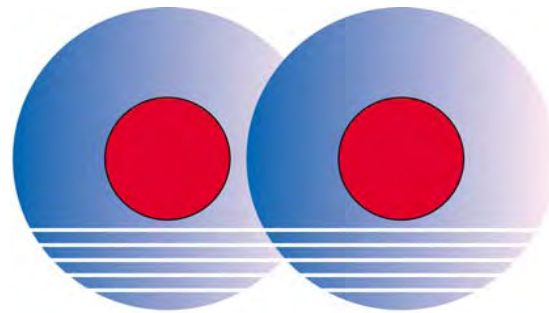


Ultra-High Reliability Fused Fiber Products For Sensing Applications



COMCORE

A Leader of Fused Fiber Technologies in the World



Comcore Technologies Properties
<http://www.comcore.com>

Ultra-High Reliability Fused Fiber Products For Sensing Applications

- KEY ISSUES FOR FFPs
- SUPERFUSION TECHNOLOGIES
- KEY COMPONENTS FOR SENSING SYSTEMS
- PRODUCT RELIABILITY
- CAPABILITY AND CAPACITY

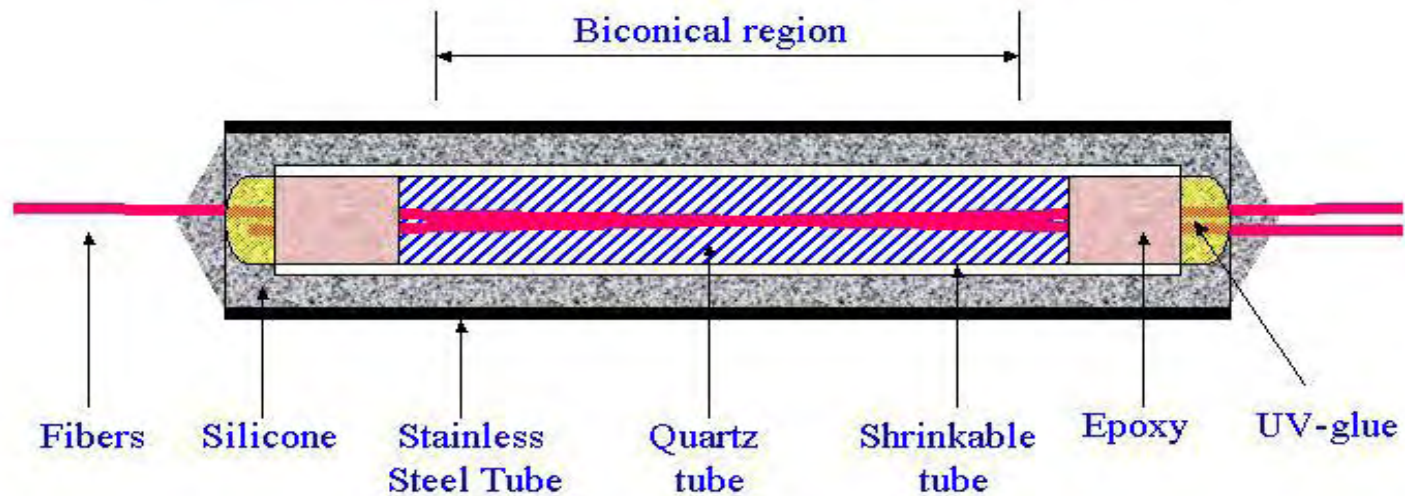
Ultra-High Reliability Fused Fiber Products For Sensing Applications

- **KEY ISSUES FOR FFPs**
- **SUPERFUSION TECHNOLOGIES**
- **KEY COMPONENTS FOR SENSING SYSTEMS**
- **PRODUCT RELIABILITY**
- **CAPABILITY AND CAPACITY**

KEY ISSUES FOR FFPs

1. Basic Structure of FFPs

Longitude Cross-Sectional Structure



Prepared by Yong Huang

3

KEY ISSUES FOR FFPs

2. Two most important issues:

- **To avoid specifications shifting outside the given values at any time during lifetime of system.**
- **To avoid fiber breakage inside stainless steel tube**

KEY ISSUES FOR FFPs

3. Designing Proposal of Reliability:

Method1: Enhancing the stability of package for environment.

- a. Hermetically sealed using special glass tube
- b. Glass solder process.

Method2: Enhancing the stability of coupling region of fused device for environment.

- a. **Strong Fusion and Stress Release**

Ultra-High Reliability Fused Fiber Products For Sensing Applications

- KEY ISSUES FOR FFPs
- **SUPERFUSION TECHNOLOGIES**
- KEY COMPONENTS FOR SENSING SYSTEMS
- PRODUCT RELIABILITY
- CAPABILITY AND CAPACITY

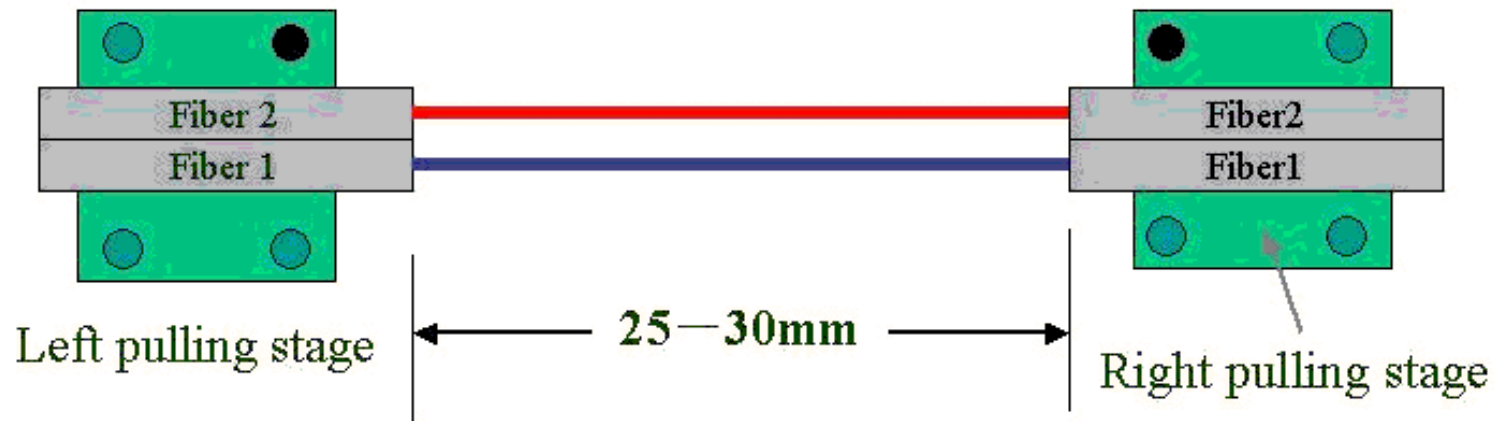
SUPERFUSION TECHNOLOGIES

1. Process Highlight

NO DUMBBELL SHAPE

SUPERFUSION TECHNOLOGIES

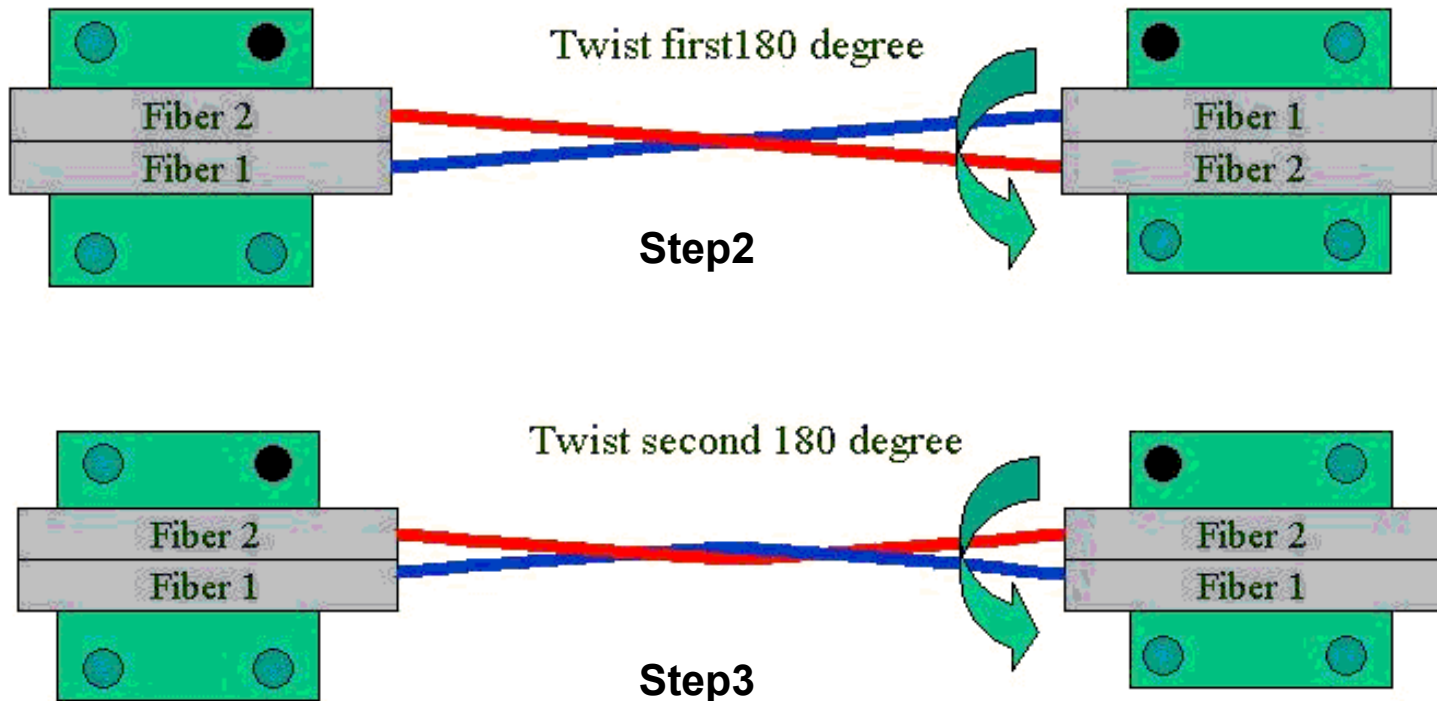
2.Manufacturing Process



Step1

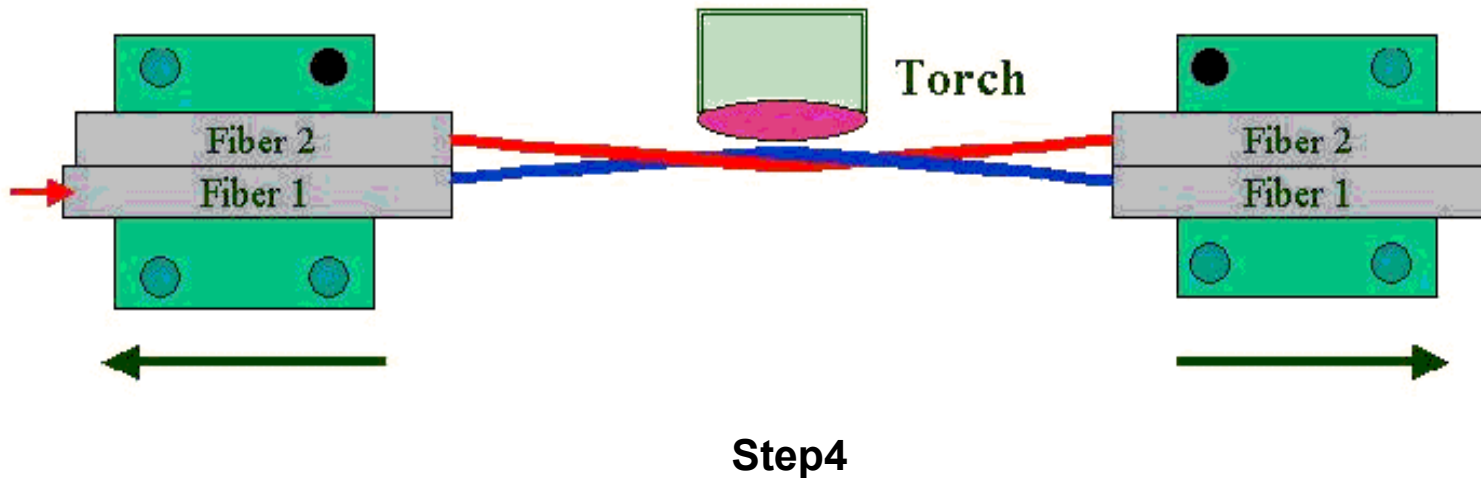
SUPERFUSION TECHNOLOGIES

2.Manufacturing Process



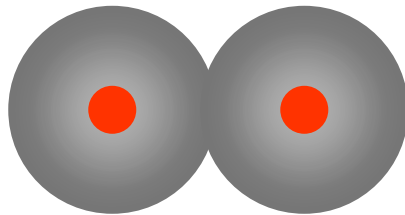
SUPERFUSION TECHNOLOGIES

2.Manufacturing Process

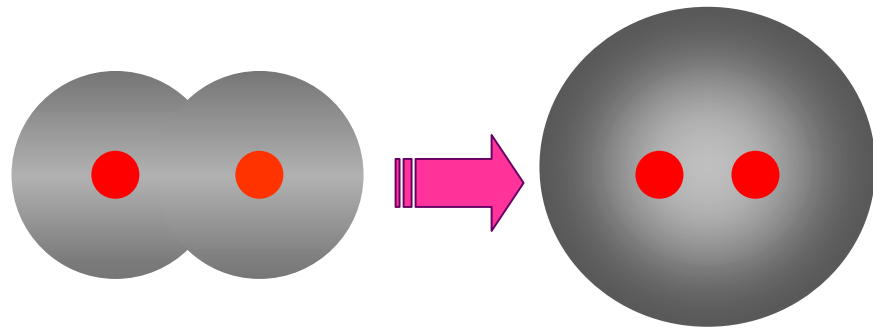


SUPERFUSION TECHNOLOGIES

3. Different Cross-sectional Shapes in Different Process



Normal Process
(stick)
1000°C



Comcore's Process
(Melting Process)
1700C

1000°C is much far from the melting point of silica of fiber, so fibers can not be truly fused or melt together, and this process is used by more than 95% of manufacturing vendors who make fused fiber components such as splitters / WDMs. But, Comcore uses special process which can totally fuse two fibers together, becoming more reliable, more stable, and against humidity.

SUPERFUSION TECHNOLOGIES

4. Real Cross-sectional Shape for Different FFPs

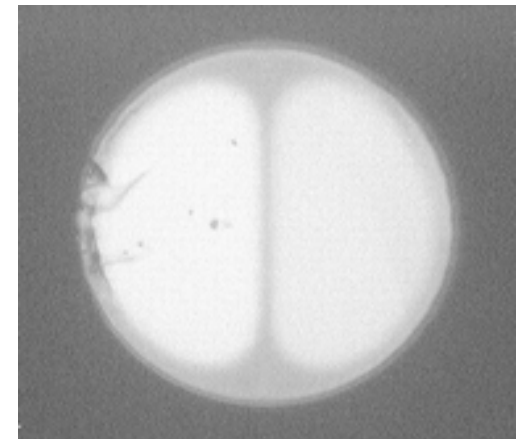
Single Mode Fiber



125/62.5um MM Fiber



125/105um MM Fiber

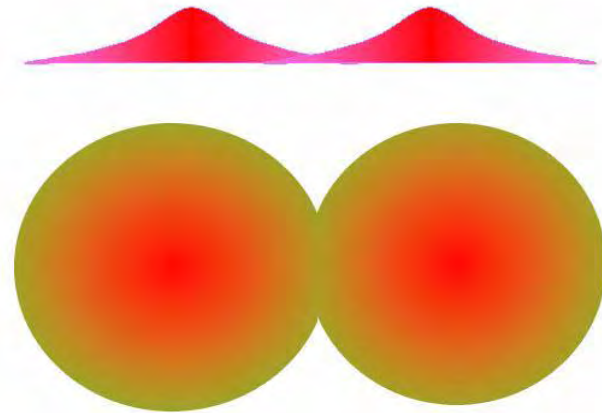


SUPERFUSION TECHNOLOGIES

5. Modal Field Distribution in Coupling Region



**In Superfusion Process
(Comcore process)**



**In Stick Process
(General process)**

SUPERFUSION TECHNOLOGIES

6.Comparison Between Different Processes

Process	Stick Process	Superfusion Process
Characteristics		
Heating temperature	Around 1000°C	Around 1700°C
Fiber contact form	Stick together	Melting together
Shape of cross section	Visible Pre-fiber Shape	Invisible pre-fiber
Micro-cracks on surface of fibers	Not eliminated	Fully Eliminated

SUPERFUSION TECHNOLOGIES

7. Features of FFPs by using Superfusion process:

- (1) The structure of coupling region is very strong, the cross-sectional shape looks like a twin core fiber.
- (2) Optical characteristics of devices are , relatively speaking, insensitive to surrounding environment.
- (3) Very small twisted effect due to almost circularly symmetric structure of cross-section.
- (4) Eliminate micro-cracks on the surface of fibers included in non-coupling and coupling region of FFP to protect the moisture enters these micro-cracks and proliferates them, causing FFP degradation and ultimate failure.
- (5) Improve polarization dependent loss and wavelength isolation for WDMs.

Ultra-High Reliability Fused Fiber Products For Sensing Applications

- KEY ISSUES FOR FFPs
- SUPERFUSION TECHNOLOGIES
- KEY COMPONENTS FOR SENSING SYSTEMS
- PRODUCT RELIABILITY
- CAPABILITY AND CAPACITY

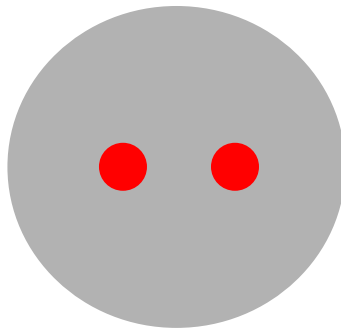
KEY COMPONENTS FOR SENSING SYSTEMS

- 1. Non-Polarization-Maintaining Fiber Splitters**
- 2. Polarization-Maintaining Fiber Splitters**
- 3. Multimode Fiber Splitters**

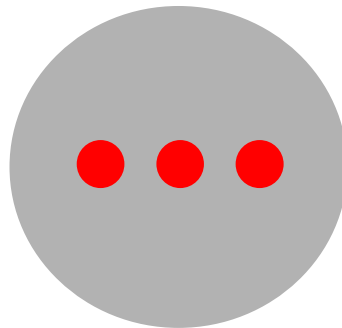
KEY COMPONENTS FOR SENSING SYSTEMS

1. Non-Polarization-Maintaining Fiber Splitters

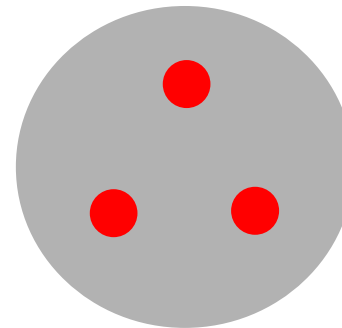
Cross-sectional shapes



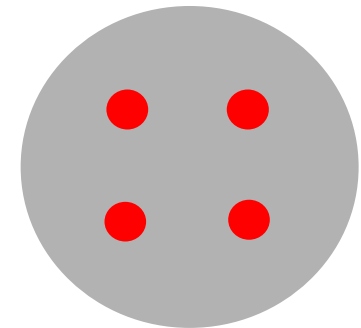
1x2 (2x2)



1x3 (3x3)



3x3



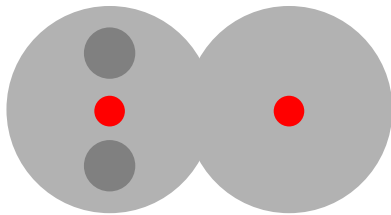
4x4

All of these components are manufactured by using Superfusion Process

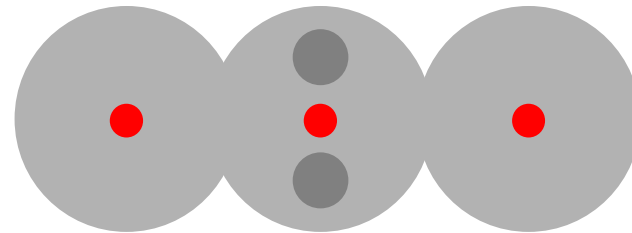
KEY COMPONENTS FOR SENSING SYSTEMS

2. Polarization-Maintaining Fiber Splitters

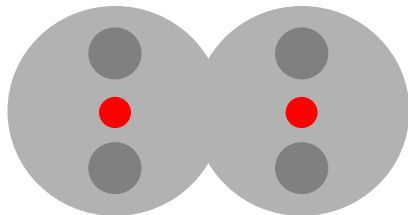
Cross-sectional shapes



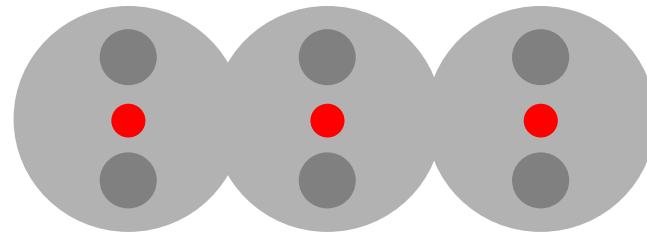
1x2(2x2) Hybrid



1x3 (3x3) Hybrid



1x2(2x2)

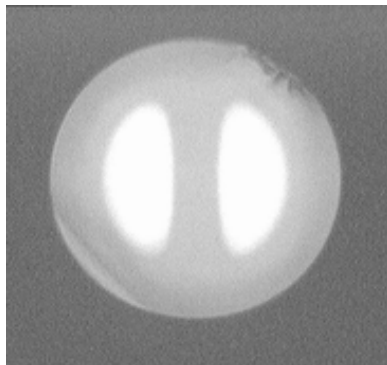


1x3 (3x3) Hybrid

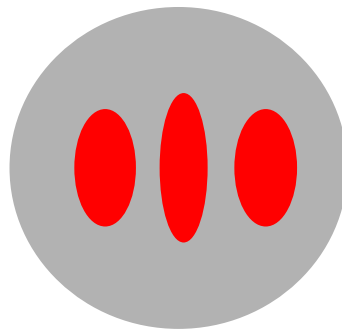
KEY COMPONENTS FOR SENSING SYSTEMS

3. Multimode Fiber Splitters

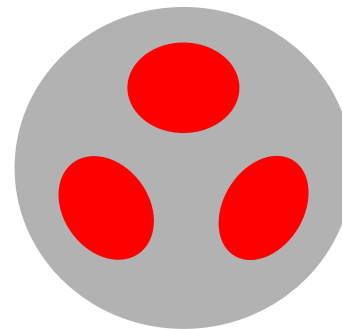
Cross-sectional shapes



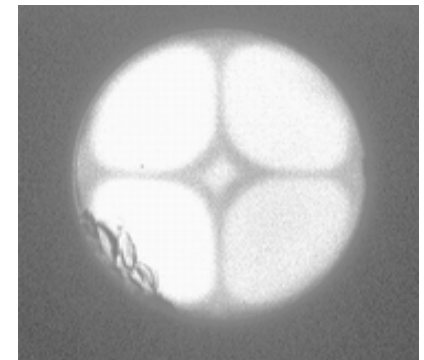
1x2 (2x2)



1x3 (2x3)



3x3



4x4

All of these components are manufactured by using Superfusion Process

Ultra-High Reliability Fused Fiber Products For Sensing Applications

- KEY ISSUES FOR FFPs
- SUPERFUSION TECHNOLOGIES
- KEY COMPONENTS FOR SENSING SYSTEMS
- **PRODUCT RELIABILITY**
- CAPABILITY AND CAPACITY

PRODUCT RELIABILITY

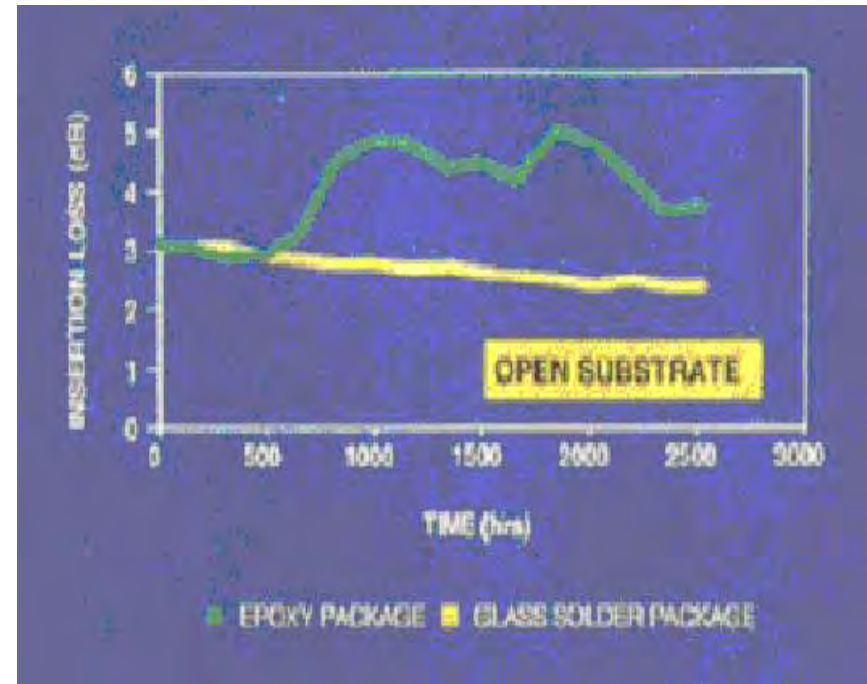
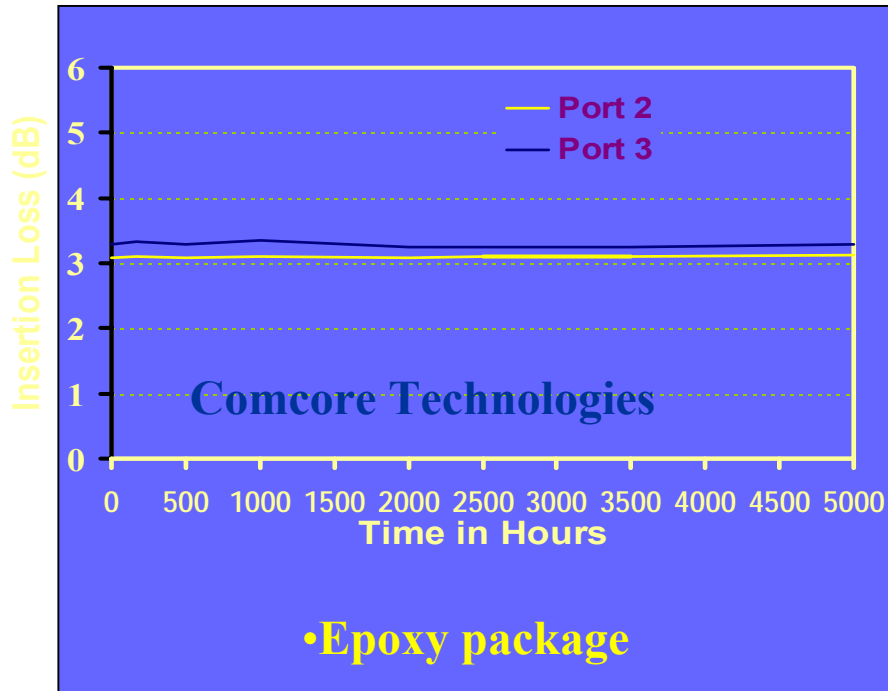
1. Quality Control Systems

- (1) **Quality Assurance System: ISO9001**
- (2) **Qualification & Reliability: Submarine Standard**
- (3) **Process Control: Comcore's Process System**

PRODUCT RELIABILITY

2. Qualification Test Results

(1) Damping Heat Test Results for 3-dB splitter in 85C/RH85%



<http://www.gouldfo.com/tech/glas.html#figure2>



Comcore Technologies'

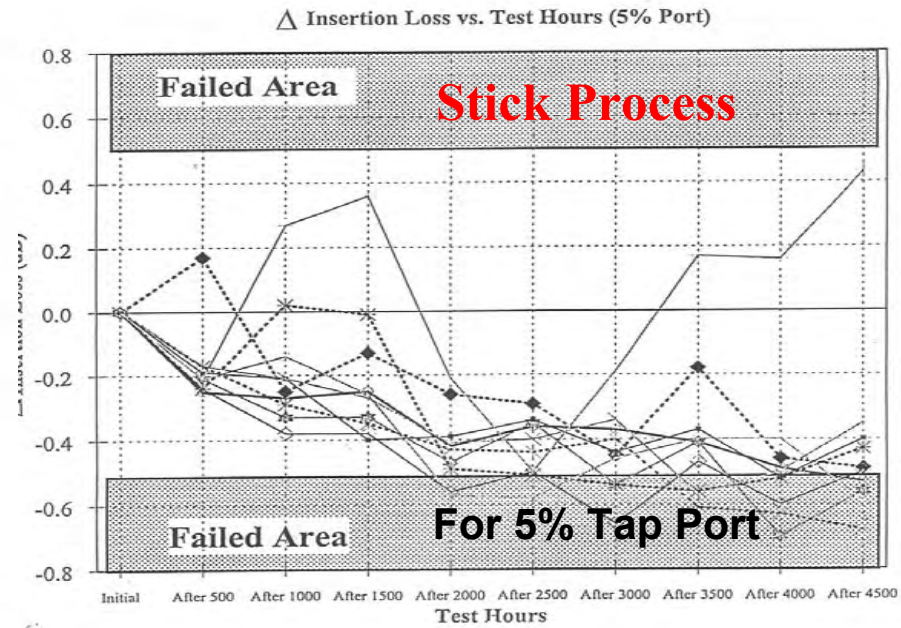
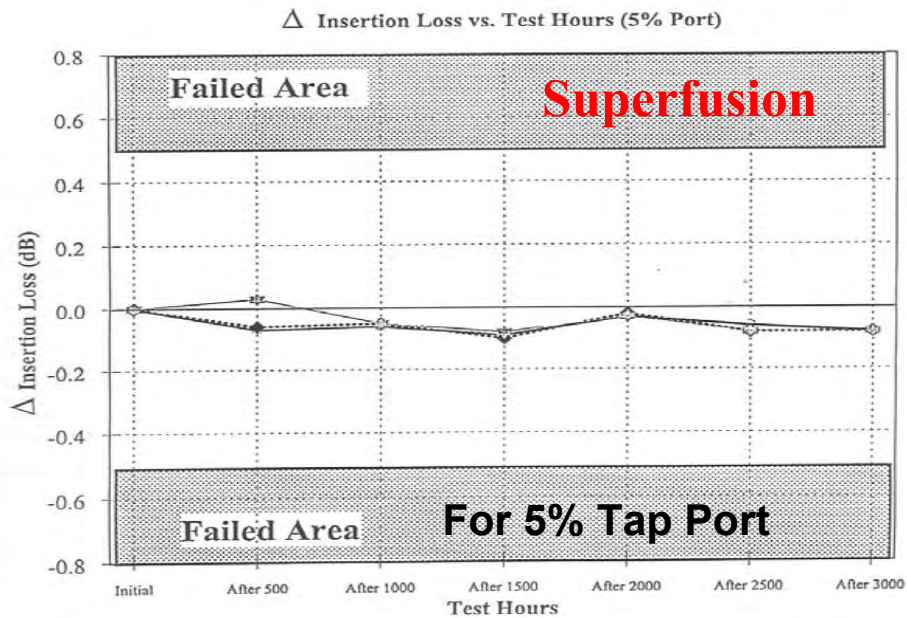
Comcore Technologies Properties
<http://www.comcore.com>

Competitor'

PRODUCT RELIABILITY

2. Qualification Test Results

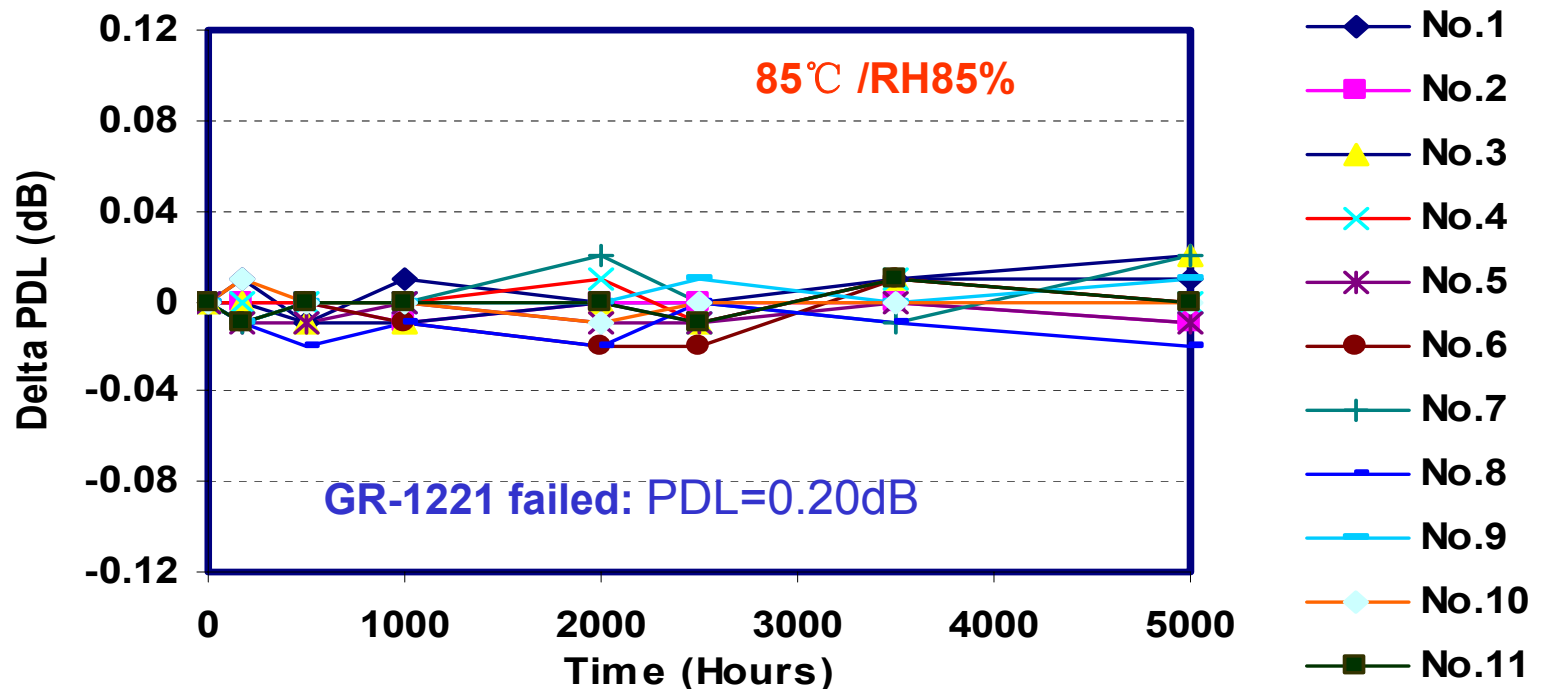
(2) Damp-Heat Testing for 1550nm 95/5% 1x2 Tap (Initial Data)



PRODUCT RELIABILITY

2. Qualification Test Results

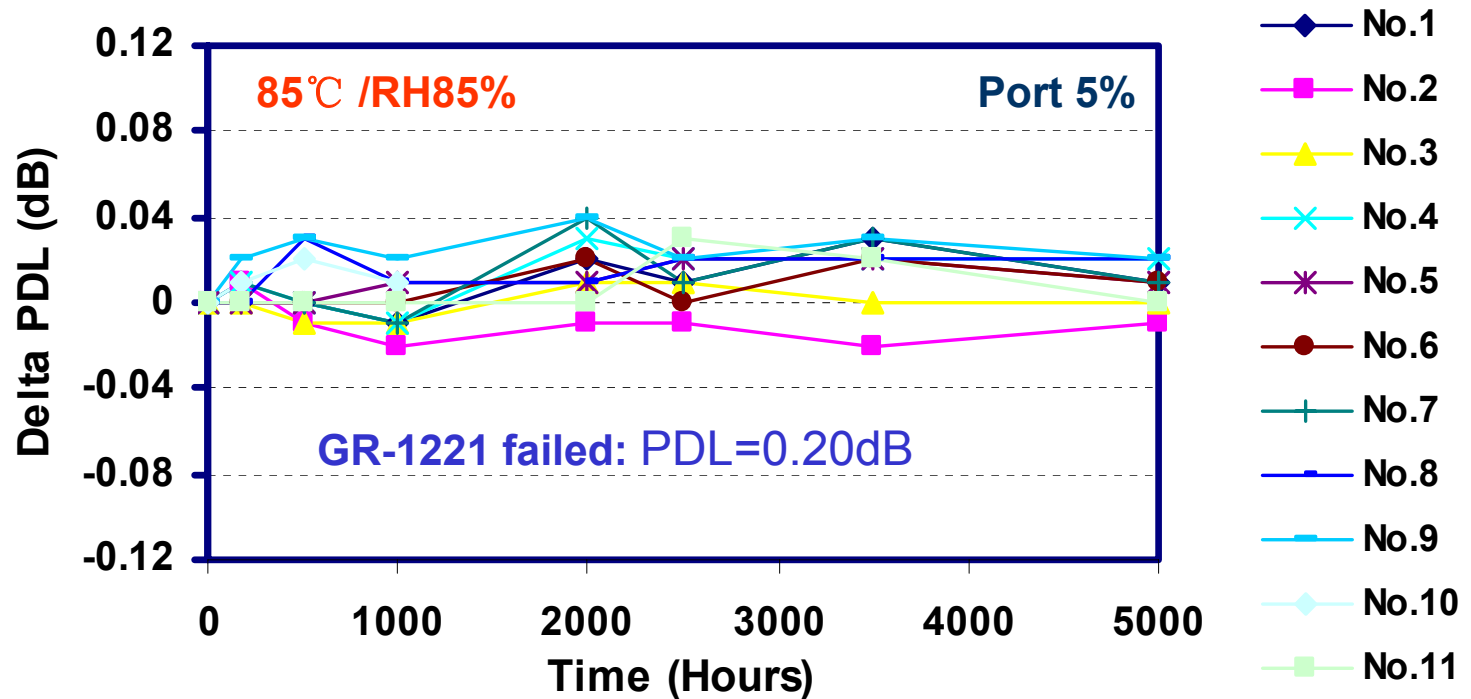
(3) Δ PDL Results of Damp Heat Test for 1550nm 50:50 1x2 Splitter



PRODUCT RELIABILITY

2. Qualification Test

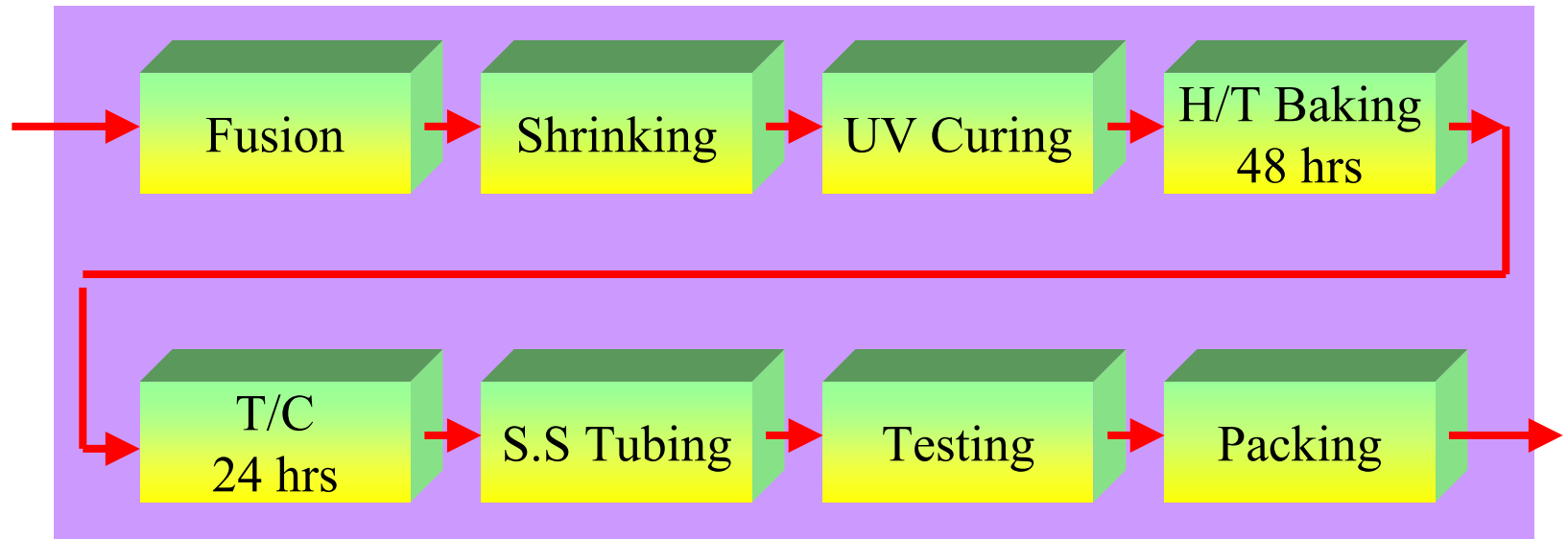
(4) Δ PDL Results of Damp Heat Test for 1550nm 95:5 1x2 Tap



PRODUCT RELIABILITY

4. Process Control: Comcore's Process System

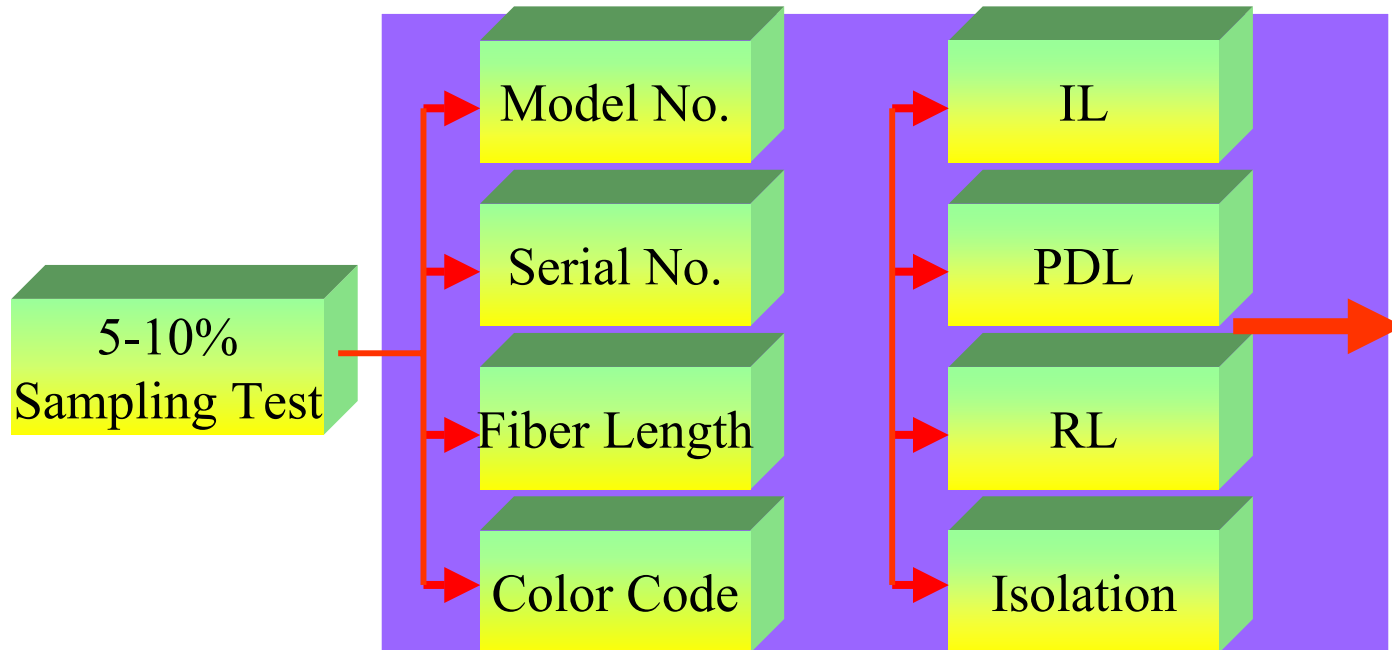
Standard Manufacturing Process of FFP



PRODUCT RELIABILITY

5. Quality Control: Comcore's Process System

Optical Quality Assurance Process



Ultra-High Reliability Fused Fiber Products

For Sensing Applications

- KEY ISSUES FOR FFPs
- SUPERFUSION TECHNOLOGIES
- KEY COMPONENTS FOR SENSING SYSTEMS
- PRODUCT RELIABILITY
- **CAPABILITY AND CAPACITY**

CAPABILITY AND CAPACITY

2. Manufacturing Capacity*

Product Type	Qty/Month
1x2 (2x2) Single Mode Splitter / Mixer	1000
NxM Monolithically-Fused Multimode Splitter / Mixer	300
1x2 (2x2) Polarization-Maintaining Fiber Splitter / Mixer	150

•On base of a workstation/ person /shift. We have total 20 own workstations.

Ultra-High Reliability Fused Fiber Products For Sensing Applications

Thank You!