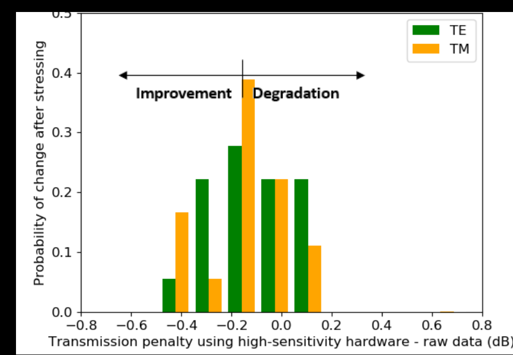
In-situ optical loss change from -10C to 150C



Thermal Cycling -40/85C&-40/125C : total 2000 cycles



Damped heat 85C 85%RH : 2000 hrs



Offer

REDEFINING THE LIMITS

Expertise

- Advance node (7nm)
- Proven material sets for high performance
- Prototyping to high volume manufacturing
- Microelectronics and Copackaged photonics
- Complexe MCM/SiP

Time to market

- Benefit from existing models and designs to accelate MCM implementation
- Beyond groundrules:
  - ✓ Customization
  - ✓ Characterization

Business Model

- Co design partners
- Streamlined manufacturing flow
- Integrated supply chain

We put our packaging know how at your service
Focusing on your application and performance

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Thank You

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ajantapo@ca.ibm.com