LOCTITE®

ELLSWORTH ADHESIVES

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Composites

Aerospace Product Selector Guide

Henkel Excellence is our Passion

Composites

Composites

With composites, your aircraft manufacturing gets moving

With LOCTITE, it takes flight

How your manufacturing can benefit from composites

To make a long story short: There are very good reasons why composites are replacing metal in aircraft manufacturing, 30 % weight savings vs. aluminium is only one of them – resulting in reduced fuel consumption, emissions and noise. Other reasons include design flexibility and process efficiency. The list is long. But when choosing LOCTITE, it gets even longer.

And how LOCTITE's composite expertise can tap its full potential for you

With more than 50 years of resin experience, LOCTITE offers a variety of composite solutions for the manufacturing process. For example, our high-end mold release agents are trusted globally. Our benzoxazine resins are specifically designed to improve performance, storage, and processing. Additionally, LOCTITE syntactic core materials provide the perfect combination of high stiffness, low weight and maximum flexibility.

With this chapter, we would like to introduce you to our broad composite expertise.

Why rely on conventional methods when you can use

LOCTITE benzoxazine resins from the start?

Composite materials developed just for you

Developed specifically for the aerospace industry, benzoxazine prepreg and infusion resin technology offers a comprehensive solution over commonly used epoxies, phenolics and BMIs. With this technology, you can be sure to apply a top-line solution to your aircraft.

With unique & specific LOCTITE benzoxazine resins benefits

The superior LOCTITE benefits appear at first sight – they refer to product performance, storage, processing, and health and safety. LOCTITE benzoxazine resins eliminate the need for refrigerated shipping and storage, enable increased service temperatures, lead to improved safety and lower residual stress, contribute to better thermal stability and save at least 30 % of weight compared to conventional metal structures.

Why choose LOCTITE benzoxazine resins?

- Stability at ambient temperature eases storage & shipping
- Improved hot / wet performance and durability
- Excellent flammability resistance
- Lower cure shrinkage and cure exotherm
- No microcracking / no water generated during cure

Helping you reach your sustainability goals

Sustainability benefits of Henkel benzoxazine resins

Performance	Improved mechanical, flammability performance and durability
Safety & Health	Improved health and hygiene
Social Progress	Expanded access to air travel due to reduced cost
Energy & Climate	Room temperature storage and shipping Suitable for automated processing Lower weight structure
Materials & Waste	Less materials needed due to higher product performance Reduced waste and hazards
Water & Wastewater	Less water and wastewater in manufacture of resins, composites and finished parts

LOCTITE benzoxazine resins:
All facts at a glance

LOCTITE benzoxazine resins compared to conventional methods

Henkel benzoxazine resins vs. epoxy:

› Higher hot / wet performance
› Lower cure shrinkage and exotherm
› Inherent FST characteristics

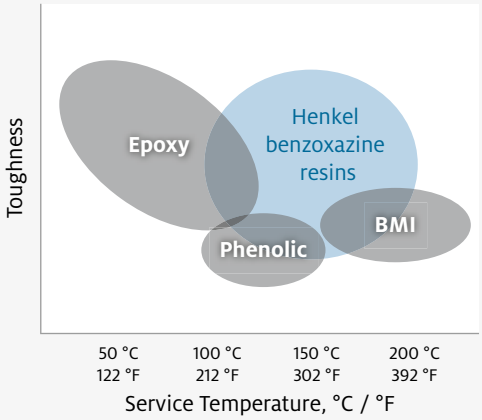
Henkel benzoxazine resins vs. BMI:

› Lower cure temperatures and shorter cure time
› Lower cost
› Higher toughness

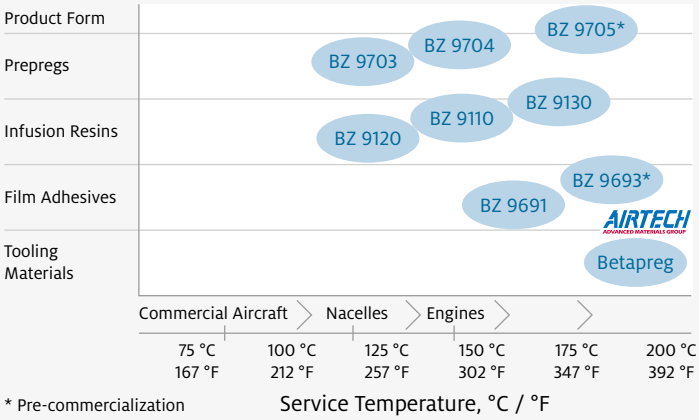
Henkel benzoxazines vs. phenolics:

› No microcracks
› No water generated

Performance of resin families



LOCTITE benzoxazine resins for the aerospace industry



* Pre-commercialization

Key factors to consider when choosing the right LOCTITE benzoxazine resin

› Service temperature
› Toughness, damage tolerance
› Product technology: prepreg vs. liquid resin infusion
› Processing method:

Prepreg	Hand lay-up Automated tape laying (ATL) Automated fiber placement (AFP) Autoclave Vacuum bag only
Infusion	Resin transfer molding (RTM) Vacuum only infusion and cure (VARTM)

Benzoxazines: Infusion Structural Resins

Applications	Secondary Structure 120 °C / 250 °F Service			
	Secondary Structure >120 °C / 250 °F Service	•		
	Primary Structure 120 °C / 250 °F Service		•	
	Primary Structure > 120 °C / 250 °F Service			•
Product Characteristics	Tg Dry (°F / °C)	376 °F 191 °C	356 °F 180 °C	491 °F 255 °C
	Tg Wet (°F / °C)	322 °F 161 °C	293 °F 145 °C	385 °F 196 °C
	Toughness	Medium	High	Medium
	Compression After Impact Strength at 73 °F (ksi) / 23 °C (MPa)	29 ksi 201 MPa	35 ksi 241 MPa	25 ksi 174 MPa
	Open Hole Compression Strength at 73 °F (ksi) / 23 °C (MPa)	52.4 ksi 361 MPa	49 ksi 335 MPa	51 ksi 350 MPa
	Continuous Service Temperature (F° / °C)	Maximum 300 °F 149 °C	Maximum 250 °F 121 °C	Maximum 334 °F 168 °C
	Tensile Strength at 73 °F (ksi) / 23 °C (MPa)	327 ksi 2,255 MPa	286 ksi 1,974 MPa	310 ksi 2137 MPa
	Tensile Modulus at 73 °F (Msi) / 23 °C (GPa)	19.8 Msi 137 GPa	20.4 Msi 141 GPa	20.1 Msi 139 GPa
Process & Handling	Cure Temperature (°F / °C)	365 °F 185 °C	365 °F 185 °C	365 °F + 450 °F * 185 °C + 232 °C
	Cure Time	2 Hours	2 Hours	2 Hours + 1 Hour
	Storage Temperature (°F / °C)	73 °F 23 °C	73 °F 23 °C	73 °F 23 °C
	Storage Time	> 6 Months	> 6 Months	> 3 Months
	Processing Information	One-Part Resin VARTM Processable	One-Part Resin VARTM Processable	One-Part Resin VARTM Processable
Products	New Product Name	**LOCTITE BZ 9110 AERO**	**LOCTITE BZ 9120 AERO**	**LOCTITE BZ 9130 AERO**
	Known As	Epsilon™ 99110	Epsilon™ 99120	LM 41005
Regional Availability & Packaging	Asia Pacific	Can	Can, Pail, Drum	Can
	Europe / Middle East / Africa	Can	Can, Pail, Drum	Can
	Latin America	Can	Can, Pail, Drum	Can
	North America	Can	Can, Pail, Drum	Can
Description		• Room temperature stability • Air shipment • Easy processing • VARTM capable • One-part system • Low exotherm during cure • Good flame, smoke and toxicity • High hot / wet property retention • Improved UV resistance	• Room temperature stability • High toughness • Air shipment • Easy processing • VARTM capable • One-part system • Low exotherm during cure • Microcrack resistant • Improved UV resistance	• Room temperature stability • High thermal resistance • Air shipment • Easy processing • VARTM capable • One-part system • Low exotherm during cure • Good flame, smoke and toxicity • High hot / wet property retention • Improved UV resistance

Benzoxazines: Structural Prepregs

Applications	Secondary Structure 120 °C / 250 °F Service	•		
	Secondary Structure >120 °C / 250 °F Service			
	Primary Structure 120 °C / 250 °F Service			
	Primary Structure > 120 °C / 250 °F Service		•	•
Product Characteristics	Tg Dry (°F / °C)	390 °F 199 °C	399 °F 204 °C	446 °F 230 °C
	Tg Wet (°F / °C)	350 °F 177 °C	330 °F 166 °C	365 °F 185 °C
	Toughness	Medium	High	Medium
	Compression After Impact Strength at 73 °F (ksi) / 23 °C (MPa)	28 ksi 193 MPa	45 ksi 310 MPa	34 ksi 230 MPa
	Open Hole Compression Strength at 73 °F (ksi) / 23 °C (MPa)	52 ksi 358 MPa	55 ksi 379 Mpa	43 ksi 296 MPa
	Continuous Service Temperature (F° / °C)	Maximum 250 °F 121 °C	Maximum 284 °F 140 °C	Maximum 350 °F 177 °C
	Tensile Strength at 73 °F (ksi) / 23 °C (MPa)	334 ksi 2,303 MPa	314 ksi 2,165 MPa	318 ksi 2,198 MPa
	Tensile Modulus at 73 °F (Msi) / 23 °C (GPa)	18.8 Msi 130 GPa	20.7 Msi 143 GPa	21.9 Msi 151 GPa
Process & Handling	Cure Temperature (°F / °C)	350 °F 177 °C	365 °F 185 °C	365 °F + 415 °F * 185 °C + 212 °C
	Cure Time	2 Hours	3 Hours	1 hour + 2 hours
	Storage Temperature (°F / °C)	73 °F 23 °C	73 °F 23 °C	73 °F 23 °C
	Storage Time	> 6 Months	> 6 Months	> 6 Months
	Processing Information	Suitable for AFP & ATL	Suitable for AFP & ATL	Suitable for AFP & ATL
Products	New Product Name	**LOCTITE BZ 9703 AERO**	**LOCTITE BZ 9704 AERO**	**LOCTITE BZ 9705 AERO**
	Known As	–	–	–
Regional Availability & Packaging	Asia Pacific	Roll	Roll	Roll
	Europe / Middle East / Africa	Roll	Roll	Roll
	Latin America	Roll	Roll	Roll
	North America	Roll	Roll	Roll
Description		• High hot / wet poperty retention • Room temperature shipping & storage • Excellent flame, smoke, & toxicity • Low exotherm during cure • Low cure shrinkage • Improved UV resistance • Excellent tack & drape • Controlled flow resin • AFP / ATL capable	• High continuous service temperture • Excellent damage tolerance • Room temperature shipping & storage • Fire barrier resistance • Low exotherm during cure • Low cure shrinkage • Improved UV resistance • AFP / ATL capable	• High thermal resistance • Excellent flammability and fire barrier resistance • Low cure shrinkage • Improved UV resistance • Excellent tack & drape • Straightforward cure cycle • Controlled flow resin • AFP / ATL capable

* First temperature and time are for initial cure. Second temperature and time are for free-standing post cure.

LOCTITE structural syntactic materials provide what an aircraft really needs:

Light weight and high stiffness

Our syntactic materials are as stiff and light weight

With LOCTITE structural syntactic materials, Henkel provides the right choice for structural and low density sandwich panels. Applications include low density panel stiffening, sandwich panel edge build-up, core stabilization, core filling in closed mold processes, minimum gauge stiffened panels and abradable seals for aero engines. They offer maximum structural performance, high impact resistance, high panel strength – and, of course, an optimum stiffness to weight. The range of products includes structural syntactics and expandable closed cell foams.

And as flexible as you need them to be

At the same time, LOCTITE syntactic core and expandable materials provide maximum flexibility in the manufacturing process. The syntactic cores may be machined before or after cure – for different shapes, contours and profiles. The expandable materials are available in a variety of thicknesses to meet different part configurations, and density / strength may be tailored to meet specific design needs.

Further, the cores and expanding materials are co-curable with a variety of prepregs ensuring flexibility in selection of face sheets. And finally, they are available in a wide range of forms including rolls, sheets and machined to shape – for ease of manufacturing.

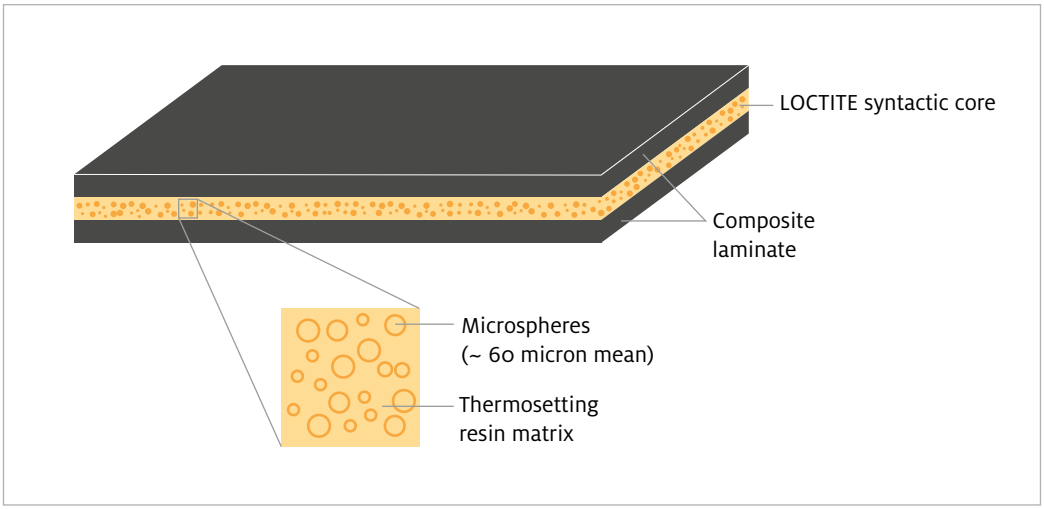
Why choose LOCTITE syntactic materials?

- Improved mechanical strength, toughness and energy absorption
- Enables thick and complex sandwich structures
- No mark-off due to bonding or honeycomb
- Panel thickness can be contoured, local build-ups can be included
- Abrasion & erosion resistance
- Expanding, low density
- User-friendly processing
- Wide range of industry qualifications

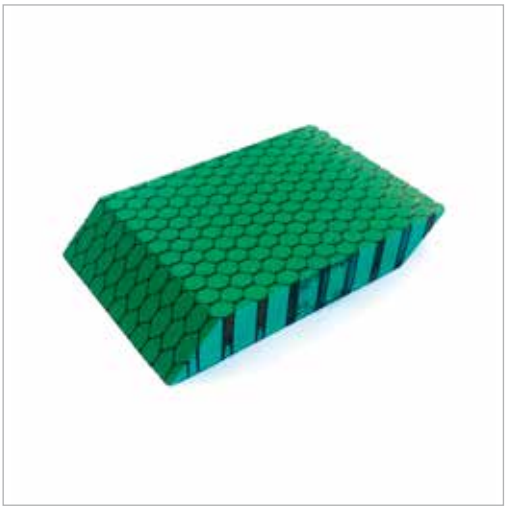
LOCTITE syntactic materials:
All facts at a glance

Key factors to consider when choosing the right LOCTITE syntactic materials

- Service temperature
- Compression strength
- Application
- Process temperature
- Core thickness required
- Expanding or non-expanding



LOCTITE syntactic core sandwich construction



LOCTITE expanding syntactic film

LOCTITE syntactic core machined shape

Syntactic Materials: Non Expandable and Expandable

Applications	Syntactic Film Non-Expanding	•	•	•	
	Syntactic Film Expanding				•
	180 °F / 82 °C Service				•
	250 °F / 121 °C Service	•			
	300 °F / 149 °C Service		•		
	300 °F / 149 °C Service – High Strength			•	
Product Characteristics	Continuous Service Temperature (F° / °C)	Maximum 250 °F 121 °C	Maximum 350 °F 177 °C	Maximum 350 °F 177 °C	Maximum 180 °F 82 °C
	Block Compressive (dry) at 73 °F (psi) / 23 °C (MPa)	9000 psi 62 MPa	8800 psi 61 MPa	21800 psi 150 MPa	3300 psi 22.7 MPa
	Tensile Strength at 73 °F (psi) / 23 °C (MPa)	4700 psi 32 MPa	4800 psi 33 MPa	5,000 psi 34.5 MPa	–
	Tensile Modulus at 73 °F (ksi) / 23 °C (MPa)	380 ksi 2606 MPa	400 ksi 2,758 MPa	580 ksi 4,000 MPa	–
Process & Handling	Cure Temperature (°F / °C)	250 °F 121 °C	350 °F 177 °C	350 °F 177 °C	250 °F 121 °C
	Cure Time	1 Hour	1 Hour	2 Hours	2 Hours
	Storage Temperature (°F / °C)	0 °F ≤ -18 °C	0 °F ≤ -18 °C	0 °F ≤ -18 °C	0 °F ≤ -18 °C
	Storage Time	> 12 Months	> 12 Months	12 Months	12 Months
	Out-time (Days at 77 °F / 25 °C)	15 Days	15 Days	15 Days	15 Days
	Out-time (Days at 90 °F / 32 °C)	10 Days	10 Days	10 Days	10 Days
Products	New Product Name	**LOCTITE HC 9823.1 AERO**	**LOCTITE HC 9872.1 AERO**	**LOCTITE HC 9875 AERO**	**LOCTITE EF 9890 AERO**
	Known As	SynCore® 9823.1™	SynCore® 9872.1™	SynCore® 9875™	SynSpand® EA 9890™ Abradable Seal
Regional Availability & Packaging	Asia Pacific	Roll, Sheet	Roll, Sheet	Roll	Roll
	Europe / Middle East / Africa	Roll, Sheet	Roll, Sheet	Roll	Roll
	Latin America	Roll, Sheet	Roll, Sheet	Roll	Roll
	North America	Roll, Sheet	Roll, Sheet	Roll	Roll
Description		• Structural syntactic film • Excellent moisture resistance • Lightweight syntactic core material • Modified epoxy • Co-curable with 250 °F / 121 °C prepregs	• Structural syntactic film • Excellent moisture resistance • Lightweight syntactic core material • Modified epoxy • Co-curable with 350 °F / 177 °C prepregs	• Structural syntactic film • High crush strength • Lightweight syntactic core material • Designed to withstand high compressive loading • Co-curable with 350 °F / 177 °C prepregs	• Expanding film used as abradable seals, which require high abrasion and corrosion resistance • Abrasion & erosion resistance • Expanding, low density • User-friendly processing

Notes

	•	•		
	•	•		
			•	•
	Maximum 250 °F 121 °C	Maximum 250 °F 121 °C	Maximum 300 °F 149 °C	Maximum 300 °F 149 °C
	–	–	–	–
	–	–	5600 psi 38.6 MPa	2200 psi 15.2 MPa
	–	–	370 ksi 2551 MPa	144 ksi 993 MPa
	250 – 350 °F 121 – 177 °C	250 – 350 °F 121 – 177 °C	300 °F 149 °C	300 °F 149 °C
	1 Hour	1 Hour	1,5 Hours	1,5 Hours
	0 °F ≤ -18 °C	0 °F ≤ -18 °C	0 °F ≤ -18 °C	0 °F ≤ -18 °C
	12 Months	12 Months	12 Months	12 Months
	15 Days	15 Days	15 Days	15 Days
	10 Days	10 Days	10 Days	10 Days
	LOCTITE EF 9899 AERO	**LOCTITE EF 9899CF AERO**	**LOCTITE EF 9835 AERO**	**LOCTITE EF 9840 AERO**
	SynSpand® 9899™	SynSpand® 9899CF™*	SynSpand® EA 9835™ Abradable Seal	SynSpand® EA 9840™ Abradable Seal
	Roll, Sheet	Roll, Sheet	Roll, Sheet	Roll, Sheet
	Roll, Sheet	Roll, Sheet	Roll, Sheet	Roll, Sheet
	Roll, Sheet	Roll, Sheet	Roll, Sheet	Roll, Sheet
	Roll, Sheet	Roll, Sheet	Roll, Sheet	Roll, Sheet
	• Expanding film using a unique closed cell process • Provides a completely homogenous cell structure • Applications: honeycomb core stabilization, edge close out, RTM core, etc.	• Expanding film • Medium density • Low exotherm • Suitable for core filling applications • High compressive strength provides the potential for some structural applications	• Expanding film used as abradable seals, which require high erosion resistance • Erosion resistance • Moisture resistance • Environmental resistance • Mold to net shape	• Expanding film used as abradable seals, which require high erosion resistance • Erosion resistance • Moisture resistance • Environmental resistance • Mold to net shape

Aerospace industry has many standards:

LOCTITE FREKOTE is the one for release materials

Choosing the right release material is not as easy as you might think ...

Aircraft manufacturers' demands on professional release materials are high: They require a wide range of mold releases with different characteristics to meet all needs. They want to be sure to apply a sustainable solution. And last but not least, they only accept materials that comply with the most rigorous requirements – their own ones.

... unless you discover LOCTITE FREKOTE.

Henkel's LOCTITE FREKOTE release agents, sealers and cleaners are based on over 50 years of technical experience and are the most trusted for consistent release of composite parts from tools. These wax- and silicone-free release agents polymerize to create a low surface energy film which is durable, chemically resistant and thermally stable. A minimal transfer to molded components, minimized fouling, easy application and the highest number of releases possible per application are guaranteed.

Why choose LOCTITE FREKOTE mold release materials?

- Semi-permanent mold release bonds to mold surface for consistent release
- Higher productivity and profitability through reduced downtime
- Low reject rates
- Available with no volatile organic compounds (VOCs) and CFCs for improved sustainability
- Dispensing equipment available

LOCTITE FREKOTE mold release materials:
All facts at a glance

Key factors to consider when choosing the right LOCTITE mold release

- Water-based vs. solvent-based
- Slip / release characteristics
- Service temperature
- Transfer characteristics

LOCTITE FREKOTE mold releases can be used with following materials:

- Thermoset epoxies, phenolics and BMIs
- Natural & synthetic rubbers
- Silicones
- Urethanes
- Thermoplastic polymers
- Thermoset prepregs
- Thermoplastic prepregs
- Polyester resins
- Vinyl ester resins
- MRO & repair

LOCTITE FREKOTE mold releases can be used in all composite manufacturing processes:

- Hand lay-up
- Automated fiber placement & tape laying
- Autoclave molding
- Vacuum bag only molding
- Resin transfer molding
- Vacuum infusion processes
- Resin film infusion
- Filament winding
- Injection molding
- Compression molding
- Pultrusion
- Rotational molding
- Metallic, ceramic and composite tooling
- Automated spray application

With support from its authorized aerospace distribution network, Henkel delivers LOCTITE FREKOTE mold release agents for aerospace customers throughout the globe.

Mold Release

Applications	Mold Cleaning	•	•		
	Mold Sealing			•	
	Composites Molding				•
	Compression Molding				•
	Casting				•
	Vacuum bagging				•
	High release				
	Filament Winding				
Product Characteristics	Appearance	Clear Liquid	Beige-Pasty Liquid	Clear Liquid	Clear Liquid
	Finish	–	–	Gloss	Matte
	Density at 77 °F / 25 °C (g/ml)	0.821 to 0.854 LMS	0.97 to 0.99 LMS	0.745 to 0.775 LMS	0.76 to 0.782 LMS
Process & Handling	Cure Temperature (°F / °C)	Ambient	Ambient	Ambient / 210 – 300 °F 100 – 150 °C	Ambient / 210 – 300 °F 100 – 150 °C
	Cure Time	–	–	24 Hours / 60 Minutes	3 Hours / 15 Minutes
	Application Temperature Range	68 – 86 °F 20 – 30 °C	68 – 104 °F 20 – 40 °C	60 – 140 °F 15 – 60 °C	60 – 140 °F 15 – 60 °C
	Storage Temperature (°F / °C)	46 – 70 °F 8 – 21 °C	46 – 70 °F 8 – 21 °C	46 – 70 °F 8 – 21 °C	46 – 70 °F 8 – 21 °C
	Storage Time	24 Months	24 Months	12 Months	12 Months
Products	New Product Name	**LOCTITE FREKOTE PMC AERO**	**LOCTITE FREKOTE 915WB AERO**	**LOCTITE FREKOTE B-15 AERO**	**LOCTITE FREKOTE 44-NC AERO**
	Known As	Frekote® PMC™	Frekote® 915WB™	Frekote® B-15™	Frekote® 44-NC™
Regional Availability & Packaging	Asia Pacific	Can, Pail	Can	Can, Pail	Can, Pail, Drum, Aerosol
	Europe / Middle East / Africa	Can, Pail	Can	Can, Pail	Can, Pail, Drum, Aerosol
	Latin America	Can, Pail	Can	Can, Pail	Can, Pail, Drum, Aerosol
	North America	Can, Pail	Can	Can, Pail	Can, Pail, Drum, Aerosol
Description		• Easy to use • Eliminates contaminants • Enhances release effectivness	• Water-based polisher • Polishing Liquid • Removes cured films	• Seals mold porosity, scratches, or imperfections • No contaminating transfer • High thermal stability	• Better mold utilization • Non-contaminating transfer • No mold build-up • Significantly lower mold maintenance costs

Notes

•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
	•	•	•
		•	

Clear Liquid	Clear Liquid	Clear Liquid	Milky White Emulsion
Satin	Gloss	Gloss	Matte
0.715 to 0.725 LMS	0.755 to 0.764 LMS	0.715 to 0.725 LMS	0.98 to 1.02 LMS

Ambient	210 – 300 °F 100 – 150 °C	Ambient	210 – 300 °F 100 – 150 °C	Ambient	Ambient	210 – 300 °F 100 – 150 °C
30 Minutes	5 Minutes	10 Minutes	5 Minutes	5 – 10 Minutes	3 Hours	12 Minutes
60 – 140 °F 15 – 60 °C		60 – 275 °F 15 – 135 °C		60 – 140 °F 15 – 60 °C	59 – 122 °F 15 – 50 °C	
46 – 70 °F 8 – 21 °C		46 – 70 °F 8 – 21 °C		46 – 70 °F 8 – 21 °C	37 – 68 °F 3 – 20 °C	
12 Months		12 Months		12 Months	9 Months	

LOCTITE FREKOTE 55-NC AERO	**LOCTITE FREKOTE 700-NC AERO**	**LOCTITE FREKOTE 770-NC AERO**	**LOCTITE FREKOTE C-800 AERO**
Frekote® 55-NC™	Frekote® 700-NC™	Frekote® 770-NC™	Frekote® Aqualine® C-800™

Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail
Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail
Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail
Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail, Drum, Aerosol	Can, Pail

• Fast drying • Non-contaminating transfer • High thermal stability • Non-CFC • No mold build-up	• No chlorinated solvents • High gloss finish • High slip • No contaminating transfer • No mold build-upup	• No contaminating transfer • High gloss finish • High slip • No mold build-up • Low odor	• High slip • Easy application • Multiple releases • Low transfer • No corrosion / oxidation of the mold surface • Minimal mold build-up

LOCTITE®
BONDERITE®
TECHNOMELT®
TEROSON®
AQUENCE®

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