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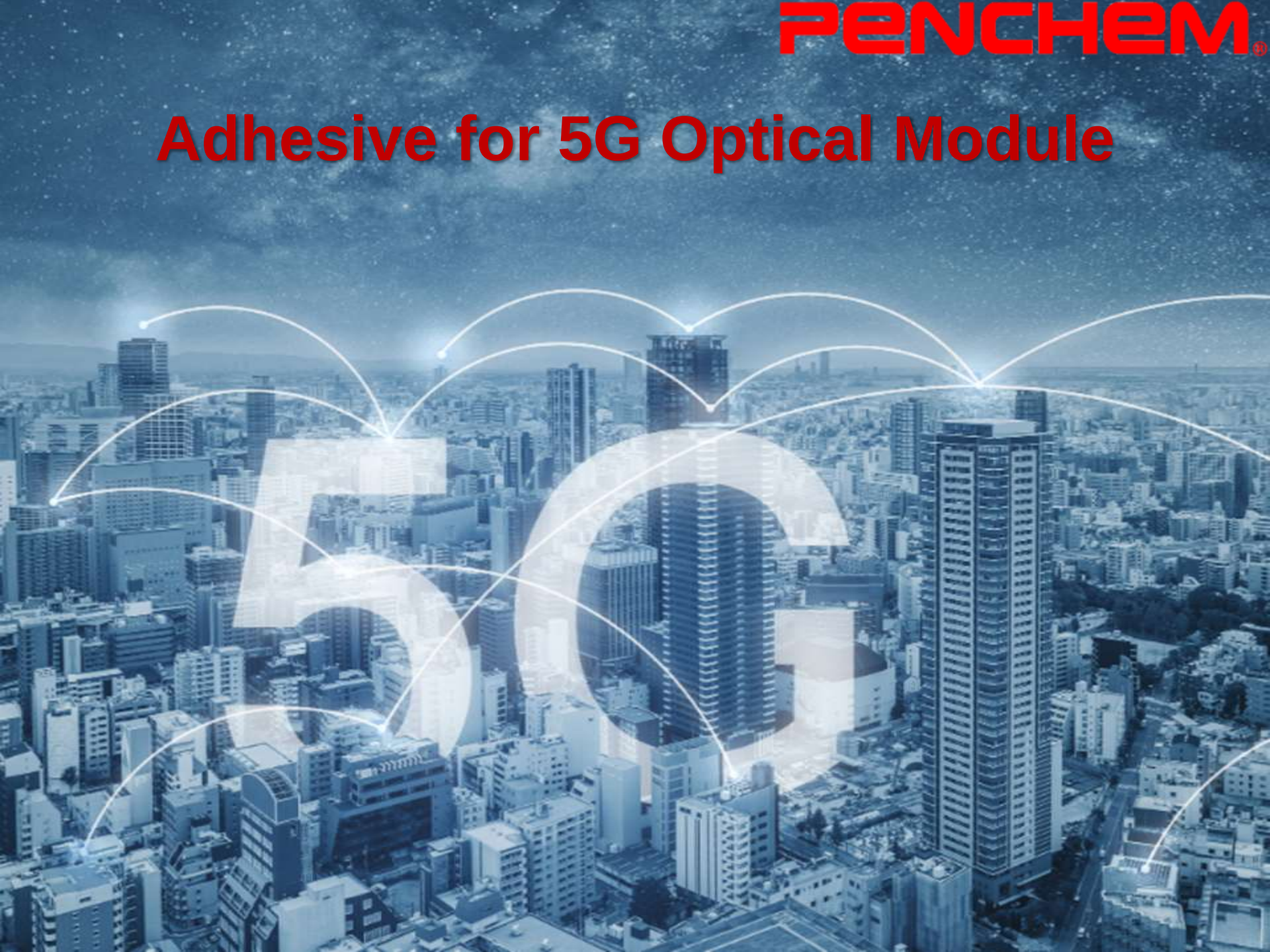
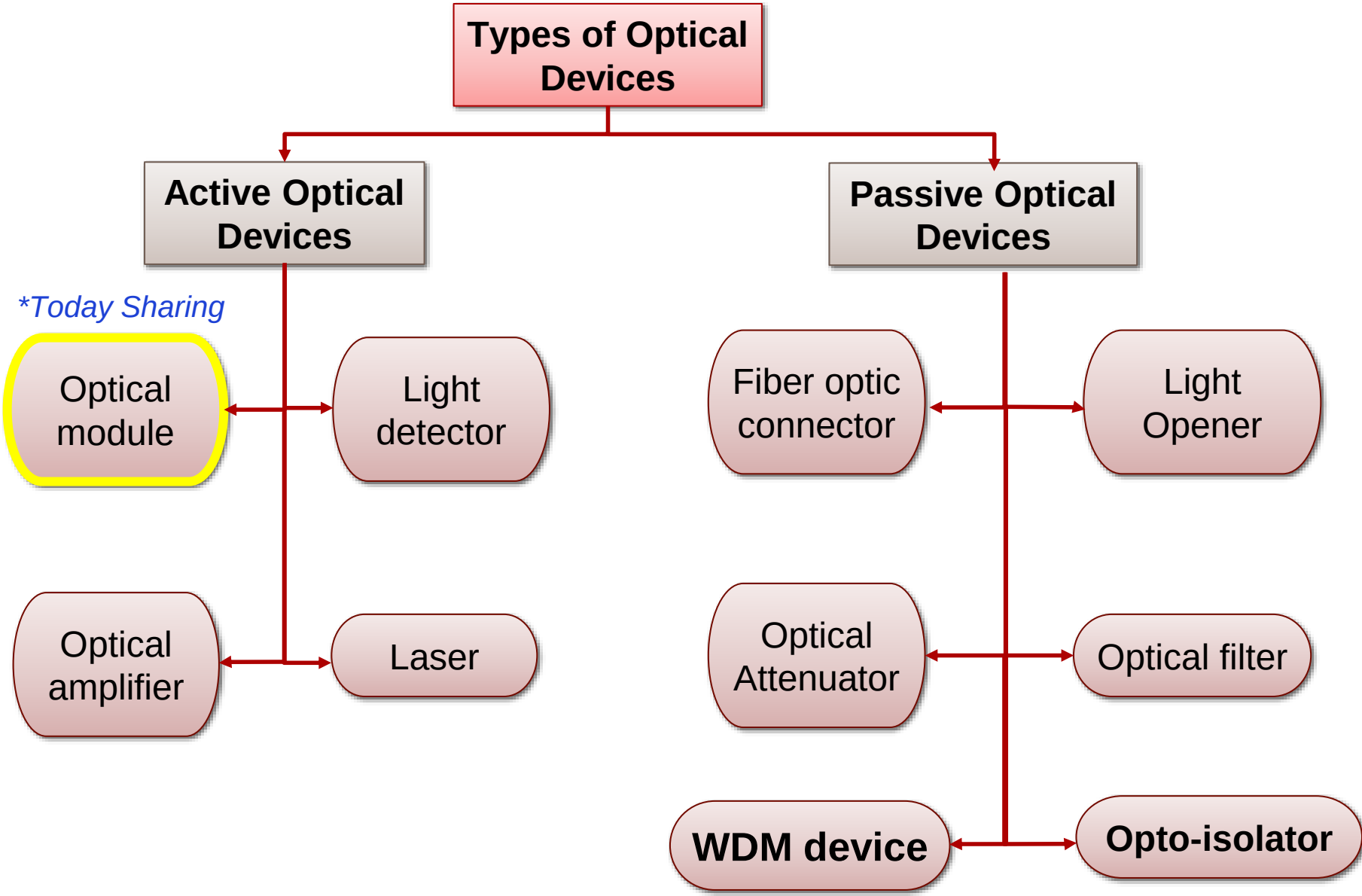
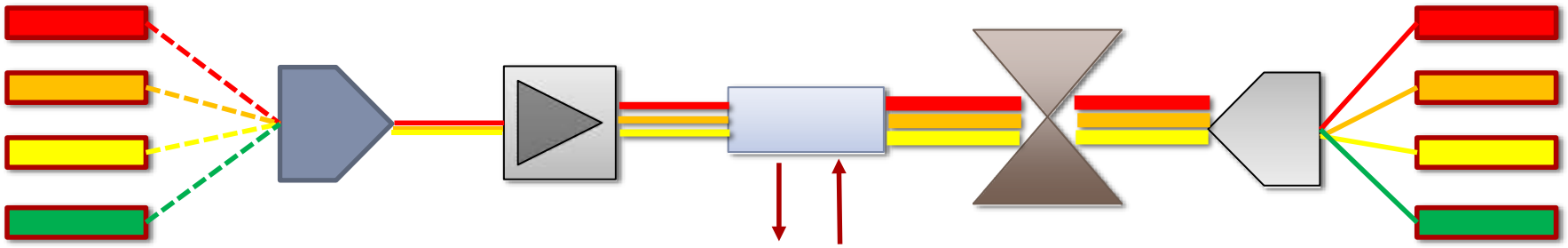
Adhesive for 5G Optical Module



- Introduction of 5G
- Devices for optical fiber communication
- Types of optical devices
- Requirements for 5G adhesives
- Case Studies for 5G adhesives

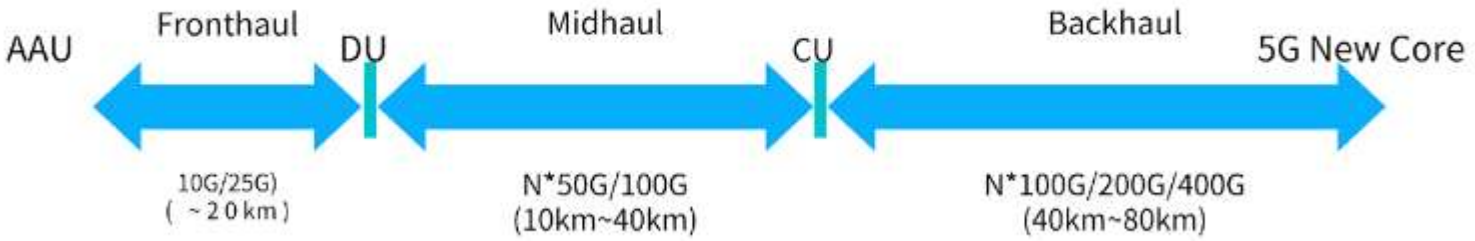

Types of Optical Devices
Active Optical Devices
Passive Optical Devices
*Today Sharing
Optical module
Light detector
Optical amplifier
Laser
Fiber optic connector
Light Opener
Optical Attenuator
Optical filter
WDM device
Opto-isolator

Devices for Optical Fiber Communication

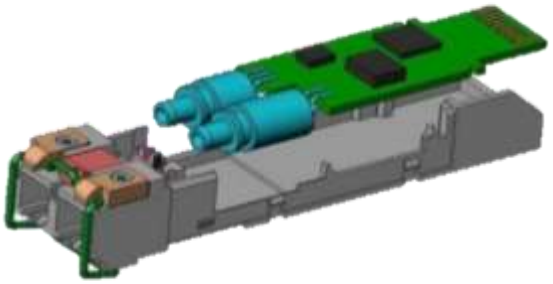


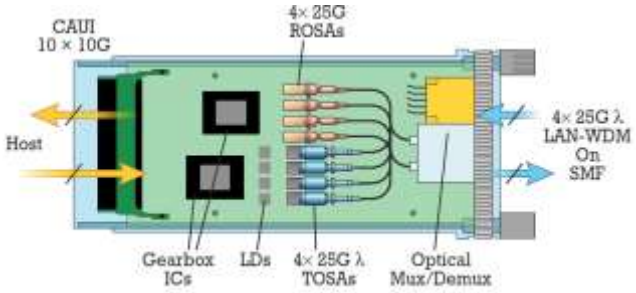
- Transmission & Receiver
  - Optical Module
  - Laser
  - Light detector
- **Wavelength Division Mutilplexing**
  - CWDM/ DWDM
  - Optical Circulator
- **Amplifier**
  - Fiber Optic Amplifier
  - Optical Isolator
- **Switch**
  - Light opener
  - Fiber optic connector
- **System Management**
  - Colour Compensator

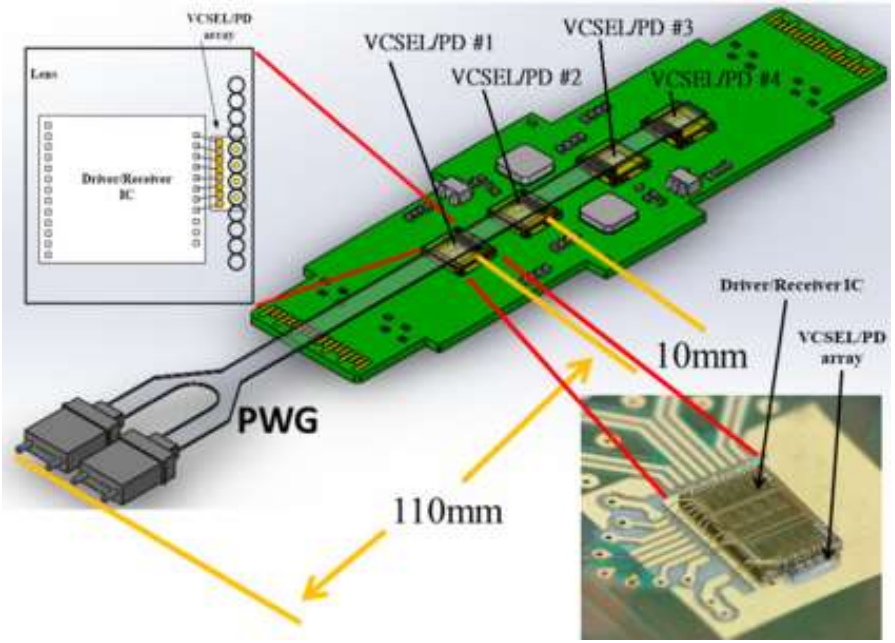
Optical Module



Configuration Optical Module

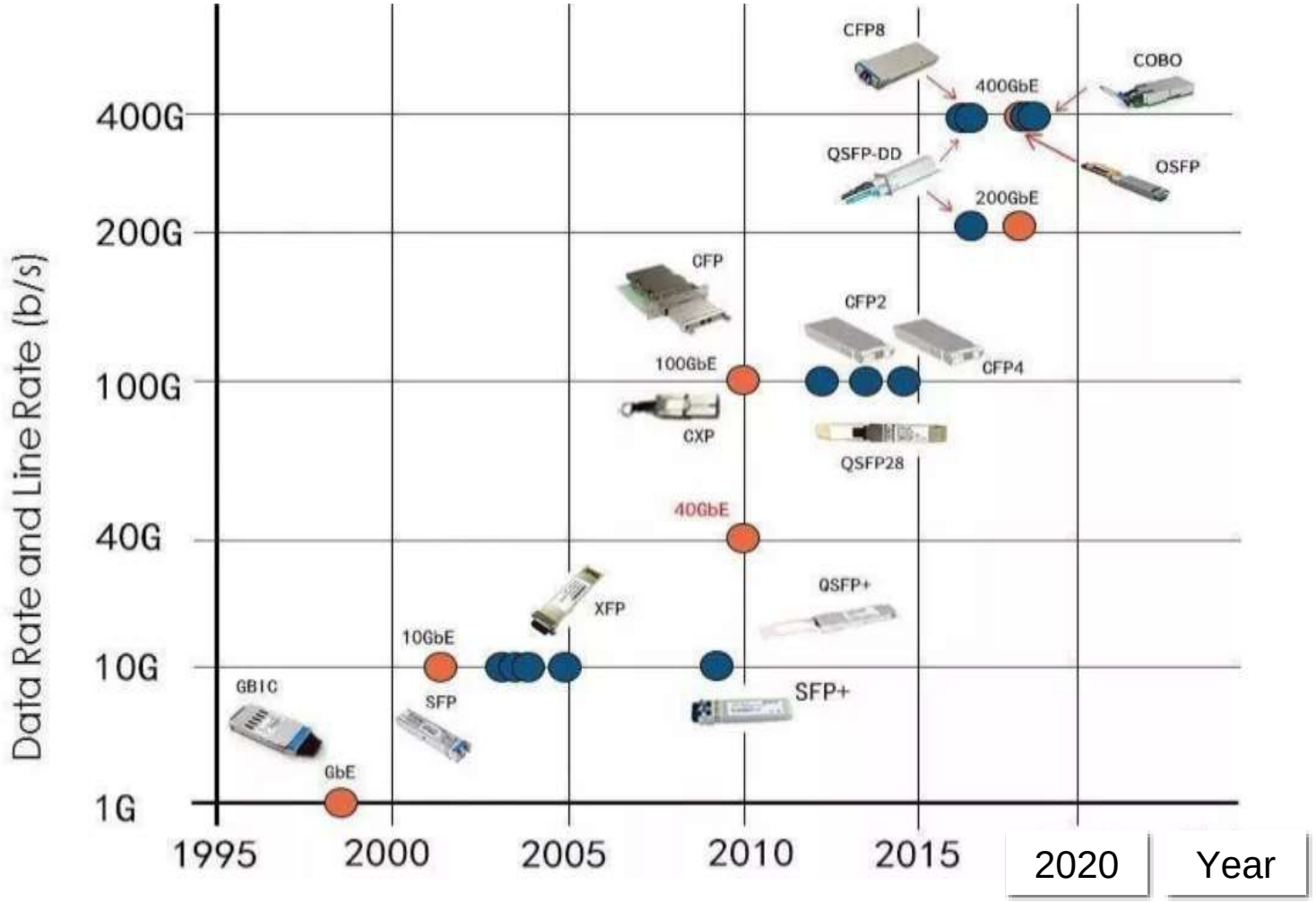


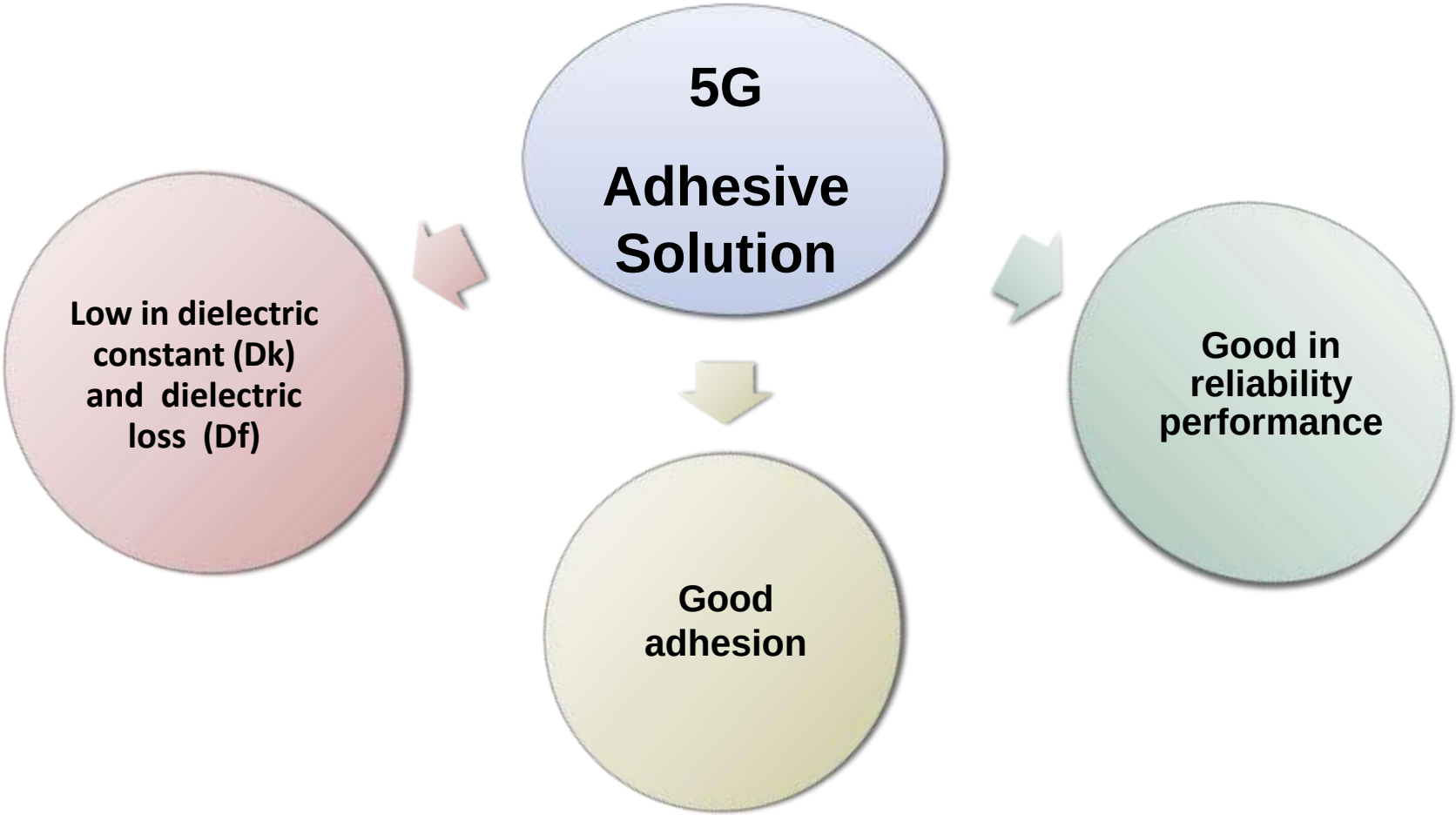




TOSA – Transceiver Optical Sub Assembly
ROSA - Receiver Optical Sub Assembly

光模块发展趋势


Data Rate and Line Rate (b/s)
400G
200G
100G
40G
10G
1G
1995
2000
2005
2010
2015
2020
Year
CFP8
COBO
400GbE
QSFP-DD
OSFP
200GbE
CFP
CFP2
CFP4
100GbE
CXP
QSFP28
40GbE
QSFP+
XFP
10GbE
SFP+
GBIC
SFP
GbE


5G
Adhesive Solution
Low in dielectric constant (Dk) and dielectric loss (Df)
Good adhesion
Good in reliability performance

胶水案例分析

Reliability Condition

Test	Condition
High Temperature Storage	85^{0}C,1000 hr
Low Temperature Storage	-40^{0}C,1000 hr
Dam Heat	85^{0}C/85%RH,2000hr - 105^{0}C/100%RH,2000hr
Temperature cycling	-40^{0}C To 85^{0}C,20^{0}C/min ramp,10 min soak
Mechanical Shock	Condition A: 500G,1ms,5 times/axis
	Condition B: 1500G,0.5ms, 5 times/axis
Thermal Shock	-40^{0}C to 85^{0}C, air to air (measured at 20 & 100 cycles)
Vibration	20G,20-2000 Hz, 4min/cycle,4 cycles/axis

1. Optical Module Application

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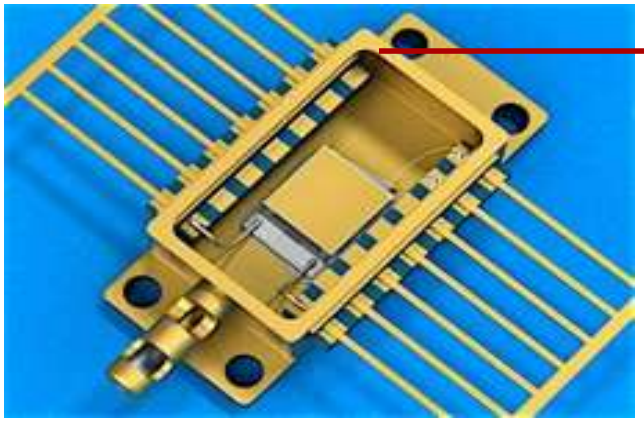

Hermetic Seal

- EN418-2 (Black, BLT <45um)
- EN418-13 (Yellowish, BLT <20um)

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BONDING TECHNOLOGIES TOGETHER

EN 418-2
Black Epoxy Encapsulant

Description

EN 418-2 is a one-part black colored adhesive based on epoxy resins. It cures fast at low temperatures. The cured epoxy adhesive/encapsulant provides good high temperature performance, good adhesion to most printed circuit boards and electronic components. It has a long shelf life even at room temperature of 25°C. The flow of this epoxy has been adjusted to control excessive overflow.

Properties

Property	Test Method	Unit	Typical value
Chemical type	-	-	Epoxy
Color	Pen 10	-	Black
Mix ratio, by weight	-	-	One component
Shelf life, -20°C	Pen 26	Month	6
Pot life, 25°C	Pen 26	Day	1
Viscosity, CAP 2000+ viscometer, 50rpm, 25°C	ASTM D4287	cps	26,500
Specific gravity	Pen 14	-	1.53
Hardness	ASTM D2240	Shore D	88
Glass Transition Temperature	Pen 19	°C	133
CTE, α1	Pen 64	ppm/K	37

Description

EN 418-13 is one-part encapsulant or adhesive based on epoxy resins. It cures fast at low temperatures. The cured epoxy adhesive/encapsulant provides good high temperature performance, good adhesion to most printed circuit boards and electronic components. The flow of this epoxy has been adjusted to prevent sagging.

Features

- One part
- Low temperature cure (85 - 100°C)
- Good adhesion to glass, FR-4, stainless steel, Kovar, ultem, etc.
- Low CTE
- Low bond-line thickness

Applications

- Encapsulation of ICs on printed circuit boards.
- General adhesive for temperature sensitive electronic components.

Uncured Properties	Typical Value	Unit	Test Method
Color	Yellowish	-	PEN 10
Viscosity at 25°C	22,500	cP	ASTM D2196 / D2556
Pot Life at 25°C	2	day	PEN 57
Extrusion rate, GA25, 50psi	12.0	mg/min	PEN 107
Filler size	<20	μm	-

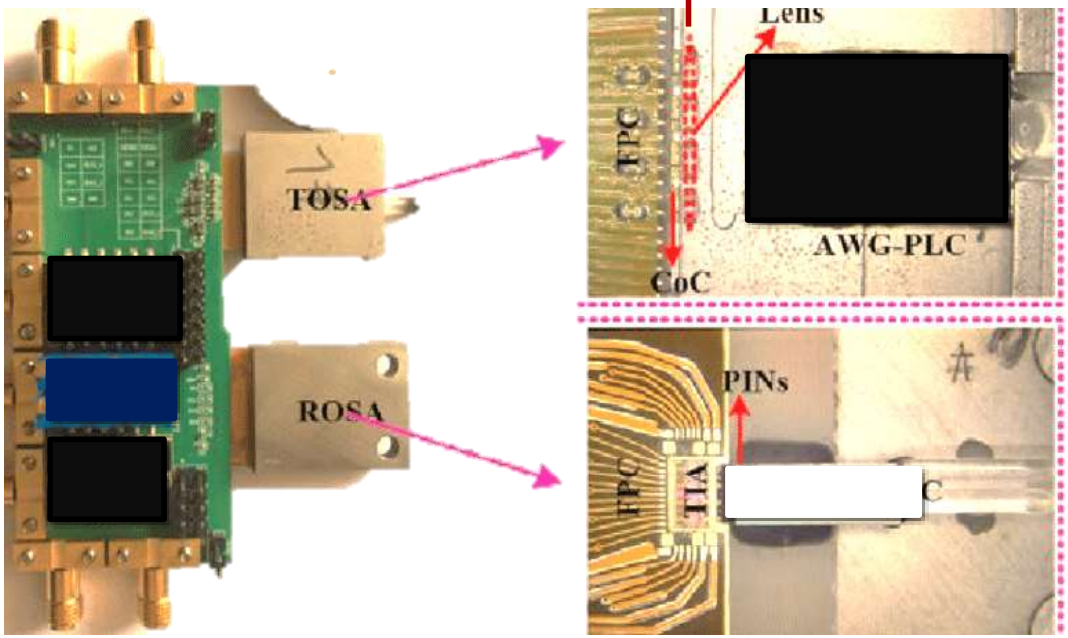
Cured Properties	Typical Value	Unit	Test Method
Hardness	89	Shore D	ASTM D2240
Density	1.52	g/cm³	ASTM D792
Glass Transition Temperature, Tg	105	°C	ASTM D3418
CTE before Tg	37	ppm/°C	ASTM D3418
CTE after Tg	134	ppm/°C	ASTM D3418
Die shear, on stainless steel	181	kgf/cm²	PEN 36
Die shear, on FR4	152	kgf/cm²	PEN 36
Die shear, on glass	190	kgf/cm²	PEN 36
Die shear, on Ultem	176	kgf/cm²	PEN 36

* The values above are tested based on batch to batch basis. These values are not use as a basis for preparing specifications.
* PEN is referring to Penchem standard test method, ASTM is for Test reference only
* N/A is referring to not applicable

2. Optical Module Application

RI Matching Adhesive

- UV781-1 (RI:1.411)
- UV773-6 (RI:1.506)
- OP993-11 (SiliconeRI:1.429)



UV781-2

Description

UV781-2 is a low refractive index and flowable UV and thermal curable urethane acrylate system. The cured material is flexible and has good toughness and adhesion to glass substrate.

Feature

- Flowable adhesive
- Low refractive index

Applications

- UV and thermal curable adhesive for low RI substrates.

Uncured Properties	Typical Value	Unit	Test Method
Color	Clear liquid	-	PEN 10
Viscosity at 25°C	6225	cP	ASTM D4287
Pot life at 25°C	4	day	PEN 57
Refractive index 589nm	1.411	-	ASTM D1218

Cured Properties	Typical Value	Unit	Test Method
Hardness	73	Shore D	PEN 29
Die shear strength_ UV			
a) Metal chip to glass	51	kgf/cm^2	PEN 93
Die shear strength_ UV+Heat			
a) Metal chip to glass	62	kgf/cm^2	PEN 93
Glass transition temperature	53	°C	ASTM D7028-07
CTE-α_1	136	ppm/K	ASTM E831-03
Storage modulus @ -40°C	718	MPa	ASTM D4065-12
Storage modulus @ 30°C	447	MPa	ASTM D4065-12
Storage modulus @ 100°C	173	MPa	ASTM D4065-12
Linear Shrinkage	2.45	%	PEN 56
Dielectric constant			
a) 28GHz	3.28	-	GB/T 31838.1-2015
b) 39GHz	3.52	-	GB/T 31838.1-2015
Dissipation factor			
a) 28GHz	0.0025	-	GB/T 31838.1-2015
b) 39GHz	0.0032	-	GB/T 31838.1-2015

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* PEN is referring to Penchem's standard test method; ASTM is for test reference only.
* N/A is referring to not applicable.

** We do have even lower Dk and Df performance version. Send us your request to enquiry@penchem.com*

Recommended Cure

Cure condition:

Pre-Curing Condition
Wavelength: 365nm
Intensity: 150 mW/cm^2 for 200s

Post Curing Condition
100°C or higher for 1 hour

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UV773-6

Description

UV773-6 is a high refractive index and flowable UV and Heat curable epoxy system. The cured material is hard and has good toughness and adhesion to glass substrate.

Features

- Flowable
- High refractive index
- High glass transition temperature
- Passed PCT without delamination up to 24 hours
- Passed reflow for 15min (max. 260°C) without delamination

Applications

- Flowable UV curable adhesive for glass and metal substrates.

Uncured Properties	Typical Value	Unit	Test Method
Color	Clear liquid	-	PEN 10
Viscosity at 25°C	378	cP	ASTM D4287
Pot life at 25°C	7	day	PEN 57
Refractive index, 589 nm	1.506		ASTM D1218

Cured Properties	Typical Value	Unit	Test Method
Optical transmittance			
a) 850nm	>90	%	UV-VIS NIR
a) 1100nm	>80	%	UV-VIS NIR
b) 1300nm	>80	%	UV-VIS NIR
c) 1550nm	>80	%	UV-VIS NIR
Glass transition temperature	168	°C	ASTM D7028-07
Storage modulus at temperature			
a) -40°C	2360	MPa	ASTM D4065-12
b) 30°C	1908	MPa	ASTM D4065-12
c) 100°C	1391	MPa	ASTM D4065-12
d) 200°C	84	MPa	ASTM D4065-12
CTE, α-1	59	ppm/K	ASTM E831-03
Weight loss at 30°C-150°C	0.50	%	PEN 92
Thermal stability, 5% weight loss at	346	°C	PEN 92
Die shear strength_ metal chip to glass			
a) 2000mW/cm^2 + RT 1H	99	kgf/cm^2	PEN 93
b) 2000mW/cm^2 + 85°C/1H	103	kgf/cm^2	PEN 93
c) 2000mW/cm^2 + 85°C/5H	96	kgf/cm^2	PEN 93
Die shear strength_ 300mW/cm^2 for 90s + 100°C/1H			
a) Metal chip to glass	150	kgf/cm^2	PEN 93
b) Glass chip to glass	140	kgf/cm^2	PEN 93
Die shear strength_ PCT 121°C, 100%RH, 2atm, 24 hours			
a) Glass chip to glass	47	kgf/cm^2	PEN 93

Recommended Cure

Cure condition:

Pre-curing condition

Wavelength 365nm

	Intensity (mW/cm2)	Time (sec)
For V-groove	100	600
Minimum	2000	15
Optimum	300	90

Post curing condition

100°C or above for 1 hour

OP 993-11
Soft Silicone Encapsulant

Description

OP 993-11 is a colorless, one part heat curable liquid silicone rubber. The cured silicone has a very low hardness, high optical clarity, high thermal stability and good adhesion to glass, thus, it is recommended for encapsulation / sealing of fiber optic component where low stresses, excellent low temperature flexibility and high temperature resistance are required.

Recommended Cure

Temperature	Cure Time
100°C	2 hours

Properties

Property	Test Method	Unit	Typical Value
Chemical type	-	-	Polysiloxane
Appearance	Pen 10	-	Slight translucent liquid
Mix ratio, by weight	-	-	One component
Pot life, 25°C	Pen 26	Hour	8
Specific gravity, 25 °C	Pen 14	-	0.98
Viscosity, CAP 2000+, C01, 30rpm, 25°C	ASTM D4287	cP	3,942
Refractive index, 589nm, 25°C	Pen 28	-	1.429
Hardness	ASTM D2240-97	Shore OO	Gel
Glass transition temperature, Tg	Pen 64	°C	-97
Cold crystallization, 0 to -65°C	Pen 64	°C	Not detected
Light transmission at 1100nm, 1.0mm thick, 25°C	Pen 40	%	98
Volatile content @ 150°C	Pen 92	%	0.14

The values above are tested based on batch to batch basis. These values are not use as a basis for preparing specifications.

3.Optical Component Application

Competitor Study vs Penchem Adhesive

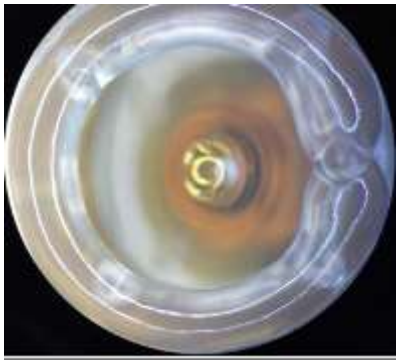
Properties	Unit	UV566-20	UV566-25
Uncured Properties		**Ultem-Metal**	**Kovar-Metal**
Viscosity,25C	cP	6,500	13,760
Thixotropic Index	-	3.0	1.91
Pot life	Days	7	7
Cured Properties			
Density	-	1.27	1.52
Glass Transition Temperature, Tg	C	>85	>100
CTE 1	ppm/k	51	37
CTE2	ppm/k	143	97
Adhesion, UV + Heat Cure	Kgf/cm^2	**124**	**150**
PCT, 121°C,100%RH, 2atm	Kgf/cm^2	**27 (48hrs)**	**48 (48hrs)**
Curing Condition	-	1W/cm2,3s 0.5W/cm2,6s 0.2W/cm2,15s + 120°C/30min	2 W/cm2,15s + 100-130°C/30min

拥有良好的可靠性

Properties	Unit	E 产品	UV566-20	UV566-25
PCT, 121°C,100%RH, 2atm	Kgf/cm^2	Drop off	27 (48hrs)	48 (48hrs)

PCT Test (Pressure Cooker Test)

- Accelerated test condition under 121°C,100%RH, 2atm



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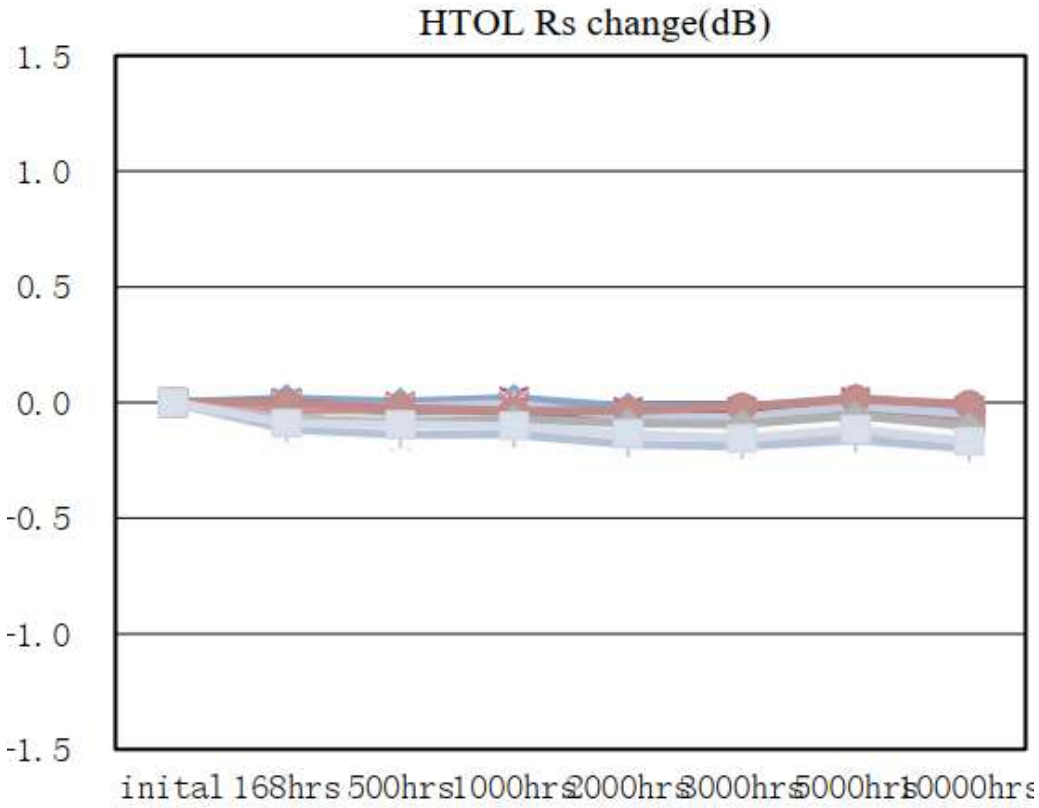

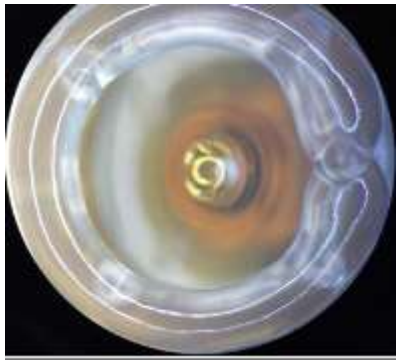

Able to pass **10,000hrs** of **HTOL** at **Temperature =85ºC**

THANK YOU!

For more information, please contact our technical and commercial team, who will be always pleased to help.

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