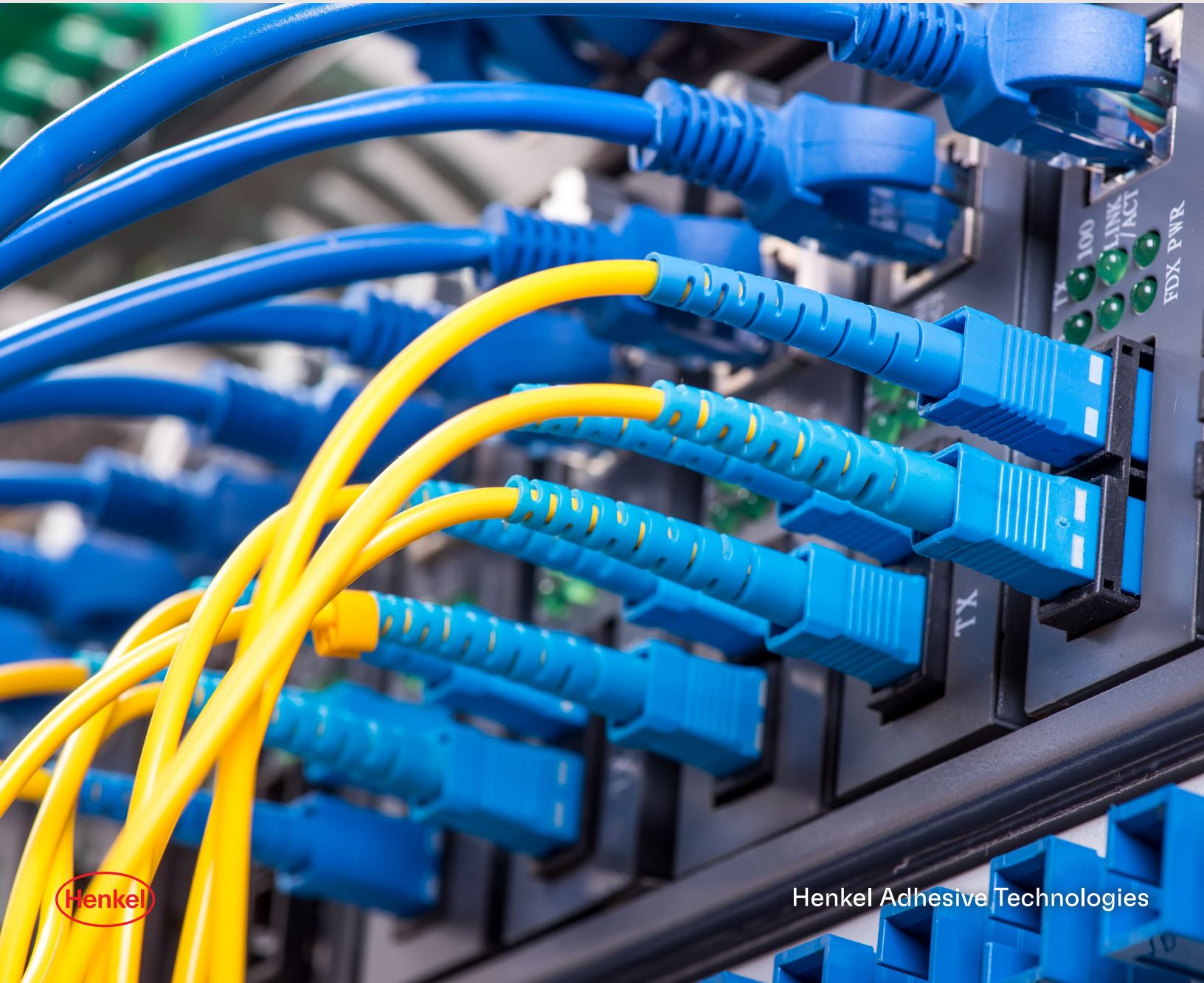
LOCTITE®

BERGQUIST®

HIGH-PERFORMANCE MATERIALS FOR

TELECOM AND DATACOM



Henkel

Henkel Adhesive Technologies

Contents

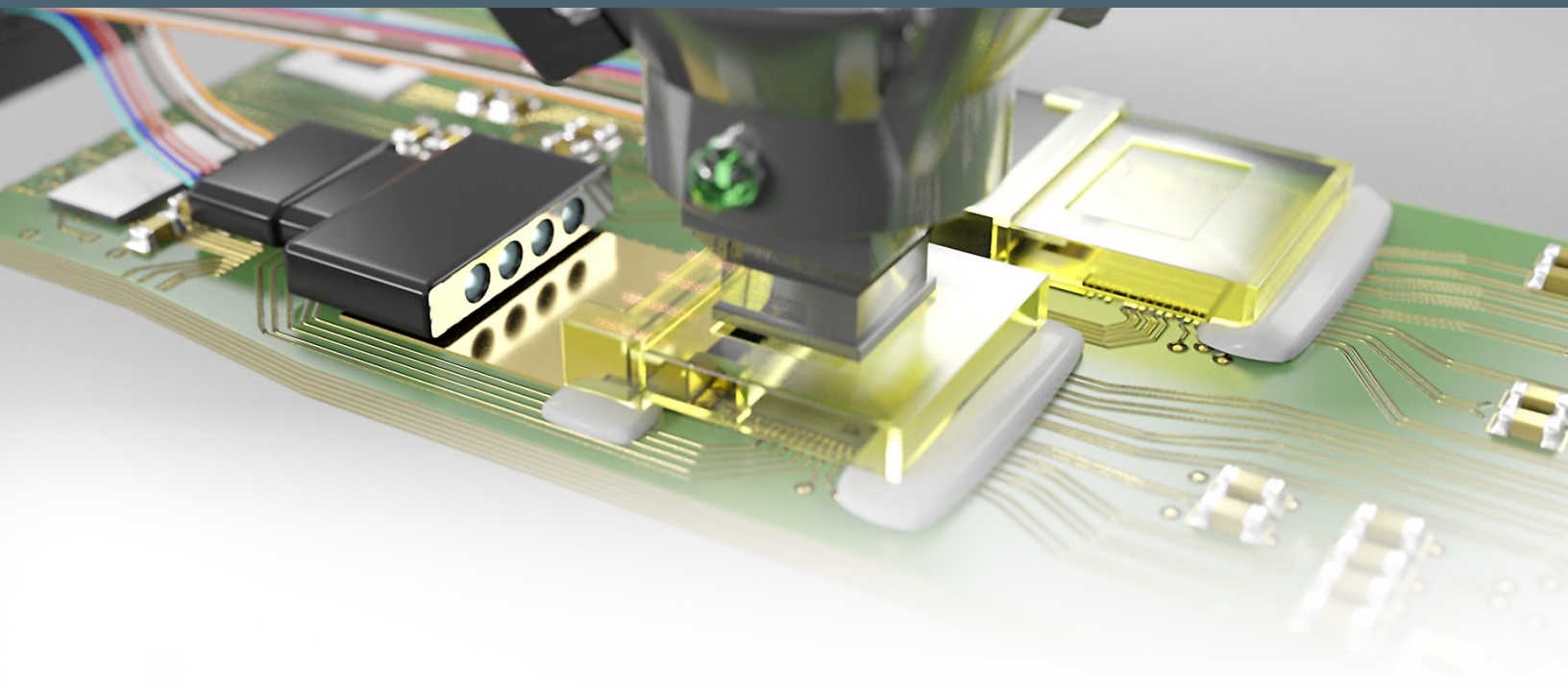
Materials for Optical Transceiver and Optical Switch

Optoelectronics: Enabling High Speed Transmission of Data for Unlimited Bandwidth Applications

Optical components including laser diodes, optical sub-assemblies (OSAs), optical transceivers and optical switches are essential for transmitting, gathering, displaying, storing and processing information, and are central to a wide variety of telecommunication and data communication applications. As data volumes multiply, the need for greater bandwidth capacity is driving the adoption of an optical wireless distributed antenna system (DAS), increasing the quantity of fiber to the x (FTTX) connections, and expanding the deployment of optical components to accommodate the high volume of global network traffic. Optical transceivers are typically hot pluggable devices that utilize laser diodes and photodiodes for high speed data transmission over fiber optic cable in high bandwidth applications. Part of the solution for high data transfer rates and improved telecom network availability lies in wavelength selective switch (WSS)-based reconfigurable optical add-drop multiplexer (ROADM) systems. These platforms, which are critical for telecom performance, enable effortless, flexible management of wavelengths, and monitoring of network optimization.

Focused Expertise and Solutions

Multiple optical components within optical modules – OSAs, fiber array units, optics for coupling, wavelength separators/combiners, and optics for focus and switching devices – must be precisely aligned and durably bonded for reliable long-term function. To address these requirements, Henkel has developed a full portfolio of materials designed to facilitate the demands of optical component assembly and performance so that customers can consistently meet the optical module functionality and reliability expectations.

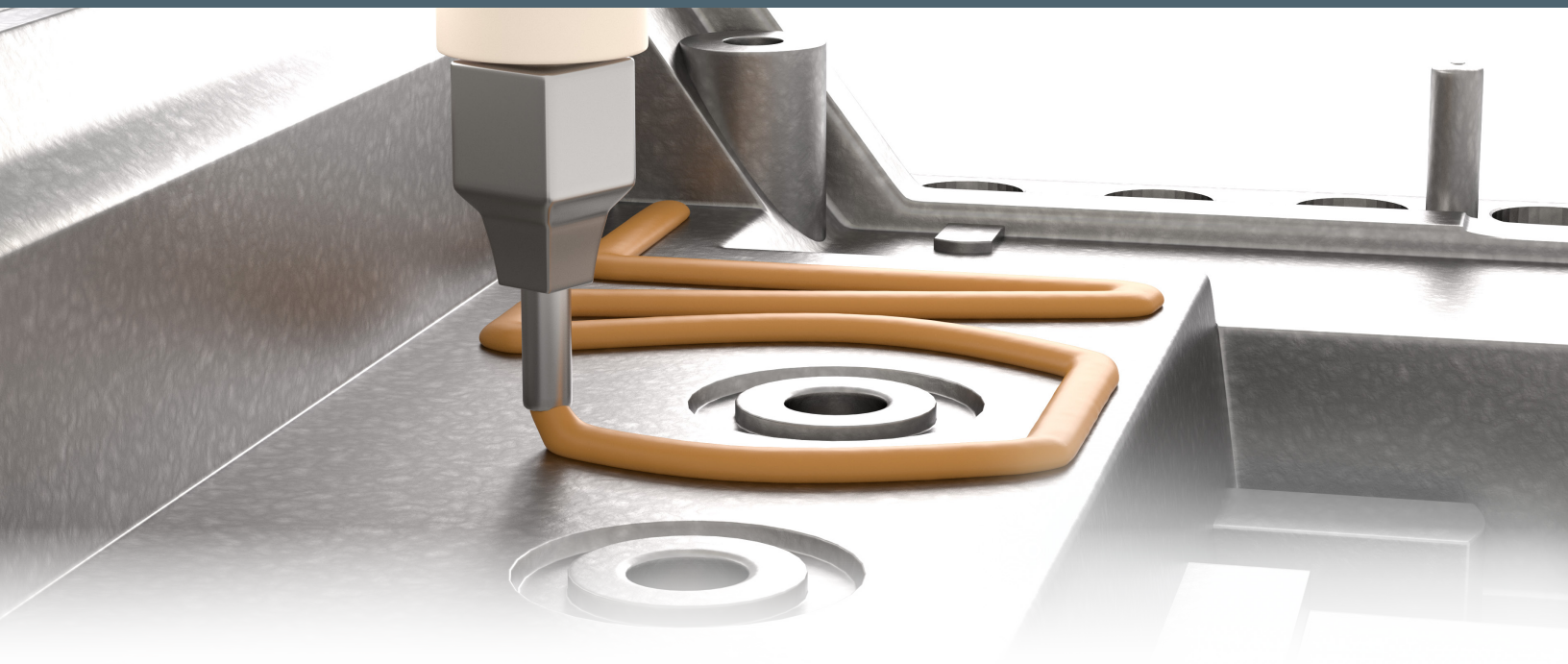


Robust and Reliable Bonds

Optical communication devices such as optical transceivers, optical switches and optical components must deliver maximum light into the optical fiber to enable high speed data transmission and high bandwidth applications. Henkel's broad portfolio of adhesives for die attach, optical sub-assembly, module assembly, lens bonding, sealing, light path and fiber bonding provide cure flexibility and processing adaptability.

- **Die attach adhesives** provide strong die bonding for reliable laser diodes. Available in multiple formulations and mediums, Henkel's innovation in die attach development continues to deliver high performance, cost-competitive application solutions.
- **Dual cure UV adhesives** are designed to precisely align optical components and facilitate maximum optical signal strength through low shrinkage, low coefficient of thermal expansion (CTE) and high integrity light transmittance.
- **Module assembly materials**, available in dual cure and thermal only options, provide reliable bonding and sealing of lenses, front covers and housings.
- **Light path adhesives** are photocurable and have a matched refractive index (RI) to enhance productivity and minimize power loss in optical fibers, FAUs and optical devices.

All Henkel optical adhesives are formulated with maximized light transmittance objectives prioritized. Critical properties such as high bond strength, minimal shrinkage on cure, low CTE, matched RI, low outgassing and high resistance to humidity are built into Henkel optoelectronic materials.



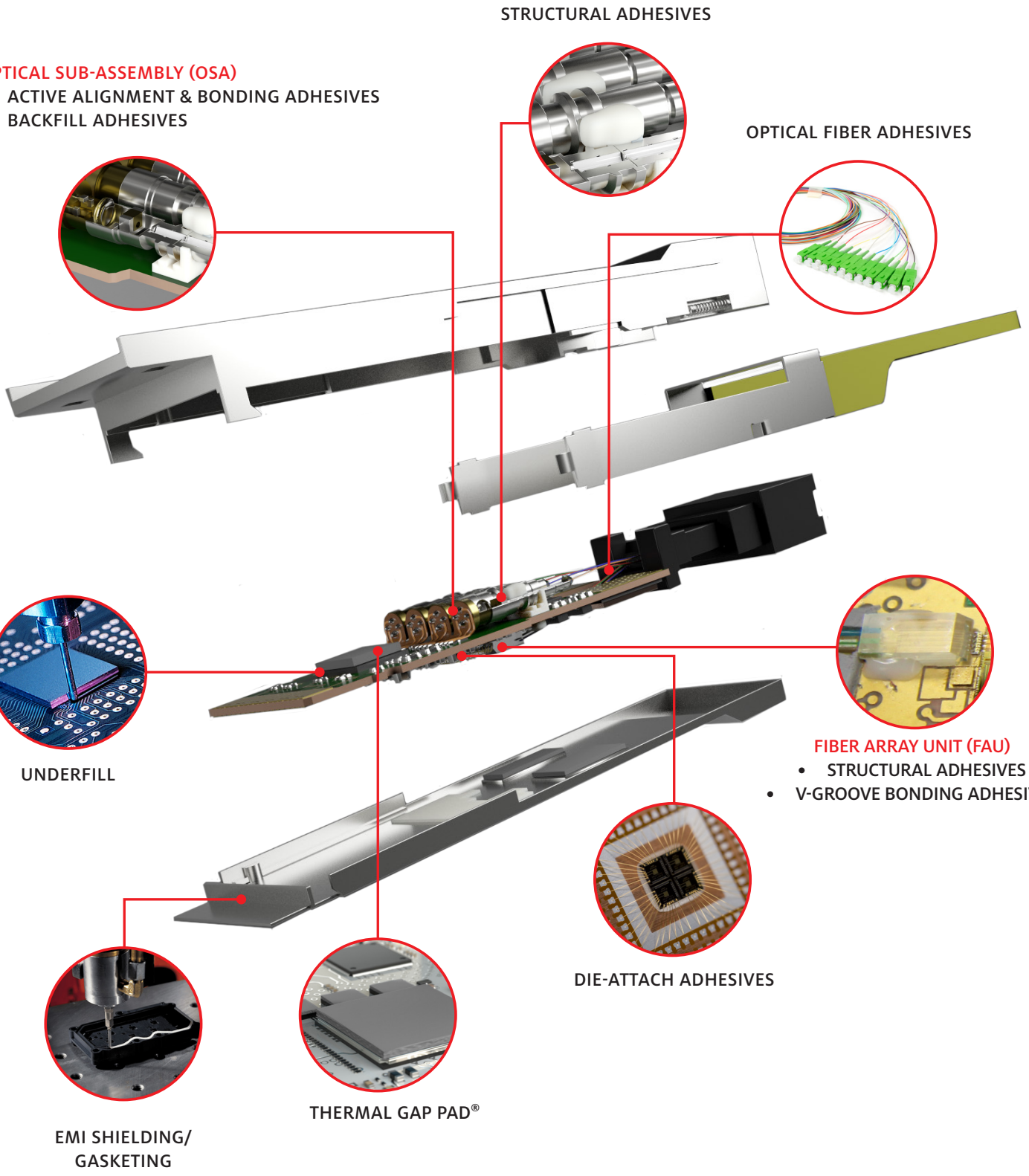
Reliable Module Protection

Henkel's range of protecting materials for optical modules and components includes underfills and encapsulants that defend delicate connections against stress and vibration, and EMI shielding pastes and coatings that minimize signal interference. These materials are available in various chemistry platforms to accommodate process preferences, performance objectives and compatibility with multiple substrates including metals and plastics.

High Performance Thermal Management

Efficient thermal management is one of the most pressing issues in electronics today. As board densities increase and higher-functioning, smaller form factor components become the norm, managing the heat has become challenging. The ICs CMOS within the optical transceiver and optical switch is a case-in-point: the processing speeds of these devices require higher power and, therefore, result in increased heat generation. The thermal load must be dissipated if optimized performance is the objective. Safeguarding the in-field reliability of transceivers, optical switches and other optical modules require flexible and robust thermal management solutions. Henkel's *BERGQUIST* brand thermal interface materials (TIMs) have been delivering this capability for decades. Liquid, pad, adhesive and gel TIMs from Henkel allow for process adaptability, while thermal conductivity and low assembly stress are balanced for outstanding performance within optical modules.

Materials Solutions for 100G Optical Transceivers

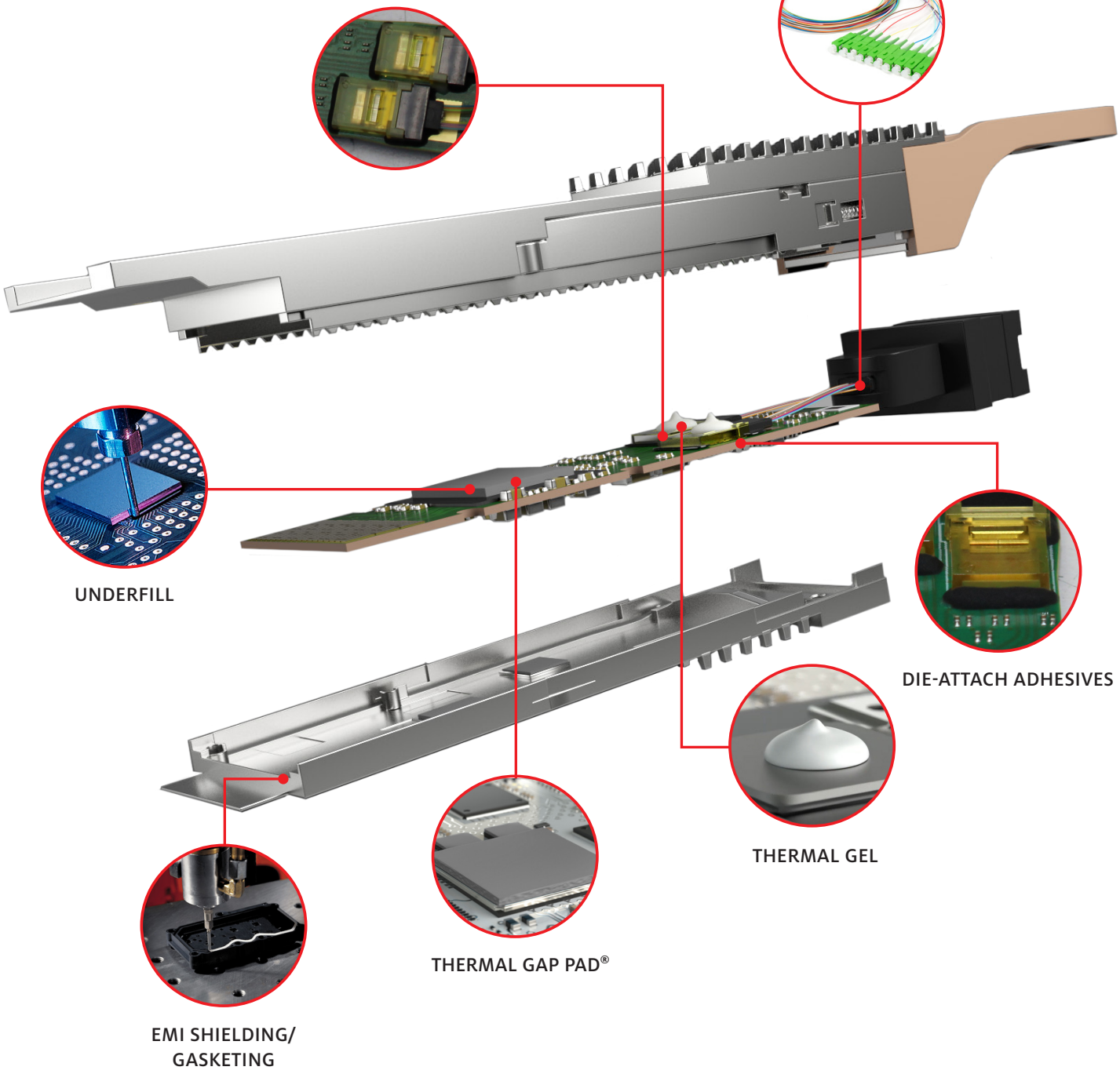


Material Solutions for 400G Optical Transceivers

OPTICAL SUB-ASSEMBLY (OSA)

- ACTIVE ALIGNMENT & BONDING ADHESIVES
- STRUCTURAL ADHESIVES

OPTICAL FIBER ADHESIVES



UNDERFILL

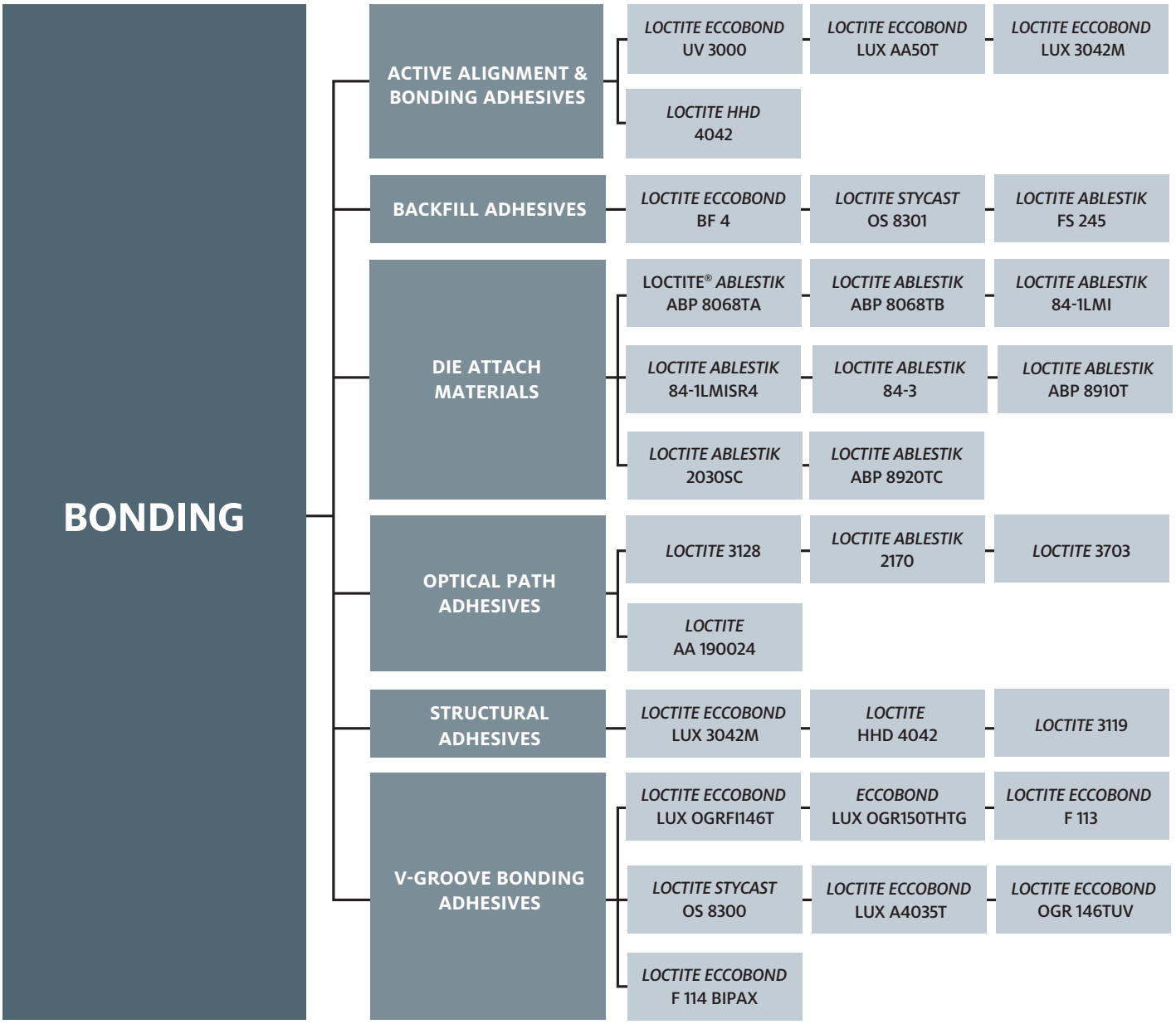
DIE-ATTACH ADHESIVES

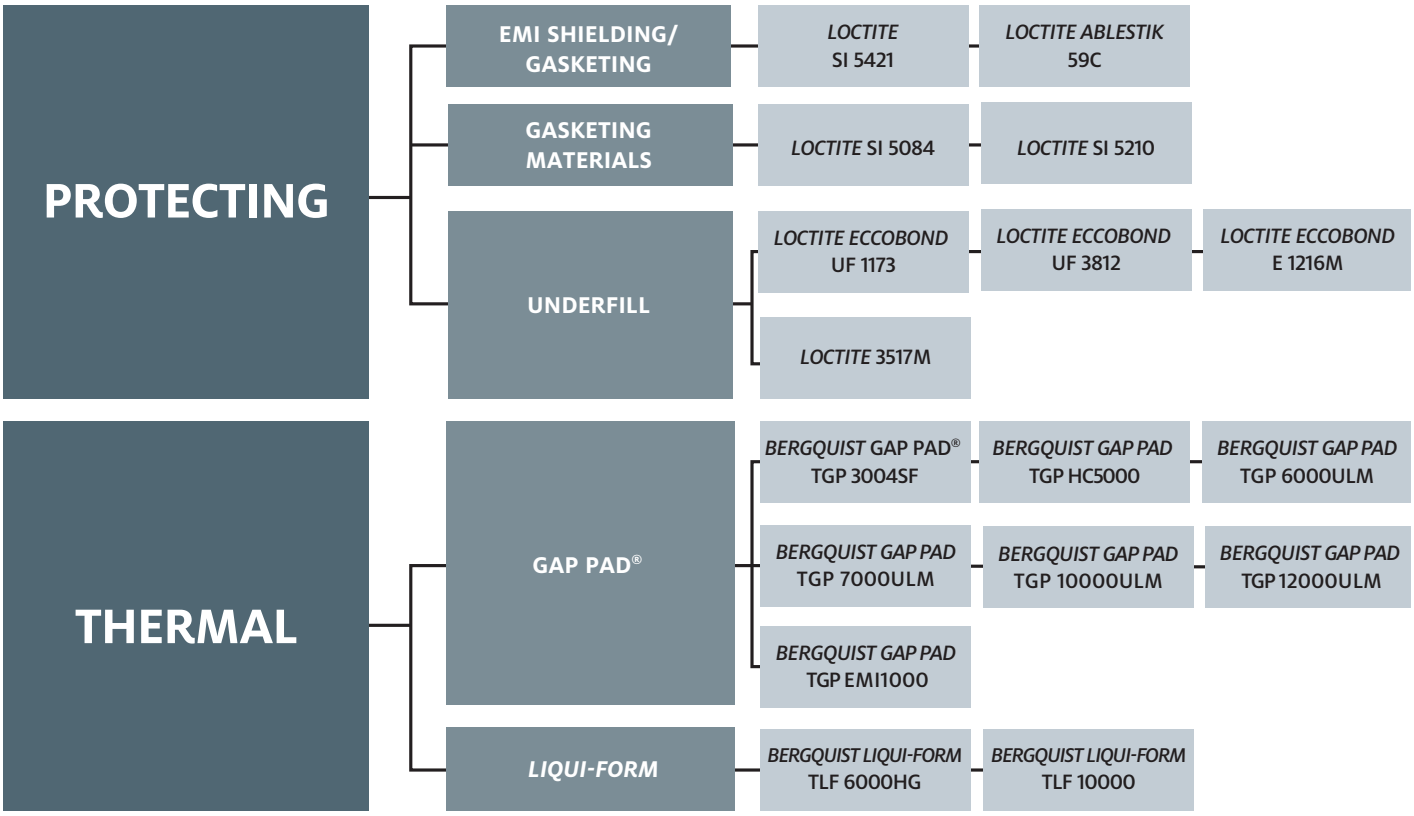
THERMAL GEL

THERMAL GAP PAD®

EMI SHIELDING/
GASKETING

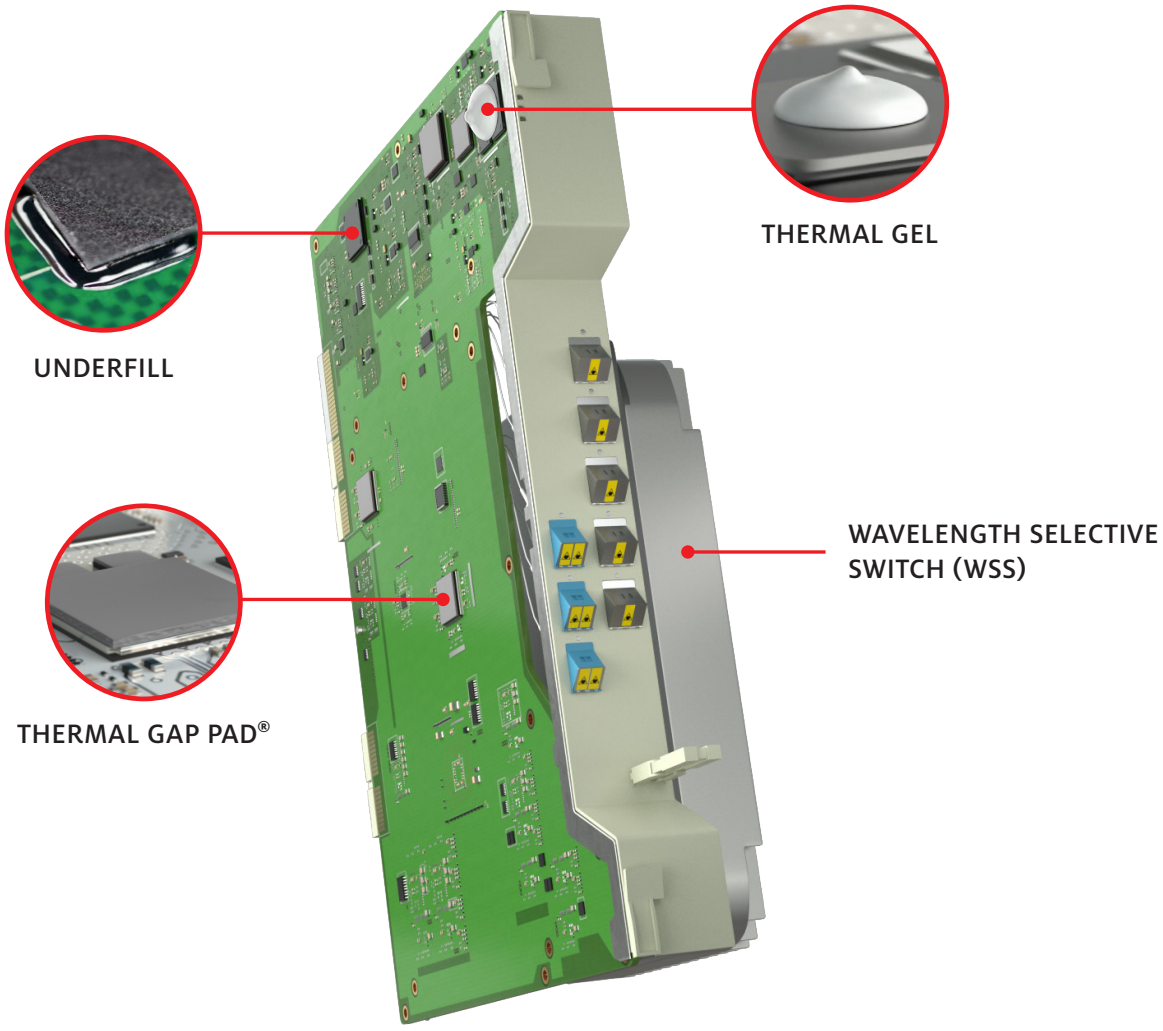
Material Solutions for 100G & 400G Optical Transceivers



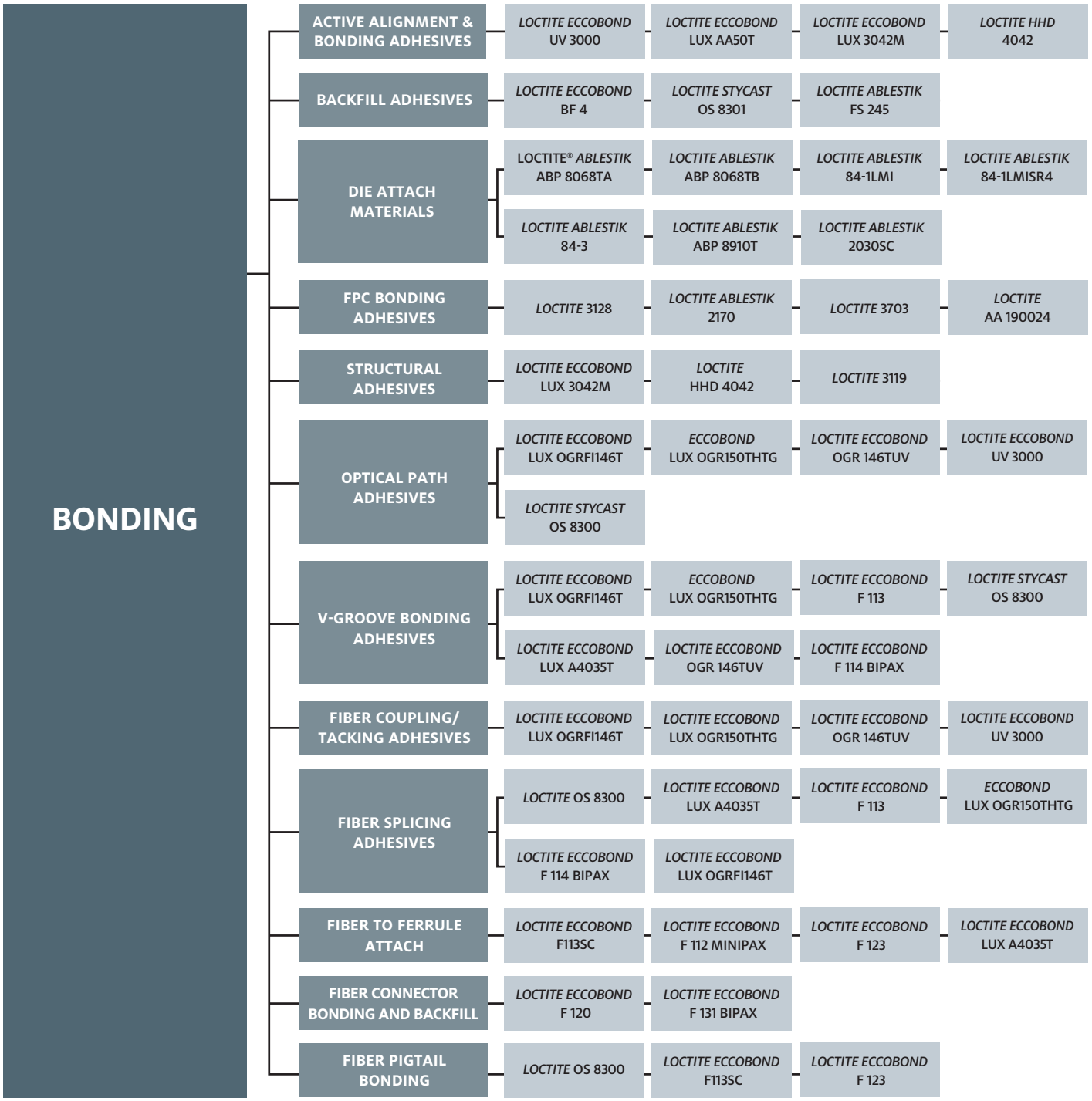

PROTECTING
EMI SHIELDING/ GASKETING
LOCTITE SI 5421
LOCTITE ABLESTIK 59C
GASKETING MATERIALS
LOCTITE SI 5084
LOCTITE SI 5210
UNDERFILL
LOCTITE ECCOBOND UF 1173
LOCTITE ECCOBOND UF 3812
LOCTITE ECCOBOND E 1216M
LOCTITE 3517M
THERMAL
GAP PAD®
BERGQUIST GAP PAD® TGP 3004SF
BERGQUIST GAP PAD TGP HC5000
BERGQUIST GAP PAD TGP 6000ULM
BERGQUIST GAP PAD TGP 7000ULM
BERGQUIST GAP PAD TGP 10000ULM
BERGQUIST GAP PAD TGP12000ULM
BERGQUIST GAP PAD TGP EMI1000
LIQUI-FORM
BERGQUIST LIQUI-FORM TLF 6000HG
BERGQUIST LIQUI-FORM TLF 10000

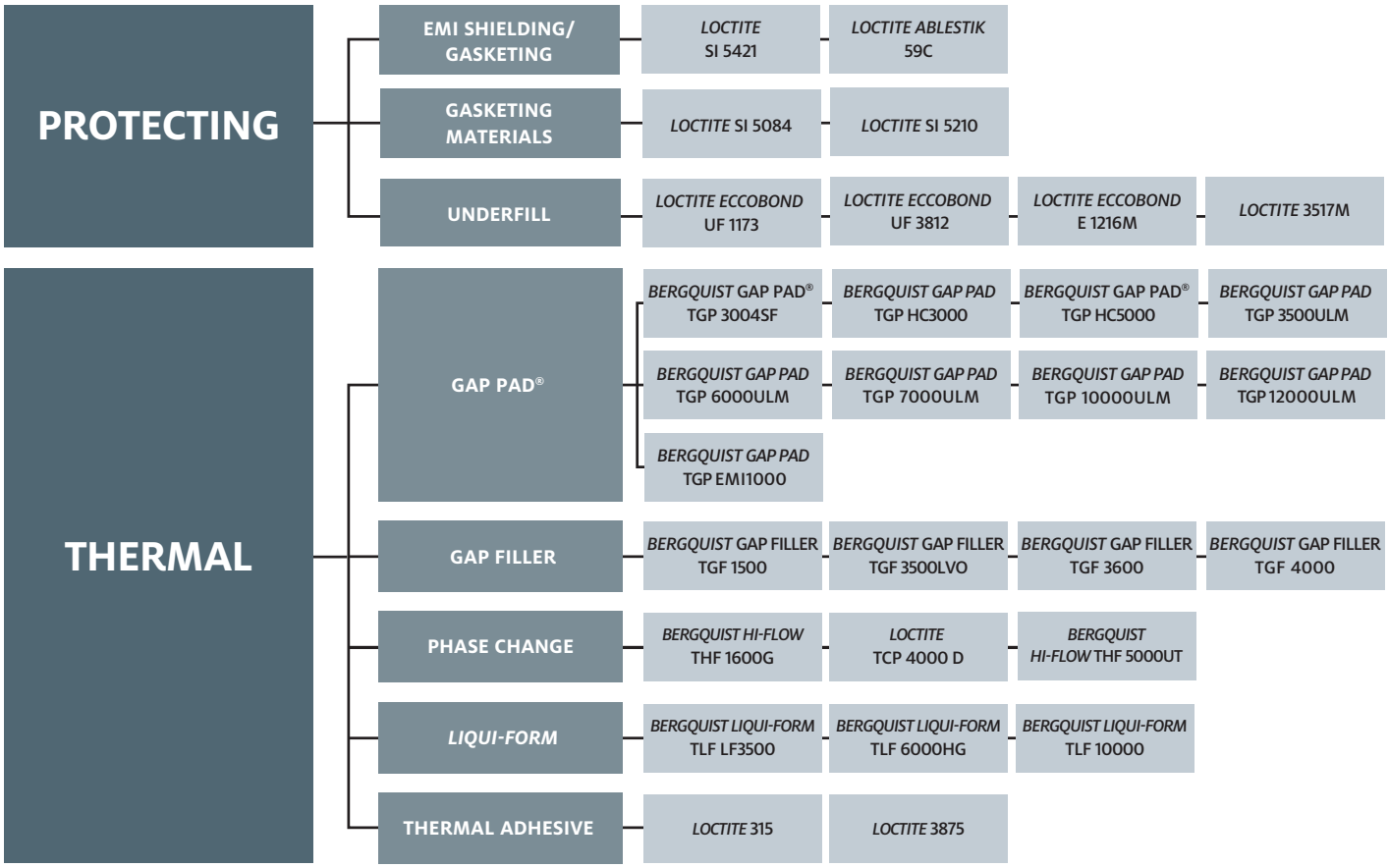
Material Solutions for Wavelength Selective Switch (WSS)

Material Solutions for Reconfigurable Optical Add-drop Multiplexer (ROADM)



Material Solutions for Optical Switch (WSS & ROADM)

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GAP PAD®
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BERGQUIST GAP PAD TGP HC3000
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BERGQUIST GAP PAD TGP 3500ULM
BERGQUIST GAP PAD TGP 6000ULM
BERGQUIST GAP PAD TGP 7000ULM
BERGQUIST GAP PAD TGP 10000ULM
BERGQUIST GAP PAD TGP 12000ULM
BERGQUIST GAP PAD TGP EM11000
GAP FILLER
BERGQUIST GAP FILLER TGF 1500
BERGQUIST GAP FILLER TGF 3500LVO
BERGQUIST GAP FILLER TGF 3600
BERGQUIST GAP FILLER TGF 4000
PHASE CHANGE
BERGQUIST HI-FLOW THF 1600G
LOCTITE TCP 4000 D
BERGQUIST HI-FLOW THF 5000UT
LIQUI-FORM
BERGQUIST LIQUI-FORM TLF LF3500
BERGQUIST LIQUI-FORM TLF 6000HG
BERGQUIST LIQUI-FORM TLF 10000
THERMAL ADHESIVE
LOCTITE 315
LOCTITE 3875

Bonding Materials for Optical Modules and Components

Active Alignment and Bonding Adhesives

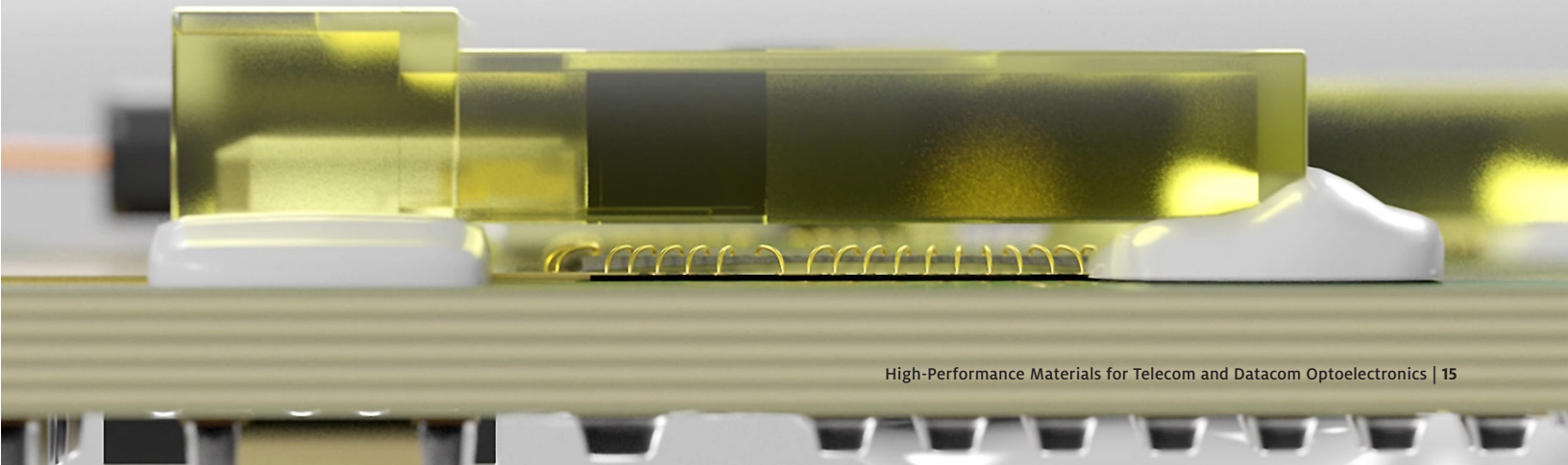
PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	COEFFICIENT OF THERMAL EXPANSION, CTE (ppm/°C)		CURE TYPE	CURE SCHEDULE
						Below T_g	Above T_g		
ACTIVE ALIGNMENT									
LOCTITE® *ECCOBOND* UV 3000	Epoxy	Sealant	• High strength • Chemical resistant • Low outgassing • Capable of 200°C • Cationic epoxy	5,300	150	–	–	UV	UV
LOCTITE ECCOBOND LUX 3042M	Acrylate	Assembly	• One component • Dual cure system • Good adhesion on PEI plastics, FR4 and various other substrates	85,000	114	87	174	UV & Heat	UV + 30 min. at 120°C
LOCTITE HHD 4042	Epoxy/Acrylate	Assembly	• 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
LOCTITE® *ECCOBOND* LUX AA50T	Acrylate	Active alignment	• 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

Back Fill Adhesives

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		
LOCTITE ECCOBOND BF 4	Epoxy	Back fill	• Low outgassing • Low moisture absorption • High T_g • Non-conductive	23,500	94	32	87	Heat	30 min. at 100°C
LOCTITE STYCAST OS 8301	Epoxy	Active alignment	• Excellent adhesion • Low weight loss • High T_g	7,500	105	55	184	Hot air drying	60 min. at 150°C
LOCTITE ABLESTIK FS 245	Epoxy	Back fill	• 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

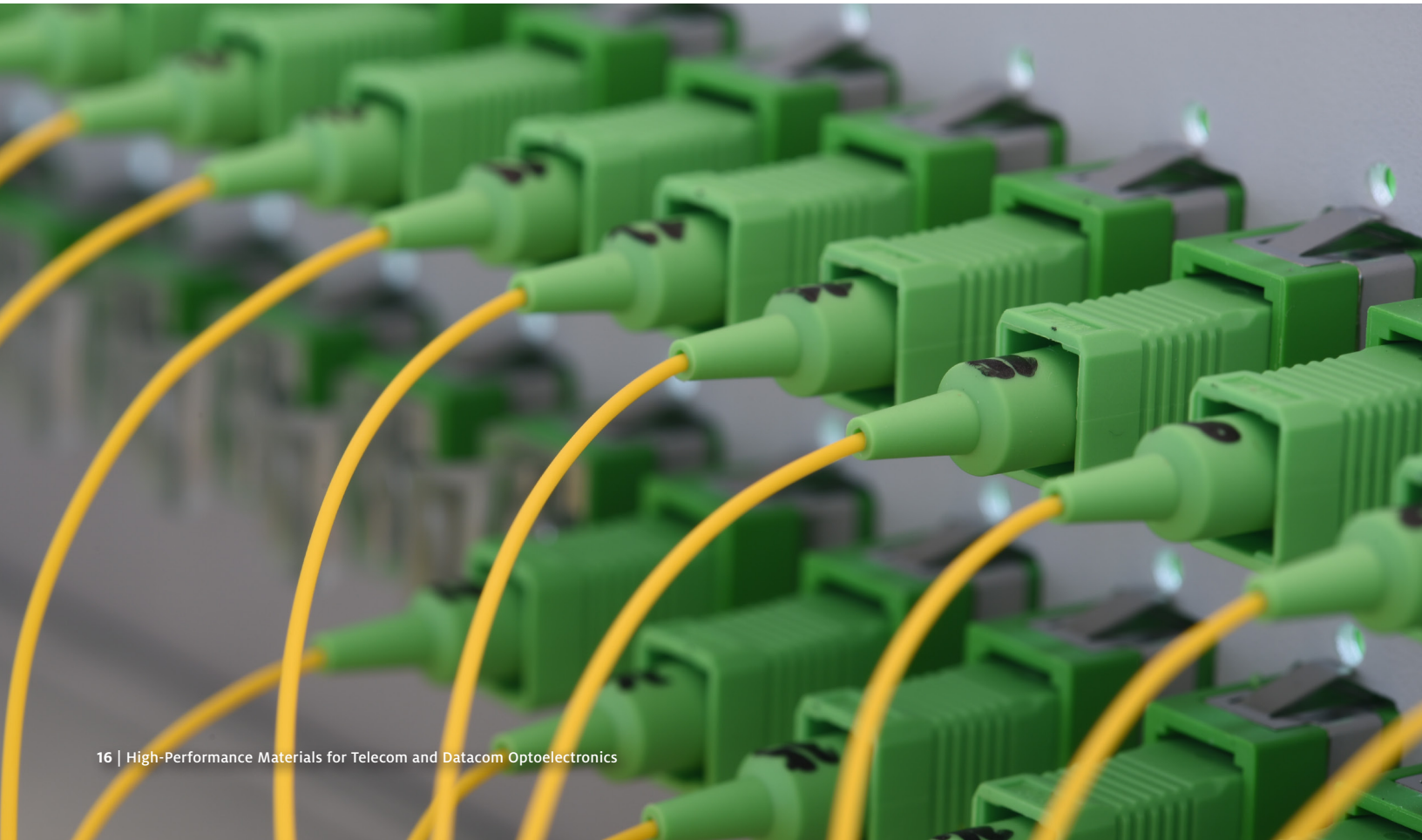
Die-Attach Adhesives

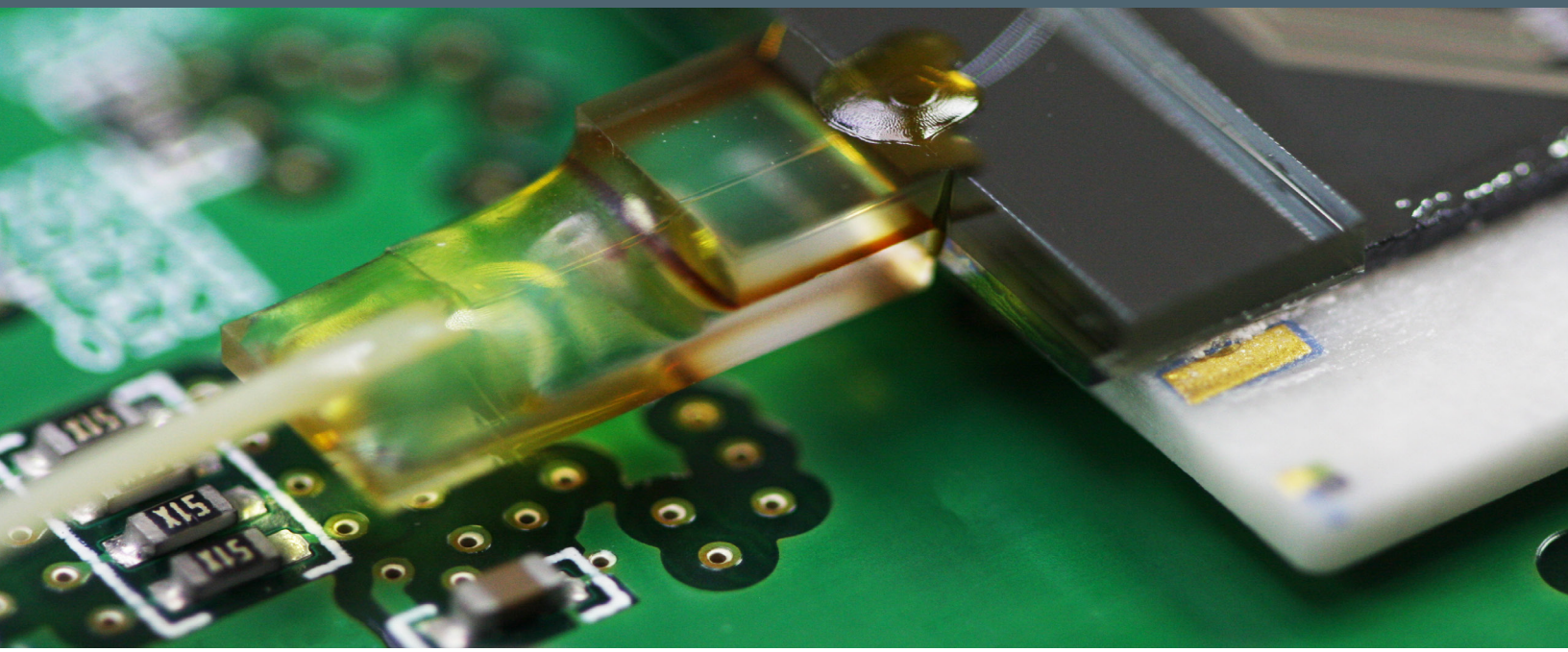
PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	THERMAL CONDUCTIVITY (W/m•K)	CURE TYPE	CURE SCHEDULE
LOCTITE ABLESTIK ABP 8068TA	Semi-sintering	Conductive adhesive	• One component • Dispensable • Printable low-temperature cure semi-sintering paste • High lead solder replacement • High thermal conductivity • High reliability	9,000	–	110	Heat	**For 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 N_2 or air oven **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 N_2 or air oven
LOCTITE ABLESTIK ABP 8068TB	Semi-sintering	Conductive adhesive	• No resin bleed-out • One component • Good workability • Printable low-temperature cure semi-sintering paste • Good electrical stability • High thermal stability • High reliability • Solder replacement	11,500	25	110	Heat	**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 N_2 or air oven. **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 N_2 or air oven
LOCTITE ABLESTIK 84-1LMI	Epoxy	Die-attach	• 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	• Conductive • Excellent dispensability • Minimal tailing and stringing	8,000	120	2.5	Heat	60 min. at 175°C
LOCTITE ABLESTIK ABP 8910T	BMI hybrid	Die-attach	• 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	• Non-conductive • Solvent free formulation • Long work life	50,000	85	0.8	Heat	60 min. at 150°C
LOCTITE ABLESTIK 2030SC	Proprietary hybrid chemistry	Die-attach	• Snap curable • Low Stress	11,600	–	2.3	Heat	90 sec. at 110°C
LOCTITE ABLESTIK ABP 8920TC	BMI hybrid	Electronic material, semiconductor die attach paste	• High MRT performance • High thermal conductivity • Good adhesion • Good electrical insulation • Small and controlled particle size	16,000	49	3.0	Heat	30 min. ramp to 175°C, hold for 1 hr. in air or N2



Optical Fiber Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE® 3128	Epoxy	Bonding heat sensitive components	• Low cure temperature • Excellent adhesion on wide range of materials • Typical applications: memory cards, CCD/CMOS assemblies	7,000 – 27,000	45	88D	Heat	30 min. at 80°C
LOCTITE ABLESTIK 2170	Epoxy	Non-conductive adhesive	• 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
LOCTITE 3703	Acrylic	Bonding	• Load bearing and shock absorbing characteristics • Thixotropic • Excellent adhesion to a wide variety of substrates: glass, plastics and most metals	18,000 –35,000	–	–	Ultraviolet (UV)/ visible light	30 mW/cm², measured at 365 nm, for 80 sec. using a Zeta® s7410 light source
LOCTITE ABLESTIK AA 190024	Acrylic	Bonding	• Load bearing and shock absorbing characteristics • Thixotropic • Excellent adhesion to a wide variety of substrates: glass, plastics and most metals	18,000 –35,000	–	–	Ultraviolet (UV)/ visible light	30 mW/cm², measured at 365 nm, for 80 sec. using a Zeta® s7410 light source





Optical Path Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	REFRACTIVE INDEX (RI)	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE ECCOBOND LUX OGRFI146T	Acrylate	Adhesive	• One component • Photo-curable • Optical grade • Low refractive index • Cures in shadowed areas	• 1.463 at 589 nm • 1.457 at 830 nm • 1.452 at 1,320 nm • 1.449 at 1,550 nm	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	• One component • Photo-curable • High T_g • Fast UV cure • Cures in shadowed areas • Low-temperature cure	• 1.5202 at 589 nm • 1.5123 at 830 nm • 1.5061 at 1,320 nm • 1.5038 at 1,550 nm	1,000	145	76D	UV / visible light & Heat	UV/visible light + 1 hr. at 100°C, or 2 hr. at 85°C
LOCTITE ECCOBOND OGR 146TUV	Acrylate	Adhesive	• Single component • Photocurable • Cures in shadowed areas • Low refractive Index	• 1.464 at 589 nm • 1.462 at 633 nm • 1.458 at 830 nm • 1.455 at 1,320 nm • 1.454 at 1,550 nm	1,250	77	60D	Ultraviolet (UV) light	UV 365 nm wavelength, 1 hr. at 100°C or 2 hr. at 85°C
LOCTITE® *ECCOBOND* UV 3000	Epoxy	Sealant	• High strength • Chemical resistant • Low outgassing • Capable of 200°C • Cationic epoxy	–	5,300	150	N/A	UV	UV
LOCTITE STYCAST OS 8300	Epoxy	Assembly	• Two components – requires mixing • High spectral transmission • Excellent adhesion • Low weight loss • Low halogen content	• 1.5683 at 25°C 589 nm	4,000	103	85D	Heat	60 min. at 150°C

Bonding Materials for Optical Modules and Components – Continued

Structural Adhesives

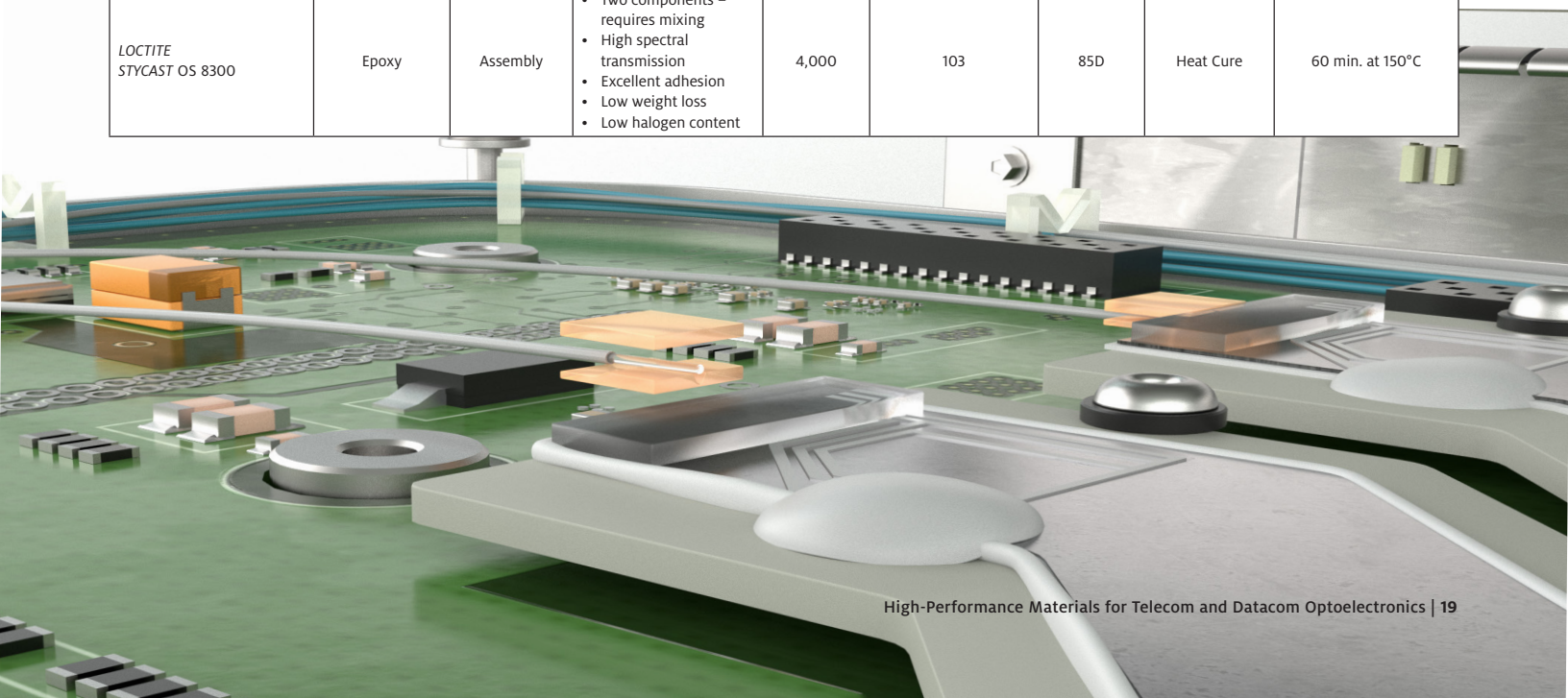
PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	CURE TYPE	CURE SCHEDULE
LOCTITE® *ECCOBOND* LUX 3042M	Acrylate	Assembly	• One component • Dual cure system • Good adhesion on PEI plastics, FR4 and various other substrates	85,000	114	UV & Heat	UV + 30 min. at 120°C
LOCTITE HHD 4042	Epoxy/Acrylate	Assembly	• 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
LOCTITE ABLESTIK 3119	Epoxy	Bonding	• Low-temperature 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

FPC Bonding Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE 3128	Epoxy	Bonding heat sensitive components	• Low cure temperature • Excellent adhesion on wide range of materials • Typical applications: memory cards, CCD/CMOS assemblies	7,000 – 27,000	45	88D	Heat	30 min. at 80°C
LOCTITE ABLESTIK 2170	Epoxy	Non-conductive adhesive	• 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
LOCTITE 3703	Acrylic	Bonding	• Load bearing and shock absorbing characteristics • Thixotropic • Excellent adhesion to a wide variety of substrates: glass, plastics and most metals	18,000 –35,000	–	–	Ultraviolet (UV)/ visible light	30 mW/cm², measured at 365 nm, for 80 sec. using a Zeta® s7410 light source
LOCTITE ABLESTIK AA 190024	Acrylic	Bonding	• Load bearing and shock absorbing characteristics • Thixotropic • Excellent adhesion to a wide variety of substrates: glass, plastics and most metals	18,000 –35,000	–	–	Ultraviolet (UV)/ visible light	30 mW/cm², measured at 365 nm, for 80 sec. using a Zeta® s7410 light source

V-groove Bonding Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE ECCOBOND LUX OGRFI146T	Acrylate	Adhesive	• 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 A4035T	Acrylate	Assembly	• Single Pack • Photocurable • Optical grade • Thin bondline	500	145	82D	Ultraviolet (UV) light, Visible light and Heat cure	Ultraviolet (UV) light: 365 UV wavelength, (nm) Light Intensity at bondline: 50 mW/cm²
LOCTITE ECCOBOND LUX OGR150THTG	Acrylate	Assembly	• 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 OGR 146TUV	Acrylate	Adhesive	• Single component • Photocurable • Cures in shadowed areas • Low refractive Index	1,250	77	60D	Ultraviolet (UV) light	UV 365 nm wavelength, 1 hr. at 100°C or 2 hr. at 85°C
LOCTITE ECCOBOND F 113	Epoxy	Assembly	• Low viscosity • Optically clear • Resistant to mechanical impact • Excellent wettability • Excellent thermal shock resistance	180	45	78D	Room Temperature or Heat Cure	24 hr. at 25°C or 1 – 2 hr. at 65°C
LOCTITE ECCOBOND F 114 BIPAX	Epoxy	Assembly	• Low viscosity • Solvent free • Excellent wicking • Good wetting • Good adhesion • Blush free cure under high humidity	625	53	83D	Room Temperature or Heat Cure	24 hr. at 25°C, or 4 hr. at 65°C
LOCTITE STYCAST OS 8300	Epoxy	Assembly	• Two components – requires mixing • High spectral transmission • Excellent adhesion • Low weight loss • Low halogen content	4,000	103	85D	Heat Cure	60 min. at 150°C



Bonding Materials for Optical Modules and Components – Continued

Fiber Coupling / Tacking Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE® *ECCOBOND* LUX OGRFI146T	Acrylate	Adhesive	• 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	• 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 OGR 146TUV	Acrylate	Adhesive	• Single component • Photocurable • Cures in shadowed areas • Low refractive Index	1,250	77	60D	Ultraviolet (UV) light	UV 365 nm wavelength, 1 hr. at 100°C or 2 hr. at 85°C
LOCTITE STYCAST OS 8300	Epoxy	Assembly	• Two components – requires mixing • High spectral transmission • Excellent adhesion • Low weight loss • Low halogen content	4,000	103	85D	Heat	60 min. at 150°C

Fiber Splicing Adhesive

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE STYCAST OS 8300	Epoxy	Assembly	• Two components – requires mixing • High spectral transmission • Excellent adhesion • Low weight loss • Low halogen content	4,000	103	85D	Heat	60 min. at 150°C
LOCTITE ECCOBOND LUX A4035T	Acrylate	Assembly	• Single Pack • Photocurable • Optical grade • Thin bondline	500	145	82D	Ultraviolet (UV) light, visible light and heat cure	Ultraviolet (UV) light: 365 UV wavelength, (nm) Light Intensity at bondline: 50 mW/cm²
LOCTITE ECCOBOND F 113	Epoxy	Assembly	• Low viscosity • Optically clear • Resistant to mechanical impact • Excellent wettability • Excellent thermal shock resistance	180	45	78D	Room temperature or heat cure	24 hr. at 25°C or 1 – 2 hr. at 65°C
LOCTITE ECCOBOND LUX OGR150THTG	Acrylate	Assembly	• 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 F 114 BIPAX	Epoxy	Assembly	• 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 LUX OGRFI146T	Acrylate	Adhesive	• 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

Fiber to Ferrule Attach

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE ECCOBOND F113SC	Epoxy	Assembly	• High T_g • Low viscosity • High bond strength • Low stress connections with no pistoning • Dark blue color	1,800	95	83D	Room temperature or heat cure	18 hr. 25°C or 1 hr. 65°C
LOCTITE ECCOBOND F 112 MINIPAX	Epoxy	Assembly	• Low viscosity • Thermal shock and impact resistant • Low stress connections with no pistoning	1,800	102	86D	Room temperature or heat cure	24 hr. at 25°C or 1 hr. at 65°C
LOCTITE ECCOBOND F 123	Epoxy	Assembly	• Fast cure • Low viscosity • Good wicking • Tough adhesion to a wide variety of fiber optic and optic materials • Resistant to mechanical impact • Excellent thermal shock resistance • Low stress connections with no pistoning • Color keyed formulation that indicates cure status	4,000	120	87D	Heat cure	5 min. at 100°C
LOCTITE ECCOBOND LUX A4035T	Acrylate	Assembly	• Single Pack • Photocurable • Optical grade • Thin bondline	500	145	82D	Ultraviolet (UV) light, visible light and heat cure	Ultraviolet (UV) light: 365 UV wavelength, (nm) Light Intensity at bondline: 50 mW/cm²

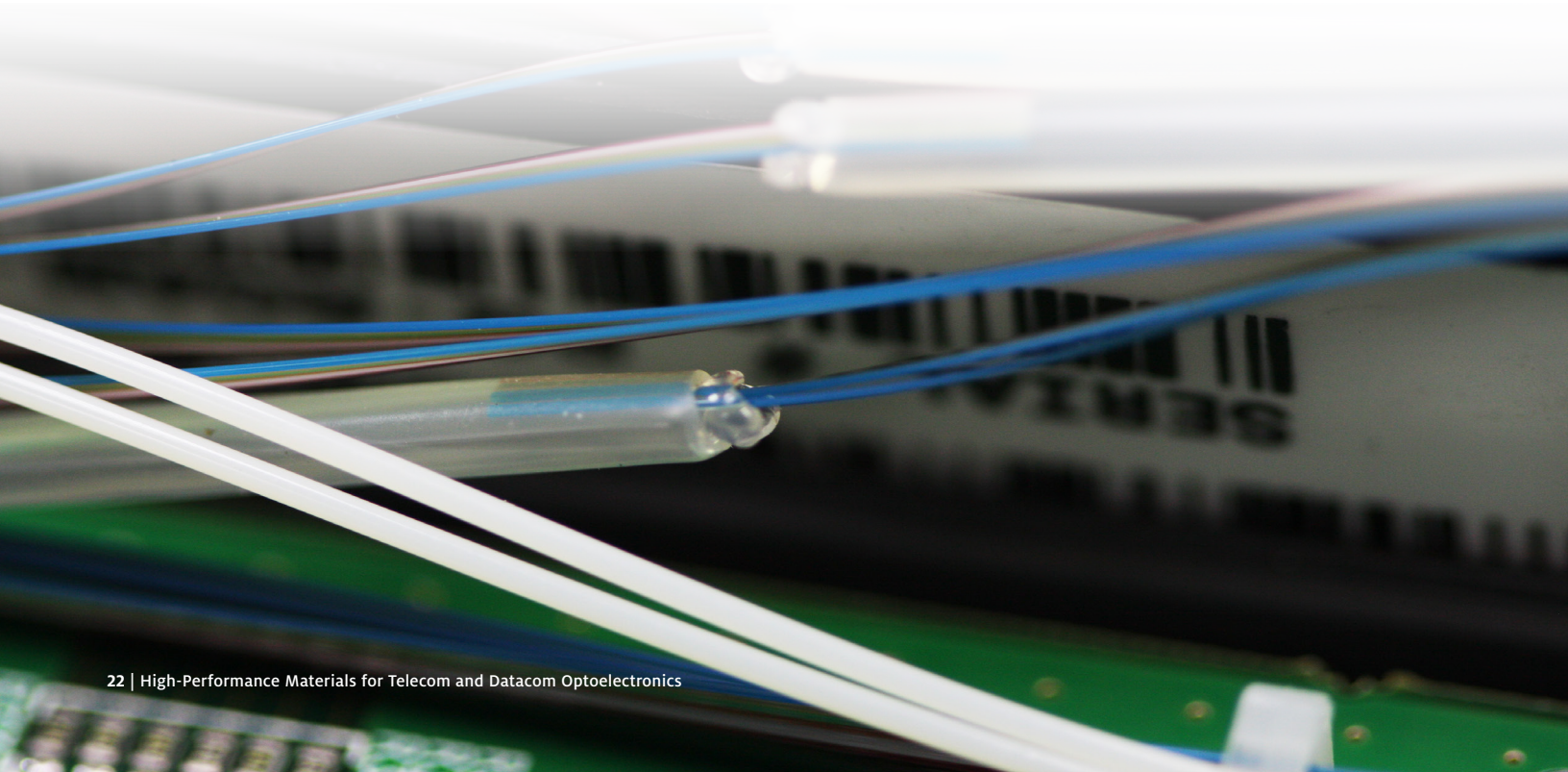
Fiber Connector Bonding and Backfill

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE ECCOBOND F 120	Epoxy	Assembly	• Fast cure • Solvent-free • Low shrinkage • Medium viscosity • Good electrical insulation • Excellent mechanical properties • Excellent chemical resistance	Resin: 14,000 Hardener: 35,000	–	72D	Room Temperature or Heat Cure	24 hr. at 25°C or 1 hr. at 65°C
LOCTITE ECCOBOND F 131 BIPAX	Epoxy	Opto/Photonics	• Room temperature cure capability • High T_g	1,800	95	78D	Room Temperature or Heat Cure	18 hr. at 25°C or 1 hr. at 65°C or 15 min. at 90°C

Bonding Materials for Optical Modules and Components – Continued

Fiber Pigtail Bonding

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	HARDNESS	CURE TYPE	CURE SCHEDULE
LOCTITE® *STYCAST* OS 8300	Epoxy	Assembly	• Two components – requires mixing • High spectral transmission • Excellent adhesion • Low weight loss • Low halogen content	4,000	103	85D	Heat	60 min. at 150°C
LOCTITE ECCOBOND F113SC	Epoxy	Assembly	• High T_g • Low viscosity • High bond strength • Low stress connections with no pistoning • Dark blue color	1,800	95	83D	Room Temperature or Heat cure	18 hr. 25°C or 1 hr. 65°C
LOCTITE ECCOBOND F 123	Epoxy	Assembly	• Fast cure • Low viscosity • Good wicking • Tough adhesion to a wide variety of fiber optic and optic materials • Resistant to mechanical impact • Excellent thermal shock resistance • Low stress connections with no pistoning • Color keyed formulation that indicates cure status	4,000	120	87D	Heat cure	5 min. at 100°C



EMI Shielding / Gasketing Materials

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	CURE TYPE	CURE SCHEDULE
LOCTITE SI 5421	Silicone	Bonding/ Gasketing	• 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	• 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

Gasketing Materials

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	VISCOSITY (cP)	GLASS TRANSITION TEMPERATURE, T_g (°C)	CURE TYPE	CURE SCHEDULE
LOCTITE SI 5084	Silicone	Gasketing	• Highly flexible • Non-corrosive • Enhances load bearing and shock absorbing characteristics of the bond area	Paste	N/A	UV & RT	UV + Moisture
LOCTITE SI 5210	Silicone	Potting	• Ultra-fast curing • Non-corrosive RTV • Designed for potting, wire tacking, selective sealing • Vibration dampening and repair/rework applications on PCBs	Paste	-52	RTV	22 °C/50% RH AT ≤5 min.

Underfill Materials

PRODUCT	DESCRIPTION	VISCOSITY (PA·S)	COEFFICIENT OF THERMAL EXPANSION, CTE (ALPHA 1 - PPM/°C)	COEFFICIENT OF THERMAL EXPANSION, CTE (ALPHA 2 - PPM/°C)	GLASS TRANSITION TEMPERATURE, T_G (°C)	POT LIFE (DAY)
UNDERFILL						
LOCTITE ECCOBOND UF 1173	Low CTE, high T_g underfill for extreme T-Cycle conditions	7.5	26	103	160	2
LOCTITE ECCOBOND E 1216M	Fast flow, non-anhydride underfill	4	35	131	125	–
LOCTITE ECCOBOND UF 3812	Room temperature flow, reworkable underfill	0.35	48	175	131	3
LOCTITE 3517M	Low temperature cure, reworkable underfill	2.6	65	191	78	7

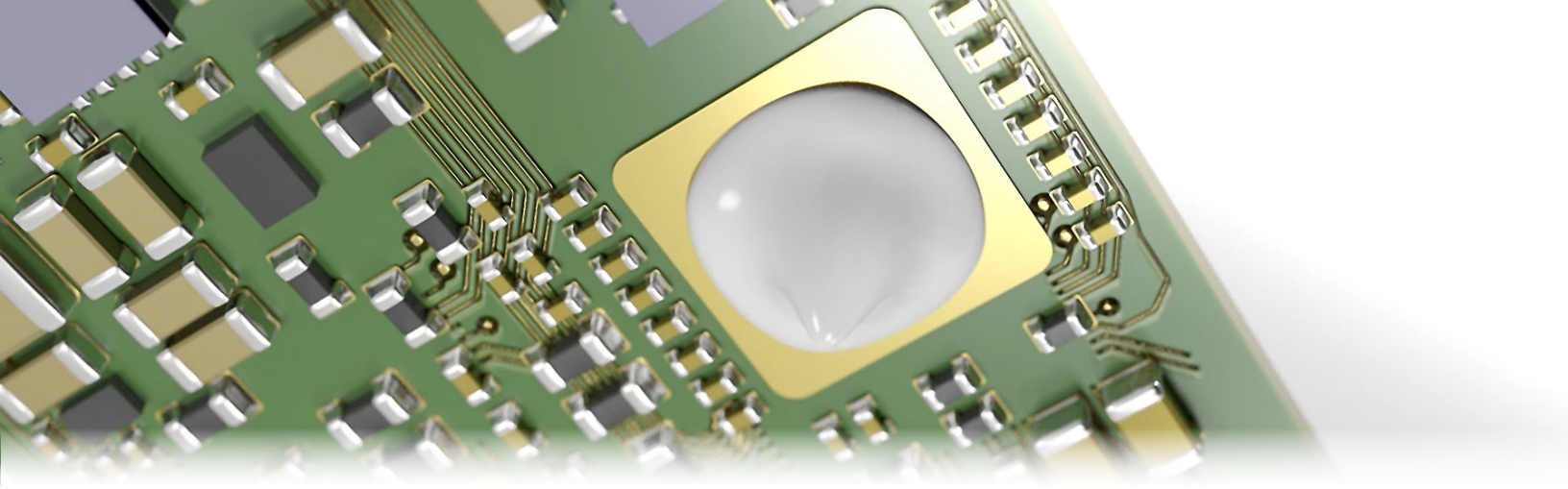
Thermal Materials for Optical Modules and Components

GAP PAD®

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	THICKNESS (mm)	SHORE HARDNESS	THERMAL CONDUCTIVITY (W/m·K)
THERMAL PAD						
BERGQUIST® GAP PAD® TGP 3004SF	Silicone-free	Thermal pad	• 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 (Shore 00)	3.0
BERGQUIST GAP PAD TGP HC3000	Silicone	Thermal pad	• Thermal Conductivity: 3.0 W/m-K • High-compliance, low compression stress • Fiberglass reinforced for shear and tear resistance	0.508 – 3.175 mm	15 (SHORE 00)	3.0
BERGQUIST GAP PAD TGP HC5000	Silicone	Thermal pad	• High-compliance, low compression stress • Fiberglass reinforced for shear and tear resistance	0.508 ~ 3.175	35 (Shore 00)	5.0
BERGQUIST GAP PAD TGP 3500ULM	Silicone	Thermal pad	• Thermal Conductivity: 3.5 W/m-K • Fiberglass reinforced for shear and tear resistance • Non-fiberglass option for applications that require an additional reduction in stress	0.508 ~ 3.175 mm	70 (Shore 000)	3.5
BERGQUIST GAP PAD TGP 6000ULM	Silicone base	Thermal pad	• High-compliance, low compression stress • Ultra-low modulus	1.524 ~ 3.175	60 (Shore 000)	6.0
BERGQUIST GAP PAD TGP 7000ULM	Silicone base	Thermal pad	• High-compliance, low compression stress • Ultra-low modulus	0.500 ~ 3.180	75 (Shore 000)	7.0
BERGQUIST GAP PAD TGP 10000ULM	Silicone	Thermal pad	• High-compliance, low compression stress • Ultra-low modulus	1.000, 1.500, 2.000, 2.500, 3.180	75 (Shore 000)	10
BERGQUIST GAP PAD TGP 12000ULM	Silicone	Thermal pad	• High-compliance, low compression stress • Ultra-low modulus	1.000, 1.500, 2.000, 2.500, 3.180	68 (Shore 000)	12
EMI ABSORPTION						
BERGQUIST GAP PAD TGP EMI1000	Silicone	EMI absorbing	• EMI absorbing • Highly conformable • Low hardness • Fiberglass reinforced for puncture, tear and shear resistance • Electrically isolating	0.508 – 3.175	5 (Shore 00)	1.0

Gap Filler

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	THICKNESS (mm)	SHORE HARDNESS	THERMAL CONDUCTIVITY (W/m·K)
GAP FILLER						
BERGQUIST GAP FILLER TGF 1500	Silicone	Gap filler	• Thermal Conductivity: 1.8 W/m-K • Optimized shear thinning characteristics for ease of dispensing • Excellent slump resistance (stays in place) • Ultra-conforming, with excellent wet-out for low stress • interface applications • 100% solids - no cure by-products • Excellent low and high temperature mechanical and chemical stability	N/A	40 (Shore A)	1.5
BERGQUIST GAP FILLER TGF 3500LVO	Silicone	Gap filler	• 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 (Shore 00)	3.5
BERGQUIST GAP FILLER TGF 3600	Silicone	Gap filler	• 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 (Shore 00)	3.6
BERGQUIST GAP FILLER TGF 4000	Silicone	Gap filler	• Thickness variations • Little to no stress • 100% solids – no cure by-products • Excellent low and high temperature chemical and mechanical stability	N/A	75 (Shore 00)	4.0



Phase Change

PRODUCT	TECHNOLOGY	APPLICATION	KEY ATTRIBUTES	THICKNESS (mm)	VOLUME RESISTIVITY (Ω·cm)	THERMAL CONDUCTIVITY (W/m·K)
BERGQUIST HI-FLOW THF 1600G	Phase Change	Thermal management, thermally conductive adhesive	• Thermal impedance: 0.2°C-in²/W at 25 psi • Will not drip or run like grease • Phase change compound coated on a fiberglass carrier • Typical applications: Computer and peripherals, as a thermal interface where bare die is exposed and needs to be heat sinked	0.127 mm	1×10^{8}	1.6
LOCTITE TCP 4000 D	Phase Change	Thermal management, thermally conductive adhesive	• Reworkable • Highly efficent thermal transfer • Thixotropic above phase change temperature	0.025 mm, 0.051 mm, 0.102 mm, 0.203 mm	–	3.4

PRODUCT	DESCRIPTION	MATERIAL THICKNESSES (mil)	PHASE CHANGE TEMPERATURE	OPERATING TEMPERATURE	THERMAL CONDUCTIVITY (W/m·K)	UL FLAMMABILITY RATING
BERGQUIST HI-FLOW THF 5000UT	Reworkable phase change thermal interface material suitable for use between a heat sink and variety heat generating components	8, 10, 12, 16	45°C	-40 to 150°C	Multiple Thickness, ASTM D5470 5.3 Thin Bondline Materials, modified ASTM D5470 8.5	UL 94 V-0

LIQUI-FORM

PRODUCT	DESCRIPTION	THERMAL CONDUCTIVITY (W/m·K)	CURE TYPE	DIELECTRIC STRENGTH	VOLUME RESISTIVITY (Ω·cm)	OPERATING TEMPERATURE
BERGQUIST LIQUI-FORM TLF LF3500	Thermally conductive, one-part, liquid formable gel material	3.5	Pre-cured	10,000	1×10^{11}	-60 – 200°C
BERGQUIST LIQUI-FORM TLF 6000HG	Thermally conductive, one-part, liquid formable gel material	6.0	Pre-cured	10,500 V/mm	4.37×10^{11}	-60 – 200°C
BERGQUIST LIQUI-FORM TLF 10000	Thermally conductive, pre-cured gel material	10	Pre-cured	7,080 V/mm	9.0×10^{13}	-60 – 200°C

Thermal Adhesive

PRODUCT	DESCRIPTION	THERMAL CONDUCTIVITY (W/m·K)	CURE TYPE	DIELECTRIC STRENGTH	VOLUME RESISTIVITY (Ω·cm)	SHEAR STRENGTH (psi)
LOCTITE 315	Acrylic	0.80	Activator or heat	26.7 kV/mm	1.30×10^{12}	1,000
LOCTITE 3875	Bead on bead – acrylate	1.75	Activator or heat	–	–	2,400

LOCTITE®

BERGQUIST®

AMERICAS

UNITED STATES
Henkel Corporation
14000 Jamboree Road
Irvine, CA 92606
United States
Tel: +1.888.943.6535
Fax: +1.714.368.2265

Henkel Corporation
20021 Susana Road
Rancho Dominguez, CA 90221
United States
Tel: +1.310.764.4600
Fax: +1.310.605.2274

Henkel Corporation
18930 W. 78th Street
Chanhassen, MN 55317
United States
Tel: +1.952.835.2322
Tel: +1.800.347.4572
Fax: +1.952.835.0430

BRAZIL
Henkel Brazil
Av. Prof. Vernon Krieble, 91
06690-070 Itapevi, Sao Paulo
Brazil
Tel: +55.11.3205.7001
Fax: +55.11.3205.7100

ASIA-PACIFIC

CHINA
Henkel Management Center
Building 7, No. 99 Jiang Wan Cheng Road
Shanghai 200438,
China
Tel: +86.21.2891.8000
Fax: +86.21.2891.8952

Ablestik (Shanghai) Ltd.
No. 332 Meigui South Road
WaiGaoQiao Free Trade Zone, Pu Dong
Shanghai 200131,
China
Tel: +86.21.2702.5888
Fax: +86.21.5048.4169

JAPAN
Henkel Japan Ltd.
27-7, Shin Isogo-cho
Isogo-ku Yokohama, 235-0017
Japan
Tel: +81.45.286.0161
Email: jp.ae-csdesk@henkel.com

KOREA
Henkel Korea Co., Ltd.
18th Floor of tower B, BYC High City Bldg
Gasan Digital 1-ro, Geumcheon-gu,
Seoul, 08506
South Korea
Tel: +82.2.6150.3000
Fax: +82.2.6947.5203

SINGAPORE
Henkel Singapore Pte Ltd.
401, Commonwealth Drive
#03-01/02 Haw Par Technocentre,
Singapore 149598
Tel: +65.6266.0100
Fax: +65.6472.8738 / +65.6266.1161

TAIWAN
Henkel Taiwan Ltd.
10F, No. 866, Zhongzheng Road,
Zhonghe District, New Taipei City, 23586
Taiwan
Tel: +866.2.2227.1988
Fax: +866.2.2226.8699

EUROPE

BELGIUM
Henkel Belgium N.V.
Nijverheidsstraat 7
B-2260 Westerlo
Belgium
Tel: +32.1457.5611
Fax: +32.1458.5530

UNITED KINGDOM
Henkel Ltd.
Adhesives Limited Technologies House
Wood Lane End
Hemel Hempstead
Hertfordshire HP2 4RQ
United Kingdom
Tel: +44.1442.278000
Fax: +44.1442.278071

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