VHB™ Double Coated Acrylic Foam Tapes and Adhesive Transfer Tapes

Typical Performance Characteristics

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Primary Products

Thin ←

Products		F-9460PC	F-9469PC	F-9473PC	4920	4929	4930
Peel Adhesion: To Stainless Steel Room Temperature 90° Peel Jaw Speed 12 in./min. (305 mm/min.) (180° Peel for 9460PC, 9469C, 9473PC) ASTM D-3330	lb./in. (N/100 mm)	7 (120)	8 (140)	9 (160)	15 (260)	20 (350)	
Normal Tensile: (T-block) To Aluminum Room Temperature 1 in.² (6.45 cm²) Jaw Speed 2 in./min. (50 mm/min.) ASTM D-897	lb./in.² (kPa)	100* (690)	100* (690)	100* (690)	160 (1100)	160 (1100)	160 (1100)
		Note: Tensile is highly dependent on good surface contact which can be difficult on rigid surfaces with thin tapes.					
Static Shear: Static Shear measured at various temperatures and gram loadings on stainless steel. 1/2 sq. in. (3.22 cm²) overlap. Will hold listed weight for 10,000 min. ASTM D-3654	72°F (22°C) 150°F (66°C) 200°F (93°C) 250°F (121°C) 300°F (149°C) 350°F (177°C)	1000 1000 1000 1000 500 500	1000 1000 1000 1000 500 500	1500 1000 1000 1000 1000 500	1500 500 500	1500 500 500	500 500 500
Dynamic Shear: To Stainless Steel 1 sq. in. (6.45 cm²) overlap. Room Temperature Jaw Speed 1/2 in./min. (12.7 mm/min.) ASTM D-1002	lb./in.² (kPa)	80* (550)	80* (550)	80* (550)	100 (690)	100 (690)	100 (690)
		Note: Dynamic shear is highly dependent on good surface contact which can be difficult on rigid surfaces with thin tapes.					
Temperature Tolerance: Short-Term No change in room temperature dynamic shear properties following 4 hour conditioning at indicated temperature with 100g static load	°F °C	500 (260)	500 (260)	500 (260)	300 (149)	300 (149)	300 (149)
Temperature Tolerance: Long-Term Maximum temperature where tape supports 250g in static shear for 10,000 minutes.	°F °C	300 (149)	300 (149)	300 (149)	200 (93)	200 (93)	200 (93)
Solvent Resistance: Splash testing cycle – 20 seconds sumbersion, 20 sec. airdry, 3 cycles		No apparent degradation of any VHB Tapes when exposed to splash testing of most common solvents, including gasoline, JP-4 jet fuel, mineral spirits, motor oil, ammonia cleaner, acetone, methyl ethyl ketone (MEK).					
Moisture Resistance: 8 years submersion in water, 5% salt water		Integrity of tape bond to aluminum for 4945 and 4950 tapes (also expected for other VHB Tapes) submersion in water and salt water. Note: Continuous submersion in liquids is not recommended and this information is provided to illustrate that occasional contact with liquids should not be detrimental to tape performance in ordinary use.					
U.V. Resistance:		This family of tapes has shown excellent U.V. resistance in outdoor weathering tests and weather-o-meter tests.					
Shelf Life:		24 months from date of manufacture when stored in original cartons at 70°F (21°C) and 50% relative humidity.					

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Additional Typical Performance Characteristics

Outgassing:

	%TML	%VCM
F-9640PC	0.85	0.00
F-9496PC	1.29	0.02
F-9473PC	1.23	0.01
4945	1.24	0.01

TML - Total Mass Loss
VCM - Volatile Condensible Materials
NASA Reference Publication, June 1984, "Outgassing Data for Selecting Spacecraft Materials"

Dielectric Strength:
(ASTM D1000)
RMS Voltage/Thickness

F-9460PC	1,000 Volts
F-9469PC	3,500 Volts
F-9473PC	5,500 Volts

Volts/mil

4930	500
4950	360
4945	360

Insulation Resistance:
(ASTM D1000) megaohms/in²

F-9460PC	$> 1 \times 10^6$
F-9469PC	$> 1 \times 10^6$
F-9473PC	$> 1 \times 10^6$
4930	$> 1 \times 10^6$
4950	$> 1 \times 10^6$
4955	$> 1 \times 10^6$
4959	$> 1 \times 10^6$
4945	$> 1 \times 10^6$

Thermal Conductivity:
(ASTM C177)
BTU-Ft/Ft² Hr. °F (Watts/cm °C)

9460PC	0.092	(0.0016)
9469PC	0.092	(0.0016)
9473PC	0.092	(0.0016)
4930	0.078	(0.0014)
4950	0.078	(0.0014)
4945	0.078	(0.0014)

3M VHB Tapes
UL746C Listings - File MH 17478
Category QOQW2 Component - Polymeric Adhesive Systems, Electrical Equipment

Product Families	Substrates	Temp Rating
4950, 4930, 4920, VHB Foam Tapes	Aluminum, Stainless Steel, Galvanized Steel, Enameled Steel, Glass/Epoxy, Ceramic	110°C
	PBT	90°C
	Polycarbonate, ABS, unplasticized PVC	75°C
4956, 4941, 4936, 4926 Conformable VHB Foam Tapes	Ceramic	110°C
	Aluminum, Stainless Steel, Galvanized Steel, Enameled Steel, Polycarbonate, unplasticized PVC, Glass/Epoxy, PBT	90°C
	ABS	75°C
4945 VHB Foam Tape	Phenolic, Aluminum, Galvanized Steel, Alkyd Enamel	110°C
	Polyamide (Nylon), Polycarbonate, ABS	90°C
	Unplasticized PVC	75°C
F-9473PC, F-9469PC, F-9460PC VHB Adhesive Transfer Tapes	Stainless Steel, Glass/Epoxy, Enameled Steel, Ceramic, Phenolic, Melamine, Alkyd Enamel (F-9469 only)	110°C
	Polycarbonate, Aluminum, Galvanized Steel	90°C
	Unplasticized PVC	75°C

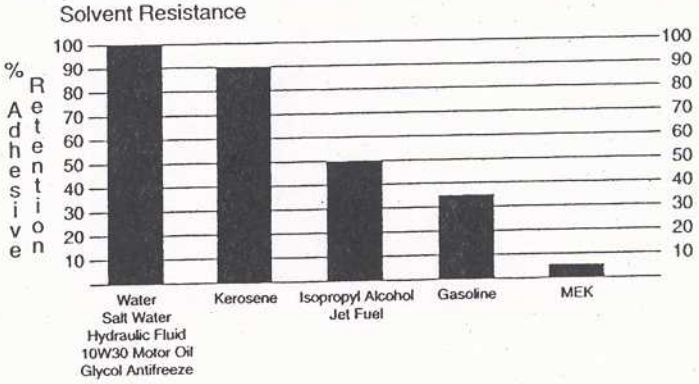
Typical VHB Properties for Modeling

Thermal Coefficient of Expansion
1×10^{-4} in/in/°F
1.8×10^{-4} mm/mm/°C

Young's Modulus (25°C, 1 Hz)
(freq. and temp. dependent)
5×10^3 kPa

Poisson's Ratio
0.5

Solvent Resistance



Test Method

- Tape between stainless steel and aluminum foil.
- 72 hours dwell at room temperature.
- Solvent immersion for 72 hours.
- Test within 45 minutes after removing from solvent
- 90° peel for foam tapes. 180° peel for transfer adhesives.
- 12 in./min. rate of peel.
- Peel adhesion compared to control.

Note: Continuous submersion in chemical solutions is not recommended. The above information is presented to show that occasional chemical contact should not be detrimental to tape performance in most applications in ordinary use.

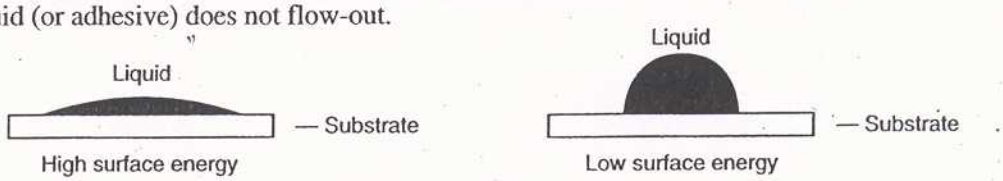
Adhesion to a Variety of Surfaces

The Effect of Surface Energy on Adhesion

Adhesion is basically the molecular force of attraction between unlike materials, similar to a magnetic force. The strength of attraction is determined by the surface energy of the material. The higher the surface energy, the greater the molecular attraction – the lower the suface energy, the weaker the attractive forces. Greater molecular attraction results in increased interfacial contact between an adhesive and a substrate. In other words, on a high surface energy material the adhesive can flow (or "wet-out") to assure a stronger bond.

Think of an automobile which has not been waxed for years. When water contacts the surface it spreads in large puddles. By comparison, on a freshly waxed car the water will bead up into small spheres.

The unwaxed car suface demonstrates high surface energy, the molecular attraction allows the water to flow. The waxed car is an example of low surface energy, where the liquid (or adhesive) does not flow-out.

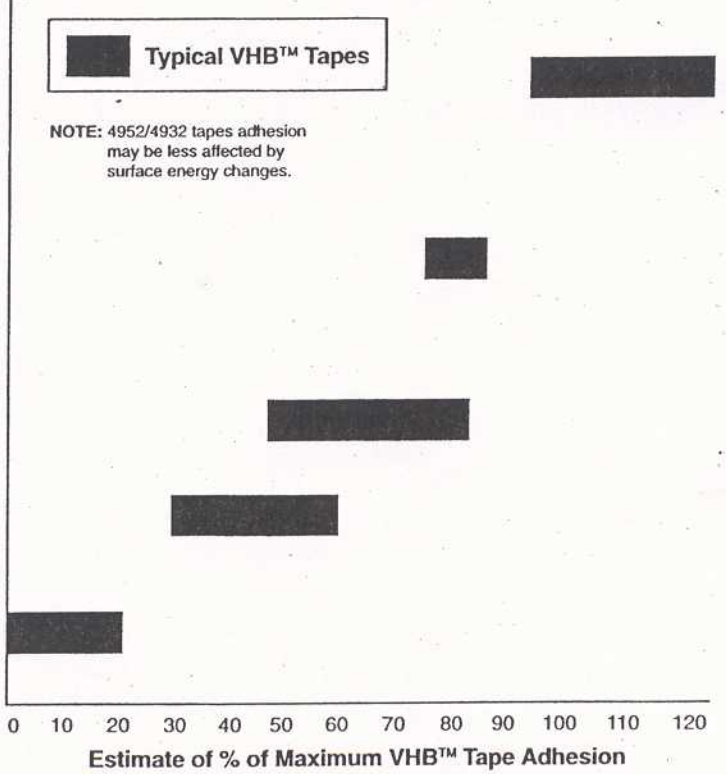


This illustration demonstrates the effect of surface energy on adhesive interfacial contact. High surface energy materials draw the adhesive closer for high bond strength.

Surface Energy Range Dynes/cm

Aluminum Stainless Steel Copper Zinc Tin Lead Anodized Aluminum Glass	400-1100
Kapton™ Phenolic Nylon™ Alkyd Enamel Polyester Epoxy Paint Polyurethane	42-50
ABS Polycarbonate (Lexan™) PVC Noryl™ Acrylic Polane™ Paint	38-39
PVA Polystyrene Acetal	36-37
EVA Polyethylene Polypropylene Tedlar™ Silicone Teflon™	18-33

Relationship of Peel Adhesion and Surface Energy



NOTES: There are a wide variety of formulations, surfaces finishes and surface treatments available on substrate materials which can affect adhesion. This chart is intended to provide only a rough estimate of the adhesion levels which can be expected on some common materials relative to a reference surface such as aluminum.

Expect silicone and Teflon™

Light surface abrasion will significantly increase adhesion levels on many materials, except when using 4952/4932 tapes.

Kapton, Tedlar, Nylon and Teflon are registered trademarks of E.I. Dupont De Nemours & Co. Inc.

Lexan and Noryl are registered trademarks of General Electric Co.

Polane is a registered trademark of Sherwin Williams Co.

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Design Considerations

- **How much tape area to use:**
  As a general rule, four square inches of tape should be used for each pound of weight to be supported in static load. More or less tape may be required depending upon the particular application. User evaluation is, therefore, required to determine optimal tape usage.

- **Bonding to rigid surfaces**
  The necessary thickness of tape depends on the rigidity of substrates, their irregularity, and the amount of application pressure which can be applied to mate the surfaces. The mismatch between surfaces must be less than half of the tape thickness, in conjunction with firm lamination pressure, to establish good surface contact. To test for surface contact problems, bond tape to the rigid or irregular surface, then laminate on a test piece of clear acrylic or polycarbonate (1/4" thick), and apply pressure. Observe the bond contact area through the clear substrate.

- **How much pressure to apply**
  Typically, good surface contact can be attained by applying enough pressure to ensure that the tape experiences approximately 15 psi (100 kPa). Rigid surfaces may require 2 or 3 times that much surface pressure to make the tape experience 15 psi.

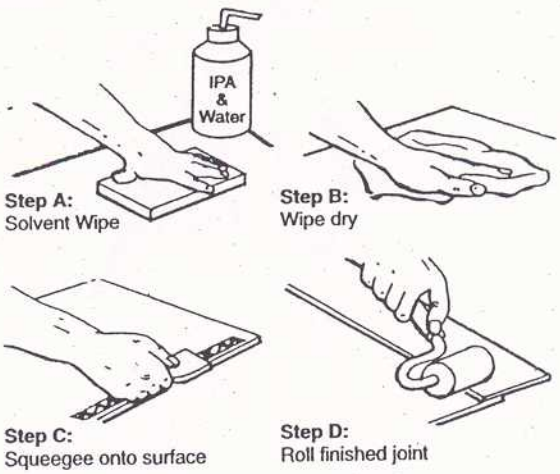
- **Allow for thermal expansion/contraction and flexibility**
  VHB Tapes can perform well in applications where two bonded surfaces may expand and contract differentially. The tapes can typically tolerate differential movement (shear or tensile) up to 3 times their thickness. Tape bonds are more flexible, so suitable design modifications or periodic use of rigid fasteners or adhesives may be needed to achieve required stiffness.

Application Techniques

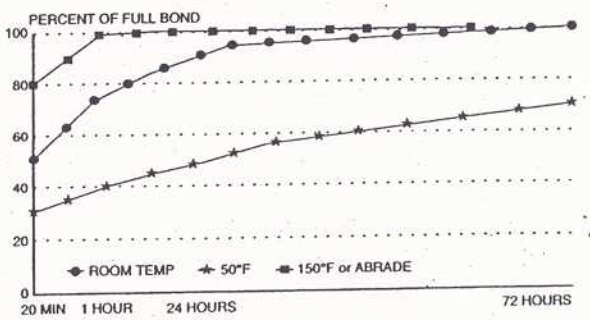
- To obtain optimum adhesion, the bonding surfaces must be clean, dry and well unified. Typical surface cleaning solvents are isopropyl alcohol/water mixture (rubbing alcohol) or heptane. **Note:** Be sure to follow solvent manufacturer's precautions and directions for use when using solvents. (Steps A and B).

- Bond strength is dependent upon the amount of adhesive-to-surface contact developed. Firm application pressure develops better adhesive contact and helps improve bond strength. (Steps C and D).

- After application, the bond strength will increase as the adhesive flows onto the suface. At room temperature approximately 50% of the ultimate strength will be acheived after 20 minutes, 90% after 24 hours and 100% after 72 hours. In some cases bond strength can be increased and ultimate bond strength can be achieved more quickly by exposure of the bond to elevated temperatures (e.g. 150°F (66°C) for 1 hour). This provides better adhesive wetout onto the substrates.



Bond Typical Build vs. Time



VHB™ Tapes Product Selection Guide

	Special Feature Products								
Thickness	Most Metals and High Surface Energy Substrates	Black	Clear	Very Conformable	Plasticizer Resistant	Conformable and Plasticizer Resistant	Low Surface Energy Substrates	Low Temp Installation	Conformable and Low Temp Installation
.002"	▲9460								
.005"	▲9469								
.010"	▲9473								
.015"	▲4920					■4926#			
.020"			▲4905*						
.025"	▲4930	▲4929*		▲4925*		■4936#	●4932		
.040"			▲4910*						
.045"	▲4950	▲4949*		▲4940*	■4945	■4941#	●4952	◆4951*	◆4943*
					■4946				
.062"						■4956#			◆4957*
.080"	▲4955*								
.120"	▲4959*								

Adhesive Types:
▲ = Multi-Purpose
■ = Plasticizer Resistant + Paint Adhesion
● = Low Surface Energy
◆ = Low Temperature Installation

*Film Liner

#Film Liner or Paper Liner Available

Application Techniques

1. Ideal tape application temperature range is 70°F to 100°F (21°C to 38°C).

   Minimum suggested application temperatures:
   50°F (10°C) - F-9460PC, F-9469PC, F-9473PC, 4905, 4910, 4920, 4925, 4929, 4930, 4932, 4940, 4949, 4950, 4952, 4955, 4959 tapes

   60°F (16°C) - 4926, 4926F, 4936, 4936F, 4941, 4941F, 4945, 4946, 4956, 4956F tapes

   32° (0°C) - 4943F, 4951, 4957F tapes

   Note: Initial tape application to surfaces at temperatures below these suggested minimums is not recommended because the adhesive becomes too firm to adhere readily. However, once properly applied, low temperature holding is generally satisfactory.

   To obtain good performance with all VHB Tapes it is important to ensure that the surfaces are dry and free of condensed moisture.

2. It may be necessary to seal or prime some substrates prior to bonding. Consult 3M ITSD Technical Bulletin on Primers for more information.

   a. Most porous (e.g. concrete) or fibered materials (e.g. wood) will require sealing to provide a unified surface. Marine grade varnishes and high performance contact adhesives (such as 3M brand 80 Neoprene Aerosol Contact Adhesive or Scotch-Grip 1357 Contact Adhesive) have been shown to produce good bond strengths with VHB tapes. **Note:** These primers must be tested by user for individual applications to determine suitability.

   b. Some materials (e.g. copper, brass, plasticized vinyl) may require priming or coating to prevent interaction between adhesive and substrate.

   c. Bonding to glass, ceramic tile or other hydrophylic surfaces in a high humidity environment may require the use of a silane coupling agent to help ensure a long-term bond. Consult Technical Bulletin.

Important Application Considerations

THE FOLLOWING APPLICATION CONDITIONS MUST BE EVALUATED THOROUGHLY BY THE USER TO DETERMINE WHETHER VHB PRODUCTS ARE SUITABLE FOR THE INTENDED USE.

- **Severe Cold Temperatures**
  Applications which require performance at severe cold temperatures must be thoroughly evaluated by the user if the intended use will subject the VHB Tape product to high impact stresses.

- **Rigid Surfaces**
  Applications of F-9460PC, F-9469PC or F-9473PC tapes involving two rigid surfaces must be evaluated by the user to ensure adequate adhesive contact and also to ensure that differences in thermal expansion rates of substrates do not adversely affect the bond line.

계 약 번 호
CONTRACT NO : KTP1C2RBK

주 문 번 호
ORDER NO : ST3-99001KD

품 명
COMMODITY : ELECTROLYTIC TINPLATE COIL

제 품 규 격
SPECIFICATION : JISG3303 SPTE-MRT3

밀 사 증 명 서
MILL TEST CERTIFICATE

포항종합제철주식회사
POHANG IRON & STEEL CO., LTD
(POHANG WORKS)

수 요 가
CUSTOMER : RENDE TRADING CO.,LTD

주 문 자
SUPPLIER : SSANGYONG CORPORATION

증명서 번호
CERTIFICATE NO : 990818-CSE-005-001

발 행 일 자
DATE OF ISSUE : AUG. 18. 1999

제품칫수 DIMENSIONS	수량 QUANTITY	중량 WEIGHT (KG)	제강번호 CHARGE NO	제품번호 PRODUCT NO	인장시험 TENSILE TEST YP	TS	EL %	COATING WEIGHT g/m² OUTER-SIDE SN	INNER-SIDE SN	HARD-NESS HR30T	화학성분 CHEMICAL COMPOSITION (%) C	Si	Mn	P	S	CEQ	REMARKS
0.50X855XC	1	3,370	K60535	3TPG0504				3.82	3.85	56.1	400	5	23	10	9		R2
"	1	3,270	"	3TPG0505				"	"	"	"	"	"	"	"		R2
"	1	4,170	"	3TPG0506				"	"	"	"	"	"	"	"		R2
*** SUB TOTAL (060) ***	3			10,810(KG)													
*** LOT TOTAL ***	3			10,810(KG)							* LOT NO ==>NCL122RBK 06033						
*** GRADE TOTAL ***	3			10,810(KG)													
*** GRAND TOTAL ***	3			10,810(KG)													

== LAST ITEM ==

U X1D0 :Z
W X1000 :J
I. X10000 :(
T. X100000 :S

H : MAXIMUM ROUGHNESS, A : AVERAGE ROUGHNESS, S : ROOT MEAN SQUARE, P : PEAK PER INCH, A : BL

LADLE ANALYSIS, : BOL-AL
CHECK ANALYSIS, : EOT-AL

SIGNATURE

WE HEREBY CERTIFY THAT THE MATERIAL HEREIN HAS BEEN MADE BY THE BASIC OXYGEN PROCESS AND TESTED IN ACCORDANCE WITH THE ABOVE SPECIFICATION AND ALSO WITH THE REQUIREMENTS CALLED FOR BY THE ABOVE ORDER.

SIGNATURE

CHIEF OF PRODUCTS INSPECTION SECTION