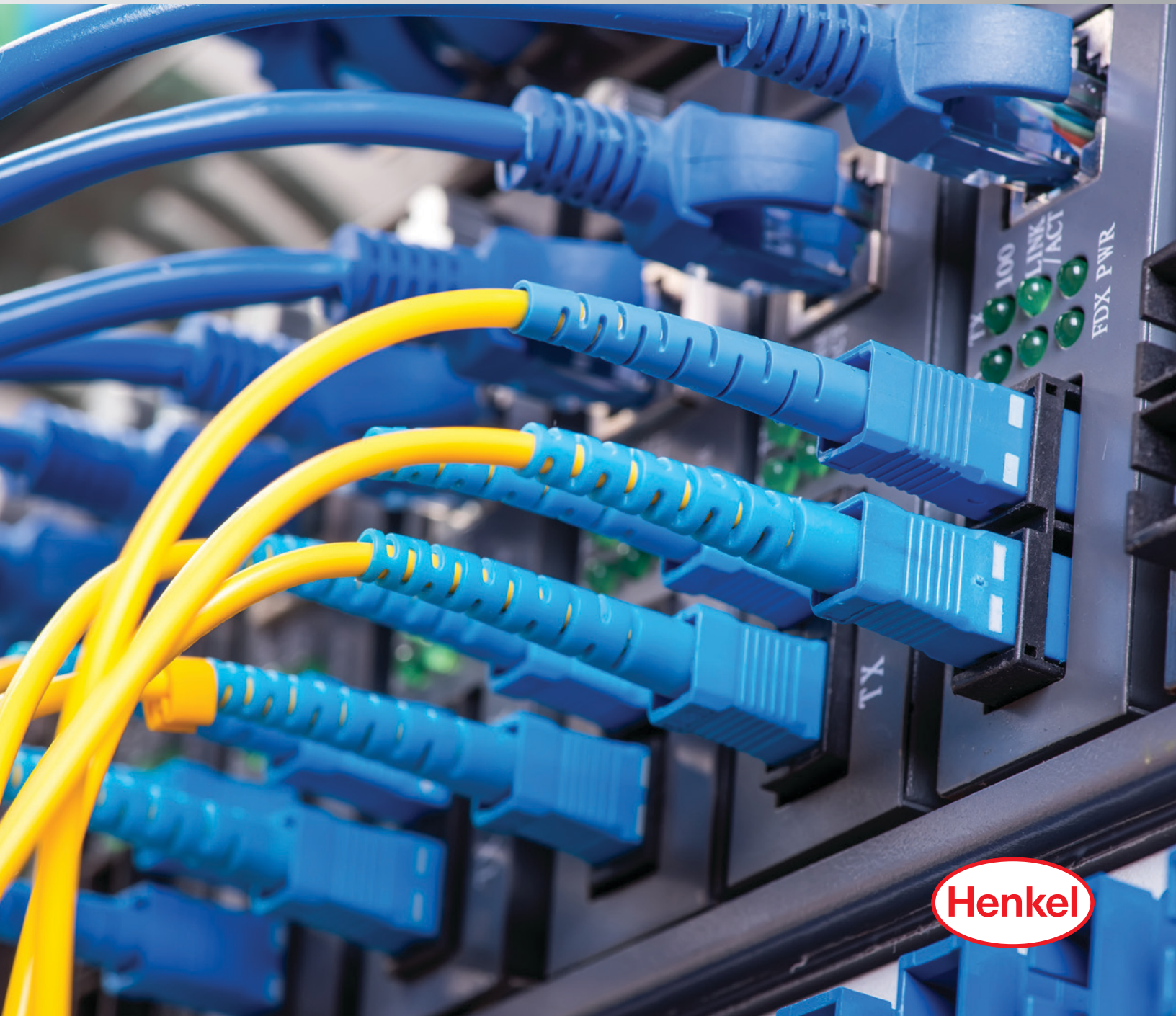


LOCTITE

BERGQUIST

**HIGH-PERFORMANCE MATERIALS FOR
TELECOM/DATACOM OPTOELECTRONICS**



Henkel

CONTENTS

Introduction.....3

Material Solutions for Transceivers4

Active Optical Components

Laser Diode Bonding6

Optical Sub-Assembly7

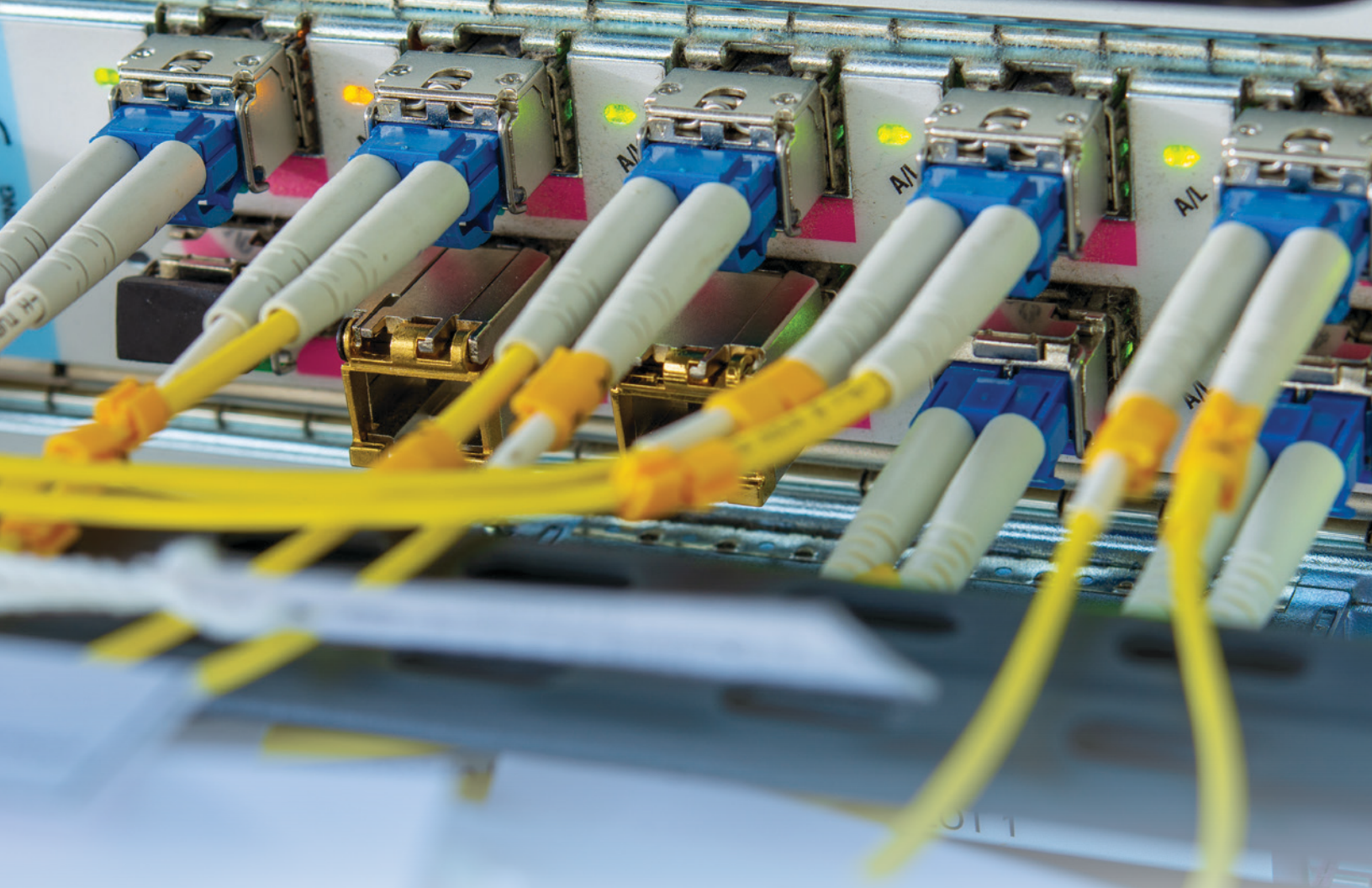
Structural Bonding8

Module Assembly10

Passive Optical Assembly

Fiber Bonding.....11

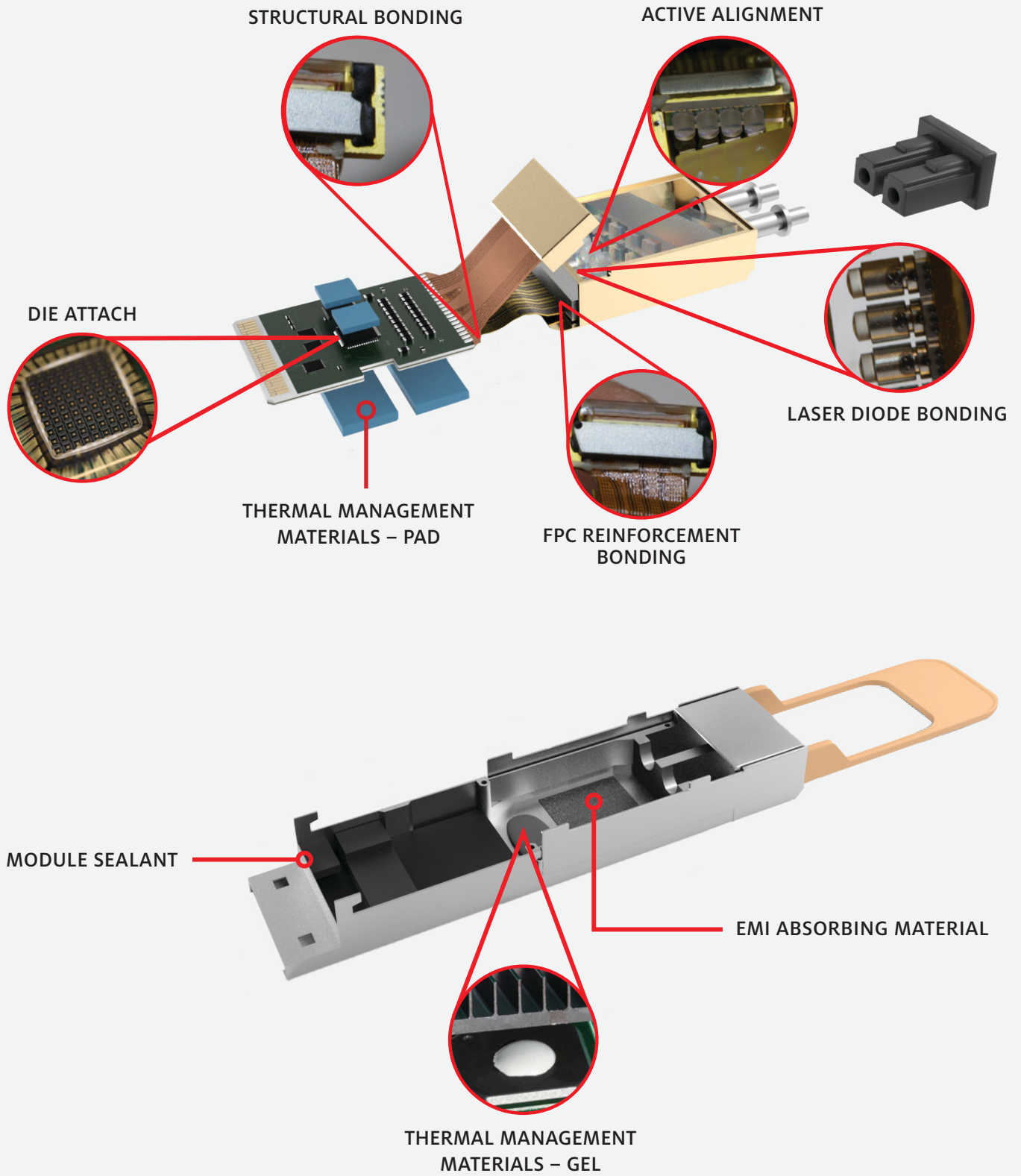
General Passive Optical Assembly13

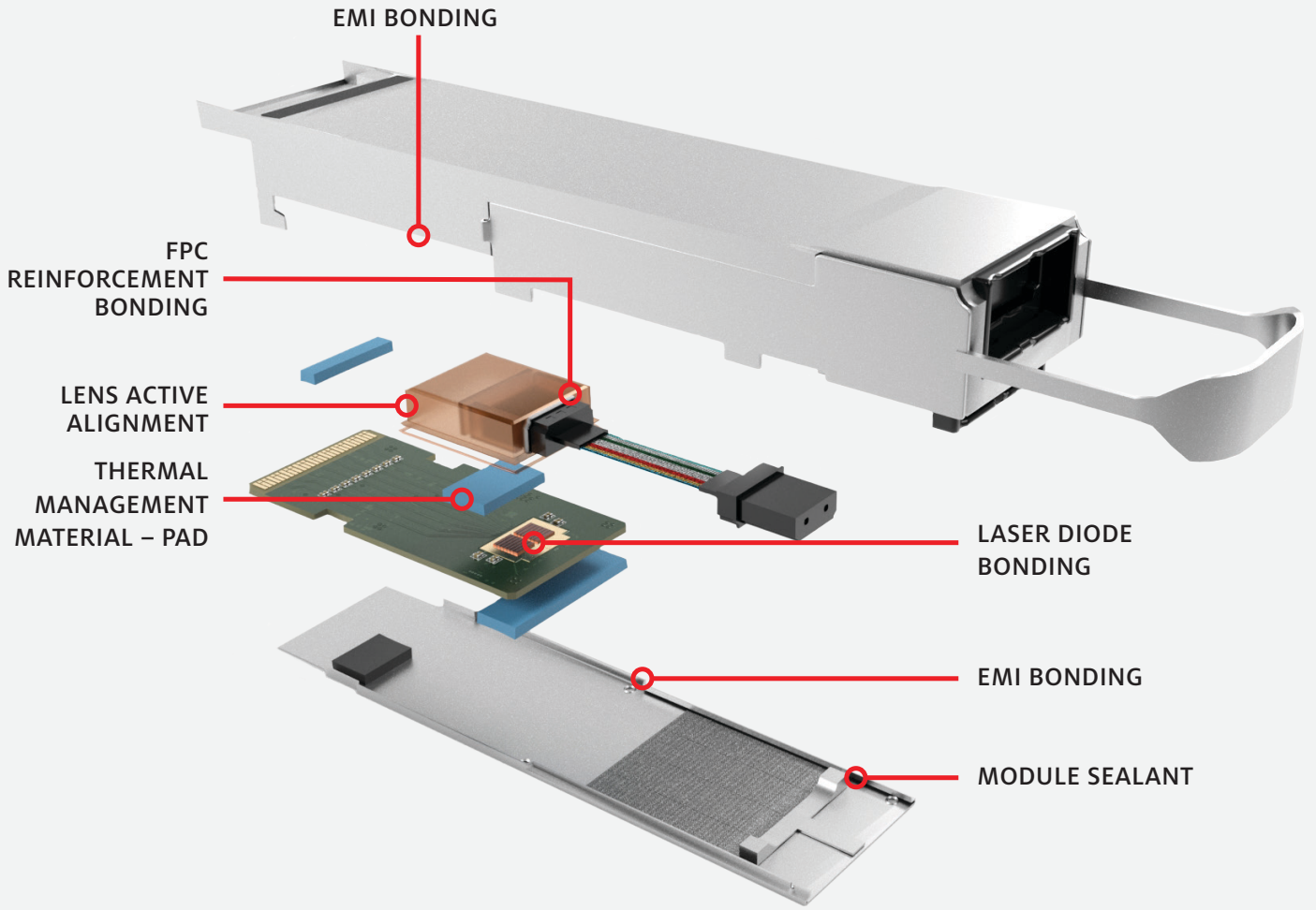


INTRODUCTION

From laser diodes to optical sub-assembly to fiber optical transceivers, optoelectronics technology is essential for transmitting, gathering, displaying, storing and processing information. Optoelectronic components are used in a wide variety of telecommunication and data communication applications. The need for greater bandwidth capacity is driving the adoption of optical wireless distributed antenna system (DAS), increasing the quantity of fiber to the x (FTTX) connections, and expanding the deployment of optical components including optical transceivers and optical fibers to accommodate the high volume of global network traffic. To address these requirements, Henkel has developed a full portfolio of materials designed to facilitate the demands of active and passive optical components so that customers can reliably meet optical module performance expectations.

MATERIALS SOLUTIONS FOR OPTICAL TRANSCEIVERS

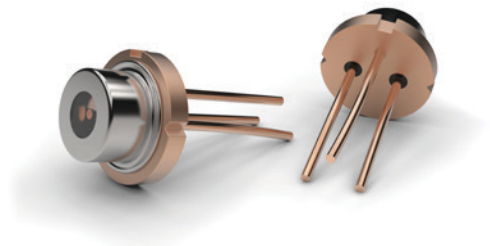
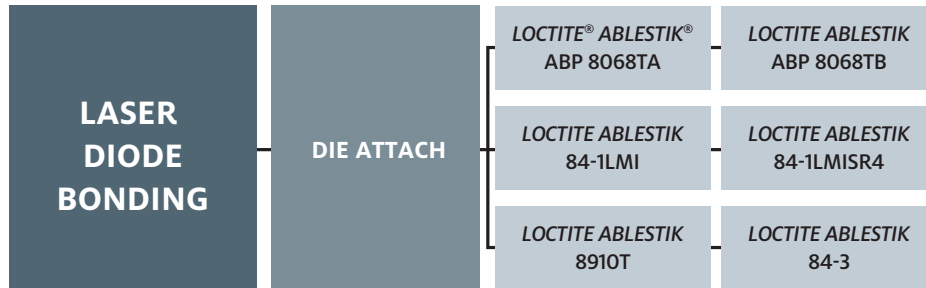




Active Optical Components - Transceiver Assembly Solutions

Laser Diode Bonding

Laser diodes are the most common type of lasers produced, with a wide range of uses including fiber optic communications. Reliably connecting these devices requires high-performance materials such as Henkel's die-attach pastes and semi sintering materials. Our new series of high thermal semi-sintering die attach materials enable robust package-level sintering and overcome the regulatory challenges of solder, thermal conductivity limitations of traditional die attach materials, and processability complexities of pure sintering pastes to provide effective thermal management solutions at the die-level.

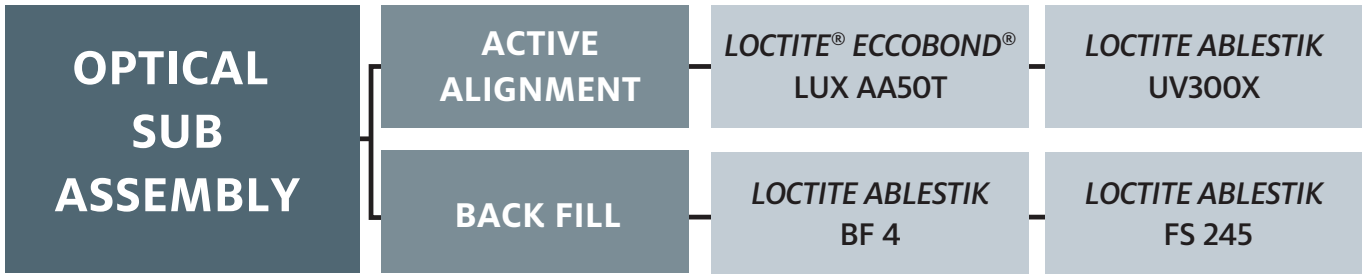


PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	THERMAL CONDUCTIVITY (W/m•K)	CURE TYPE	CURE SCHEDULE
LOCTITE ABLESTIK ABP 8068TA	Semi-Sintering	Conductive Adhesive	<ul style="list-style-type: none"> One component Dispensable Printable low temp cure semi-sintering paste High lead solder replacement High thermal conductivity High reliability 	9,000	N/A	110	Heat	<p>For the die size < 5 x 5 mm: 20 min. ramp from 25°C to 130°C, hold for 30 to 60 min.; 15 min. ramp to 200°C hold for 60 min. in N₂ or air oven</p> <p>For die size > 5 x 5 mm: 20 min. ramp from 25°C to 130°C, hold for 120 min.; 15 min. ramp to 200°C, hold for 60 min. in N₂ or air oven</p>
LOCTITE ABLESTIK ABP 8068TB	Semi-Sintering	Conductive Adhesive	<ul style="list-style-type: none"> No resin bleed-out One component Good workability Printable low temp cure semi-sintering paste Good electrical stability High thermal stability High reliability Solder replacement 	11,500	25	110	Heat	<p>For die size , < 5 x 5 mm: 20 min. ramp from 25°C to 130°C, hold for 30 – 60 min.; 15 min. ramp to 200°C, hold for 120 min. in N₂ or air oven.</p> <p>For die size > 5 x 5 mm: 20 min. ramp from 25°C – 130°C, hold for 120 min.; 15 min. ramp to 200°C, hold for 120 min. in N₂ or air over</p>
LOCTITE ABLESTIK 84-1LMI	Epoxy	Die-Attach	<ul style="list-style-type: none"> Conductive Low outgassing Low bleed Meets MIL-STD-883 Method 5011 requirements 	30,000	103	2.4	Heat	60 min. at 150°C
LOCTITE ABLESTIK 84-1LMISR4	Epoxy	Die-Attach	<ul style="list-style-type: none"> Conductive Excellent dispensability Minimal tailing and stringing 	8,000	120	2.5	Heat	60 min. at 175°C
LOCTITE ABLESTIK 8910T	BMI Hybrid	Die-Attach	<ul style="list-style-type: none"> Non-conductive High thermal conductivity High reliability 	22,000	30	1.3	Heat	30 min. ramp to 175°C + 15 min. at 175°C
LOCTITE ABLESTIK 84-3	Epoxy	Die-Attach	<ul style="list-style-type: none"> Non-conductive Solvent free formulation Long work life 	50,000	85	0.8	Heat	60 min. at 150°C

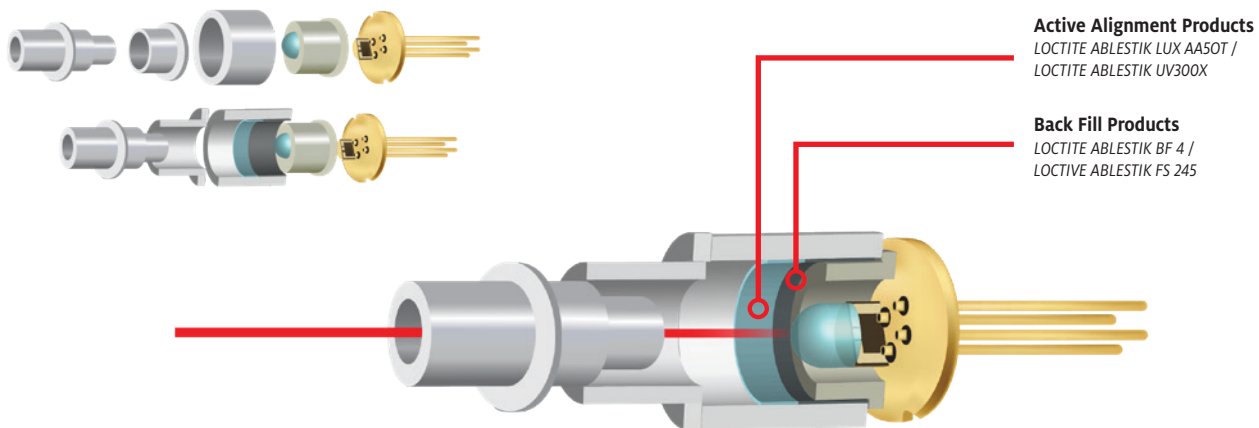
Active Optical Components - Transceiver Assembly Solutions – Continued

Optical Sub-Assembly

An optimized active optical alignment process enables accurate, cost-effective production of optical sub-assemblies such as TOSA, ROSA, BOSA. Henkel’s dual-cure UV adhesives are designed to precisely align these optical components by providing low shrinkage, low CTE, good light transmittance, high reliability and improved dispensing life.



PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	COEFFICIENT OF THERMAL EXPANSION, CTE (ppm/°C)		CURE TYPE	CURE SCHEDULE
						Below T _g	Above T _g		
ACTIVE ALIGNMENT									
LOCTITE ECCOBOND LUX AA50T	Acrylate	Active Alignment	<ul style="list-style-type: none"> Fast light cure High viscosity Low shrinkage Good mechanical stability 	96,000	163	36	98	UV/Heat	UV or visible light + 60 min. at 100°C
LOCTITE ABLESTIK UV300X	Acrylate	Active Alignment	<ul style="list-style-type: none"> One component Fast cure Refractive index: 1.52 	70,000	88	45	188	UV/Heat	UV + 60 min. at 100°C
BACK FILL									
LOCTITE ABLESTIK BF 4	Epoxy	Back Fill	<ul style="list-style-type: none"> Low outgassing, Low moisture absorption High T_g Non-conductive 	23,500	94	32	87	Heat	30 min. at 100°C
LOCTITE ABLESTIK FS 245	Epoxy	Back Fill	<ul style="list-style-type: none"> Two component Thermally conductive Excellent impact and chemical resistance 	13,500	55	50.9	N/A	RT/Heat	72 hr. at 27°C or 2 hr. at 65°C

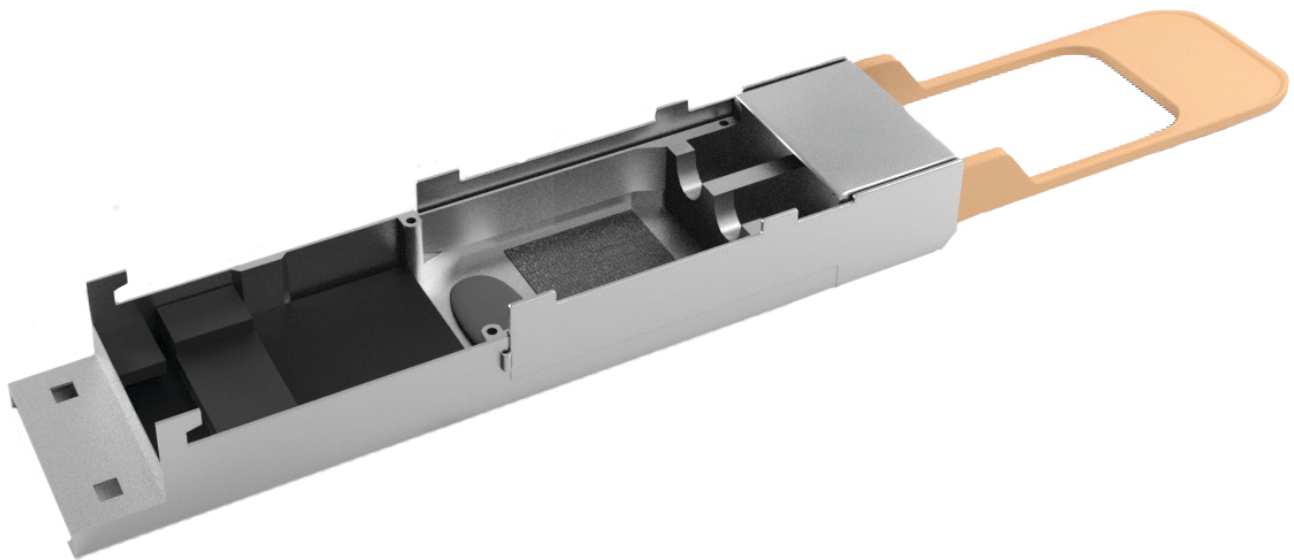


Active Optical Components - Transceiver Assembly Solutions – Continued

Structural Bonding

LOCTITE® brand structural adhesives are available in a range of different chemistries to accommodate process preferences and requirements and deliver compatibility with various substrates including metals and plastics. This flexibility and broad adhesion capability enables numerous applications including front cover and housing bonding, among others.

STRUCTURAL BONDING	STRUCTURAL BONDING	<i>LOCTITE ECCOBOND EO1016</i>	<i>LOCTITE ECCOBOND EO1072</i>	<i>LOCTITE SI 5084</i>
	EMI SHIELDING	<i>LOCTITE SI 5421</i>	<i>LOCTITE ABLESTIK 59C</i>	
LENS BONDING & SEALING	OPTICAL LENS BONDING	<i>LOCTITE ECCOBOND LUX 3042M</i>	<i>LOCTITE HHD 4042</i>	
	LENS SEALING	<i>LOCTITE 3119</i>		

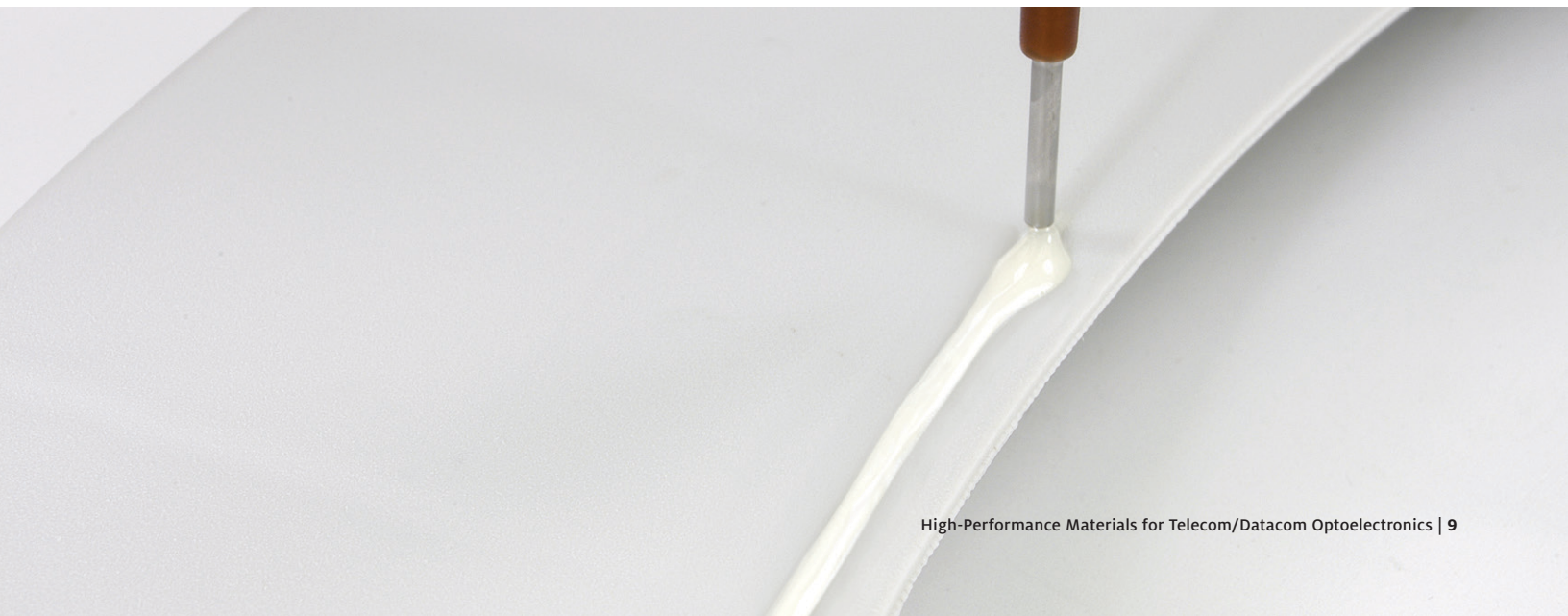


Structural Bonding

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	CURE TYPE	CURE SCHEDULE
STRUCTURAL BONDING							
LOCTITE ECCOBOND EO1016	Epoxy	Encapsulant	<ul style="list-style-type: none"> Good adhesion to metal and plastics, especially nickel and FR4 Fast curing Excellent shelf stability 	62,000	126	Heat	20 min. at 150°C
LOCTITE ECCOBOND EO1072	Epoxy	Encapsulant	<ul style="list-style-type: none"> High T_g Low extractable ionics High performance Good shelf life Fast curing 	100,000	135	Heat	5 min. at 140 – 150°C
LOCTITE SI 5084	Silicone	Gasketing	<ul style="list-style-type: none"> Highly flexible Non-corrosive Enhances load bearing and shock absorbing characteristics of the bond area 	Paste	N/A	UV & RT	UV + Moisture
EMI SHIELDING							
LOCTITE SI 5421	Silicone	Bonding/Gasketing	<ul style="list-style-type: none"> Electrically conductive RTV silicone Bonding and gasketing of EMI/RFI shielded enclosures 	Paste	N/A	RTV	Tack free in 60 min. at 23 ±2°C / 50 ±5% RH
LOCTITE ABLESTIK 59C	Silicone	Assembly	<ul style="list-style-type: none"> Electrically conductive silicone EMI / RFI shielding Thermally conductive High flexibility High tack Can be used with a variety of catalysts 	N/A	N/A	Heat	6 hr. at 150°C

Lens Bonding & Sealing

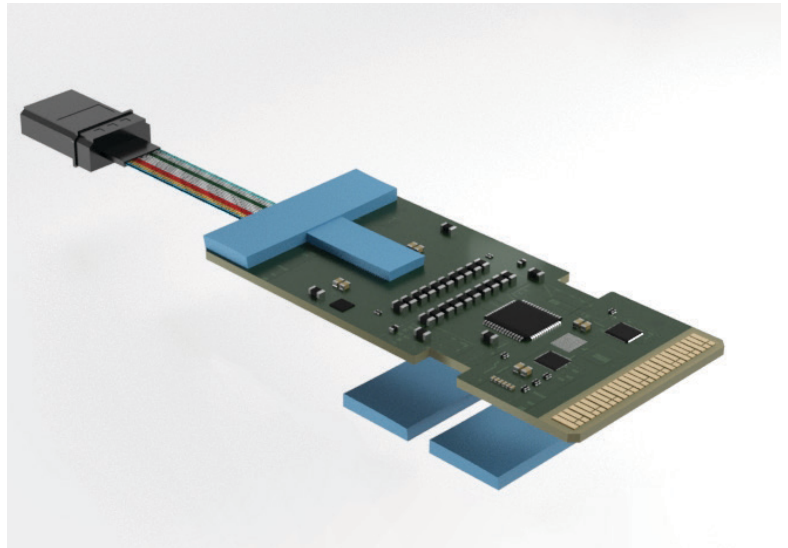
PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	CURE TYPE	CURE SCHEDULE
OPTICAL LENS BONDING							
LOCTITE ECCOBOND LUX 3042M	Acrylate	Assembly	<ul style="list-style-type: none"> One component Dual cure system Good adhesion on PEI plastics, FR4 and various other substrates 	85,000	114	UV & Heat	UV + 30 min. at 120°C
LOCTITE HHD 4042	Epoxy/Acrylate	Assembly	<ul style="list-style-type: none"> One component Dual cure system Good adhesion on PEI plastics, FR4 and various other substrates 	125,000	145	UV & Heat	UV + 60 min. at 120°C
LENS SEALING							
LOCTITE ABLESTIK 3119	Epoxy	Bonding	<ul style="list-style-type: none"> Low temp cure Excellent adhesion on wide range of substrates Very low shrinkage 	7,000 – 23,000	110	Heat	60 min. at 100°C or 20 min. at 75°C



Active Optical Components - Transceiver Assembly Solutions – Continued

Module Assembly

Design optimization and in-field reliability of transceivers and other optical modules require flexible and robust thermal management solutions which is why the world's top manufacturers trust Henkel's market-leading BERGQUIST® brand thermal interface materials. Available in both liquid and pad mediums, award-winning BERGQUIST® GAP PAD® and Gap Fillers provide engineers and designers with broad design and assembly flexibility while ensuring optimal heat management within optical modules



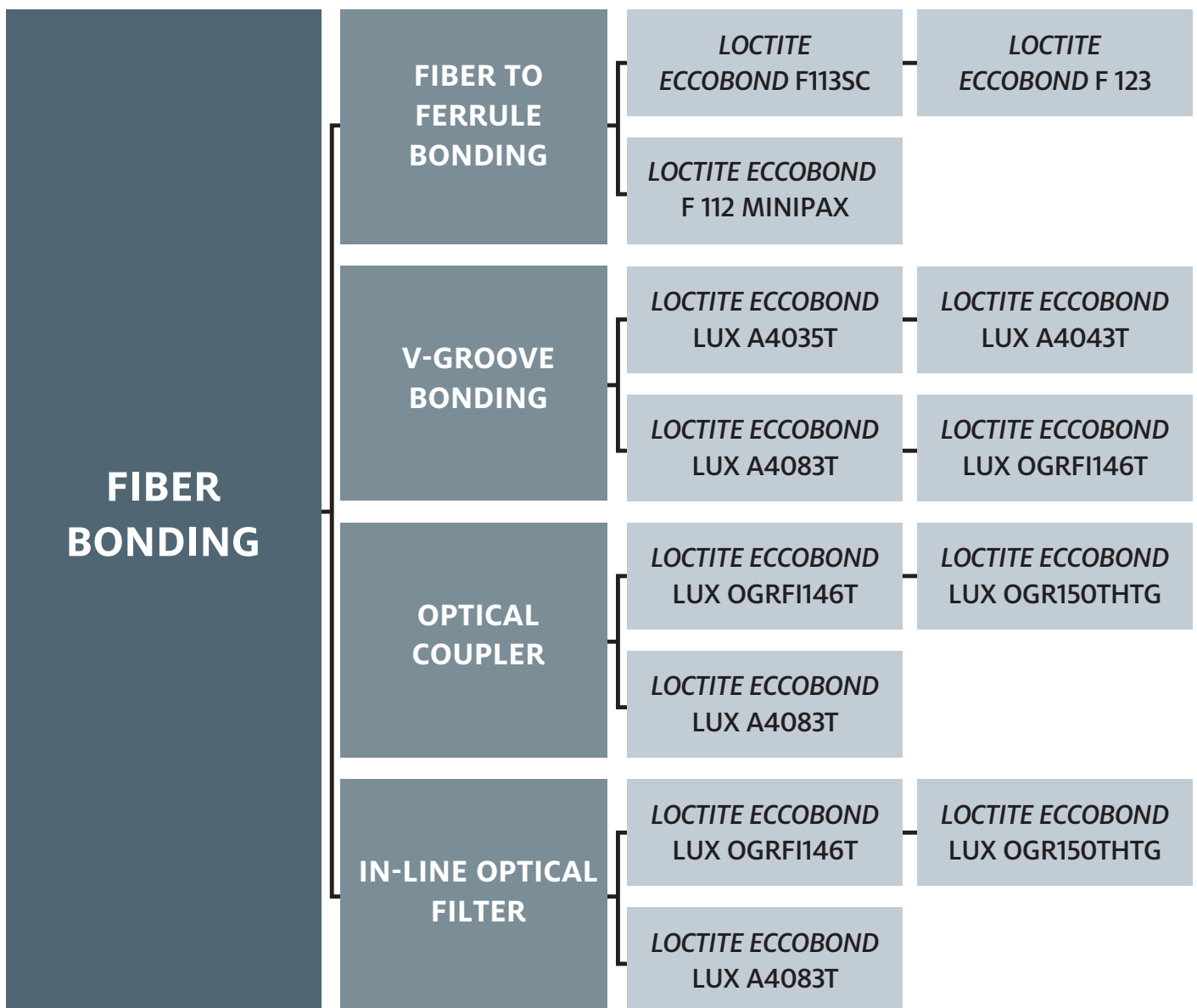
THERMAL MANAGEMENT MATERIALS	GAP PAD	BERGQUIST® GAP PAD® TGP 3004SF	BERGQUIST GAP PAD TGP HC5000	BERGQUIST GAP PAD TGP EMI1000
	GAP FILLER	BERGQUIST GAP FILLER TGF 3500 LVO	BERGQUIST GAP FILLER TGF 3600	BERGQUIST GAP FILLER TGF 4000

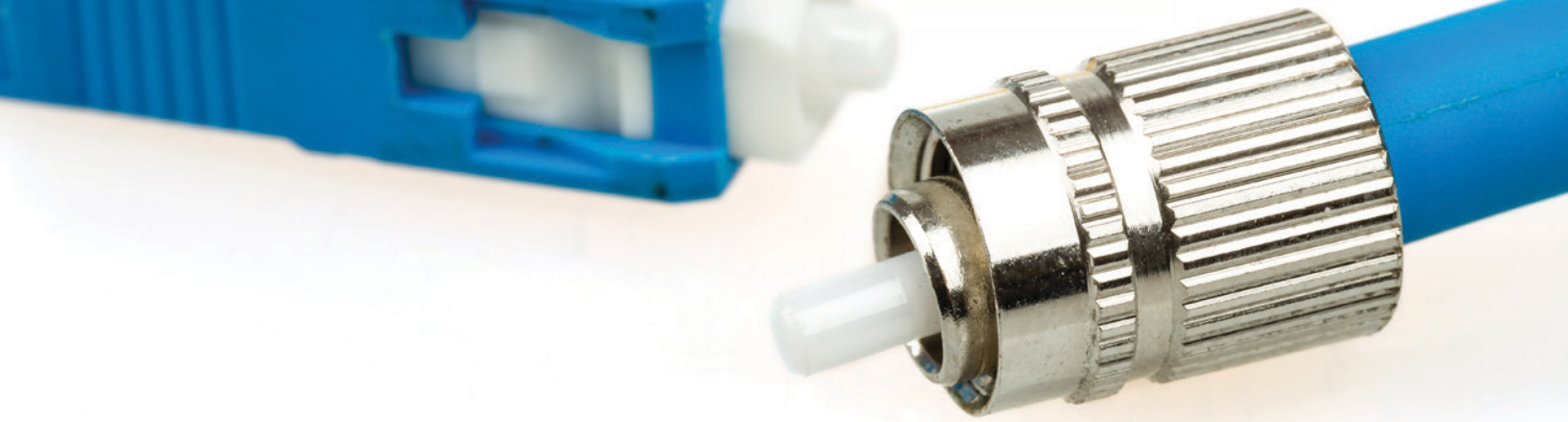
PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	THICKNESS (in/mm)	SHORE HARDNESS (SHORE 00)	THERMAL CONDUCTIVITY (W/m-K)
THERMAL PAD						
<i>BERGQUIST</i> GAP PAD TGP 3004SF	Silicone Free	Thermal Pad	<ul style="list-style-type: none"> • Silicone-Free formulation • 0.25 mil PET provides easy disassembly, leaving no residue • Tacky side allows for ease of handling and placement 	0.254 – 3.175	70	3.0
<i>BERGQUIST</i> GAP PAD TGP HC5000	Silicone	Thermal Pad	<ul style="list-style-type: none"> • High-compliance • Low compression stress • Fiberglass reinforced for shear and tear resistance 	0.508 – 3.175	35	5.0
EMI ABSORPTION						
<i>BERGQUIST</i> GAP PAD TGP EMI1000	Silicone	EMI Absorbing	<ul style="list-style-type: none"> • EMI absorbing • Highly conformable • Low hardness • Fiberglass reinforced for puncture, tear and shear resistance • Electrically isolating 	0.508 – 3.175	5	1.0
GAP FILLER						
<i>BERGQUIST</i> GAP FILLER TGF 3500LVO (TWO PARTS)	Silicone	Gap Filler	<ul style="list-style-type: none"> • Low volatility for outgassing sensitive applications • Ultra-conforming with excellent wet-out for low stress interface on applications • 100% solids - no cure by-products 	N/A	40	3.5
<i>BERGQUIST</i> GAP FILLER TGF 3600	Silicone	Gap Filler	<ul style="list-style-type: none"> • Thixotropic nature makes it easy to dispense • Two-part formulation for easy storage • Ultra-conforming - designed for fragile and low stress applications • Ambient or accelerated cure schedules 	N/A	35	3.6
<i>BERGQUIST</i> GAP FILLER TGF 4000	Silicone	Gap Filler	<ul style="list-style-type: none"> • Thickness variations • Little to no stress • 100% Solids - No cure by-products • Excellent low and high temperature chemical and mechanical stability 	N/A	75	4.0

Passive Optical Assembly

Fiber Bonding

Fiber optic cables require proper termination for optimum transmission efficiency and minimal data loss. The main fiber bonding applications include bonding and sealing fibers/ fiber bundles into a ferrule, bonding optical fiber into connectors, potting fiber bundles and bonding of v-groove arrays. As the world's leading adhesives supplier, Henkel's bonding solutions are unmatched and include epoxy adhesives that bond well to most substrates including glass, stainless steel and ceramics to ensure limited fiber displacement and mitigate interference from mechanical and thermal factors. Henkel offers dual-cure (UV/thermal), thermal cure and room temperature cure adhesives to help maintain the integrity of fiber alignment as well as protect heat-sensitive materials in the fiber optic assembly.



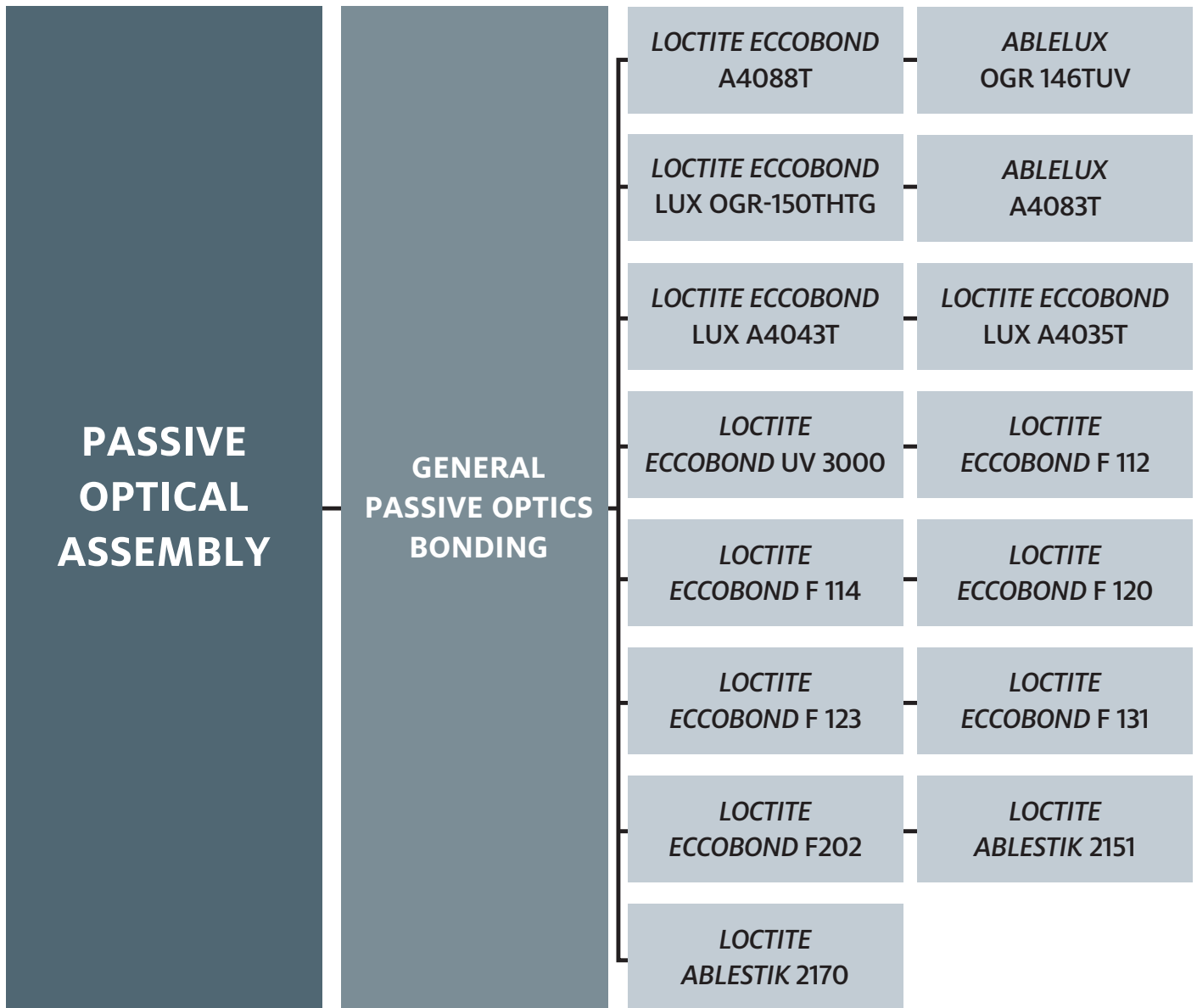


PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
FIBER TO FERRULE BONDING								
LOCTITE ECCOBOND F1135C	Epoxy	Assembly	<ul style="list-style-type: none"> Multi/ single mode connectors High T_g Low viscosity Low stress connection with no pistoning Dark blue color allow for easy polishing 	1,800	95	83D	RT/Heat	18 hr. at 25°C
LOCTITE ECCOBOND F 123	Epoxy	Assembly	<ul style="list-style-type: none"> Single Mode connectors Fast cure Low viscosity Tough adhesion to a wide variety of fiber optic and optic materials Low stress connection with no pistoning 	4,000	120	87D	Heat	5 min. at 100°C
LOCTITE ECCOBOND F 112 MINIPAX	Epoxy	Assembly	<ul style="list-style-type: none"> Multi/single mode connectors Low viscosity Thermal shock and impact resistance, Low stress connection with no pistoning 	1,800	102	86D	RT/Heat	24 hr. at 25°C or 1 hr. at 65°C
V-GROOVE BONDING								
LOCTITE ECCOBOND LUX A4035T	Acrylate	Assembly	<ul style="list-style-type: none"> Fast light cure Low viscosity Optical grade Thin bond line 	500	145	82D	UV / visible light & Heat	UV / visible light + 1 hr. at 100°C or 2 hr. at 80°C
LOCTITE ECCOBOND LUX A4043T	Acrylate	Optoelectronic	<ul style="list-style-type: none"> Strain relief Resilient optical mounts Protection of delicate components 	1,200	45	64A	UV / visible light & Heat	UV / visible light + 1 hr. at 110 °C, or 2 hr. at 90 °C
LOCTITE ECCOBOND LUX A4083T	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable Excellent adhesion Optical grade 	300	104	70D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 80 °C
LOCTITE ECCOBOND LUX OGRF1146T	Acrylate	Adhesive	<ul style="list-style-type: none"> One component Photo-curable Optical grade Low refractive index Cures in shadowed areas 	1,250	85	64D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 85 °C
OPTICAL COUPLER								
LOCTITE ECCOBOND LUX OGRF1146T	Acrylate	Adhesive	<ul style="list-style-type: none"> One component Photo-curable Optical grade Low refractive index Cures in shadowed areas 	1,250	85	64D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 85 °C
LOCTITE ECCOBOND LUX OGR150THTG	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable High T_g Fast UV cure Cures in shadowed areas Low temperature cure 	1,000	145	76D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 85 °C
LOCTITE ECCOBOND LUX A4083T	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable Excellent adhesion Optical grade 	300	104	70D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 80 °C
IN-LINE OPTICAL FILTER								
LOCTITE ECCOBOND LUX OGRF1146T	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable Optical grade Low refractive index Cures in shadowed areas 	1,250	85	64D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 85 °C
LOCTITE ECCOBOND LUX OGR150THTG	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable High T_g Fast UV cure Cures in shadowed areas Low temperature cure 	1,000	145	76D	UV / visible light & Heat	UV / visible light +1 hr. at 100 °C, or 2 hr. at 85 °C
LOCTITE ECCOBOND LUX A4083T	Acrylate	Acrylate	<ul style="list-style-type: none"> One component Photo-curable Excellent adhesion Optical grade 	300	104	70D	UV / visible light & Heat	UV / visible light + 1 hr. at 100 °C, or 2 hr. at 80 °C

Passive Optical Assembly

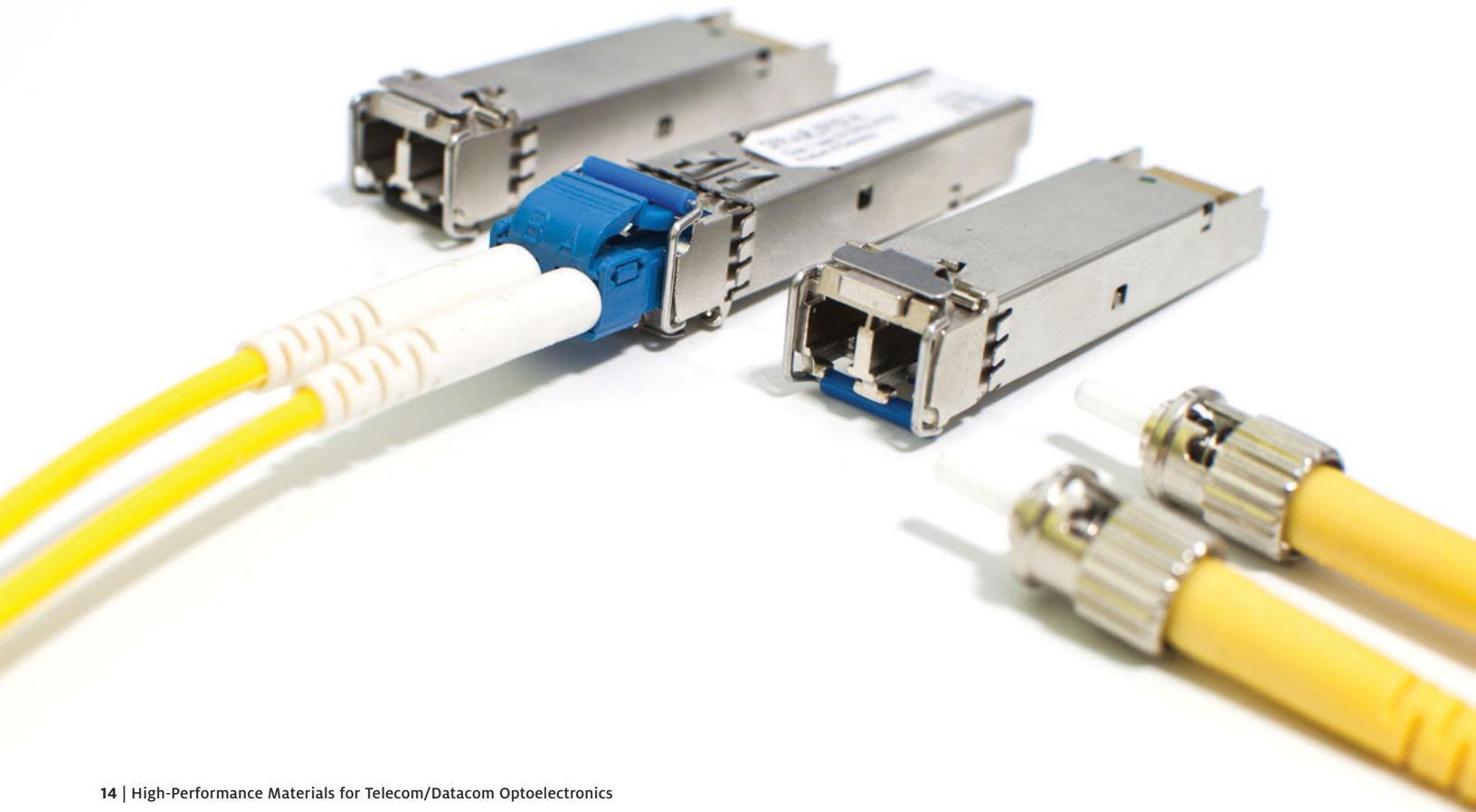
General Passive Optical Bonding

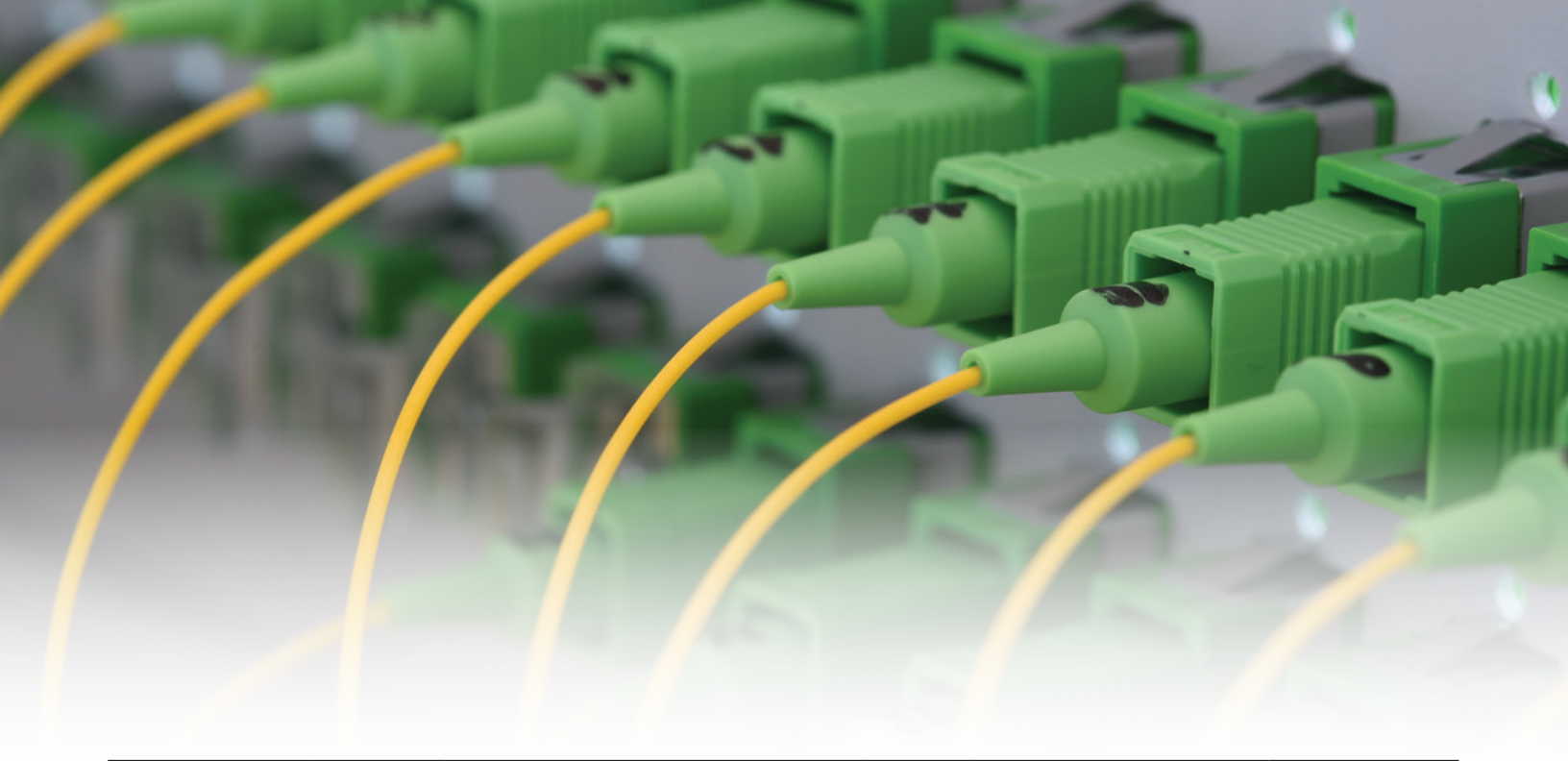
A passive optical component is primarily composed of a wavelength division multiplexer (WDM), an optical connector and an optical integrated device. The integrity of these optical devices depends on angular alignment accuracy and long-term adhesion and stability of the bonded components. Critical properties such as high strength, minimal shrinkage on cure, low CTE, matched refractive index, low outgassing and high resistance to humid environments are formulated in to Henkel's epoxy adhesives, making them ideal for bonding optical elements within optoelectronics applications.



General Passive Optical Bonding

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
ACRYLATE								
LOCTITE ECCOBOND A4088T	Acrylate	Optoelectronic	<ul style="list-style-type: none"> Enhanced temperature and humidity reliability Excellent glass and ceramic bonding 	15,000	110	70D	UV / visible light	UV
ABLELUX OGR 146TUV	Acrylate	Assembly	<ul style="list-style-type: none"> Single component Photo-curable Cures in shadowed areas Low Refractive Index 	1,250	77	60D	UV/ Heat	UV + 1 hr. at 100 °C, or 2 hr. at 85 °C
LOCTITE ECCOBOND LUX OGR-150THTG	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable High T_g Fast UV cure Cures in shadowed areas Low temperature cure 	1,000	145	76D	UV / visible light & Heat	UV / visible light +1 hr. at 100 °C, or 2 hr. at 85 °C
ABLELUX A4083T	Acrylate	Assembly	<ul style="list-style-type: none"> One component Photo-curable Excellent adhesion Optical grade 	300	104	70D	UV / visible light & Heat	UV and visible, thermal 1 hr. at 100 °C, or 2 hr. at 80 °C
LOCTITE ECCOBOND LUX A4043T	Acrylate	Optoelectronic	<ul style="list-style-type: none"> Strain relief Resilient optical mounts Protection of delicate components 	1,200	45	64A	UV / visible light & Heat	UV and visible, thermal 1 hr. at 100 °C, or 2 hr. at 90 °C
LOCTITE ECCOBOND LUX A4035T	Acrylate	Assembly	<ul style="list-style-type: none"> Fast light cure Low viscosity Optical grade Thin bond line 	500	145	82D	UV / visible light & Heat	UV and visible, thermal 1 hr. at 100 °C, or 2 hr. at 80 °C





PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T _g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
EPOXY								
LOCTITE ECCOBOND UV 3000	Epoxy	Sealant	<ul style="list-style-type: none"> • High strength • Chemical resistant • Low out gassing • Capable of 200°C • Cationic epoxy 	5,300	150	N/A	UV	UV
LOCTITE ECCOBOND F 112	Epoxy	Assembly	<ul style="list-style-type: none"> • Multi/single mode connectors • Low viscosity • Thermal shock and impact resistance • Low stress connection with no pistoning 	1,800	102	86D	RT/Heat	24 hr. at 25 °C or 1 hr. at 65 °C
LOCTITE ECCOBOND F 114	Epoxy	Assembly	<ul style="list-style-type: none"> • Low viscosity • Solvent free • Excellent wicking • Good wetting • Good adhesion • Blush free cure under high humidity 	625	53	83D	RT/Heat	24 hr. at 25 °C, or 4 hr. at 65°C
LOCTITE ECCOBOND F 120	Epoxy	Assembly	<ul style="list-style-type: none"> • Fast cure • Solvent free • Low shrinkage • Medium viscosity • Good electrical insulation • Excellent mechanical properties • Excellent chemical resistance 	Resin: 14,000 Hardner: 35,000	N/A	72D	RT/Heat	24 hr. at 25 °C, or 1 hr. at 65°C
LOCTITE ECCOBOND F 123	Epoxy	Assembly	<ul style="list-style-type: none"> • Single mode connectors • Fast cure • Low viscosity • Tough adhesion to a wide variety of fiber optic and optic materials • Low stress connection with no pistoning 	4,000	120	87D	Heat	5 min. at 100°C
LOCTITE ECCOBOND F 131	Epoxy	Opto/Photonics	<ul style="list-style-type: none"> • Room temperature cure • High T_g 	1,800	95	78D	RT/Heat	18 hr. at 25 °C, or 1 hr. at 65°C
LOCTITE ECCOBOND F202	Epoxy	Opto/Photonics	<ul style="list-style-type: none"> • Low viscosity • Excellent chemical resistance • Good adhesion to metals, ceramics, glass as well as most plastics 	1,000	130	87D	Heat	2 hr. at 125 °C + 1 hr. at 140°C
LOCTITE ABLESTIK 2151	Epoxy	Non-Conductive Adhesive	<ul style="list-style-type: none"> • Thermally conductive • Electrically insulating • High adhesion • Room temperature cure 	40,000	60	90D	RT/Heat	24 hr. at 25 °C, or 2 – 4 hr. at 65°C
LOCTITE ABLESTIK 2170	Epoxy	Non-conductive Adhesive	<ul style="list-style-type: none"> • Flexible • Thixotropic • Low viscosity • Easy application • Easy mix ratio • Room temperature cure 	3,500	10	65D	RT/Heat	25 hr. at 25 °C, or 1 hr. at 65°C

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