How to use 3M™ VHB™ Tapes

For success in using 3M™ VHB™ Tapes:
• A specific 3M™ VHB™ Tape and method of application should be selected that provides good strength to the substrates involved.
• Stresses should be within the capabilities of the tape
• Application guidelines should be followed to achieve both strength and reliability.

Design & Tape Selection
Guidelines for understanding surfaces and selecting the right tape type and thickness and for using the right amount of tape to handle the stresses involved.

Application Techniques
Instructions and guidelines for cleaning and preparing the substrates and for applying 3M™ VHB™ Tapes.

Design & Tape Selection

Guidelines for understanding surfaces and selecting the right tape type and thickness and for using the right amount of tape to handle the stresses involved.

Use the Right Tape for the Surfaces Involved

Adhesion is the molecular attraction between unlike materials, similar to magnetic force. Strength of attraction is generally determined by the surface energy of the material. The higher the surface energy, the greater the attraction. The lower the surface energy, the weaker the attractive forces.

On high surface energy surfaces a tape or adhesive can flow or "wet out" to assure a stronger bond. These surfaces include aluminum, steel or glass. On low surface energy surfaces most adhesives and tapes will resist flowing onto the surface, leaving poor surface contact and low adhesion strength. Traditionally substrates have been categorized as having high surface energy or low surface energy as it relates to bonding with adhesives. With the increasing number of substrates and with new adhesives it is common to identify substrates as having medium surface energy or even medium high or medium low surface energy.

Because the surface energy defines a level at which the adhesive can wet and bond to the surface, generally an adhesive type can bond to surfaces with a particular surface energy level and higher. Following are guidelines for matching 3M™ VHB™ Tapes adhesive types with typical substrates.

Multi-purpose Adhesive
Bonds to medium, medium high and high surface energy substrates. (Used on 4941, 4945 and 4622 (liner side) family tapes)

Modified Acrylic Adhesive
Bonds to medium low, medium, medium high and high surface energy substrates (used on 5952 family tapes)

General Purpose Adhesive
Bonds to high surface energy substrates and some medium and medium high surface energy materials. (Used on 4950, 4910 and 4611 family tapes)

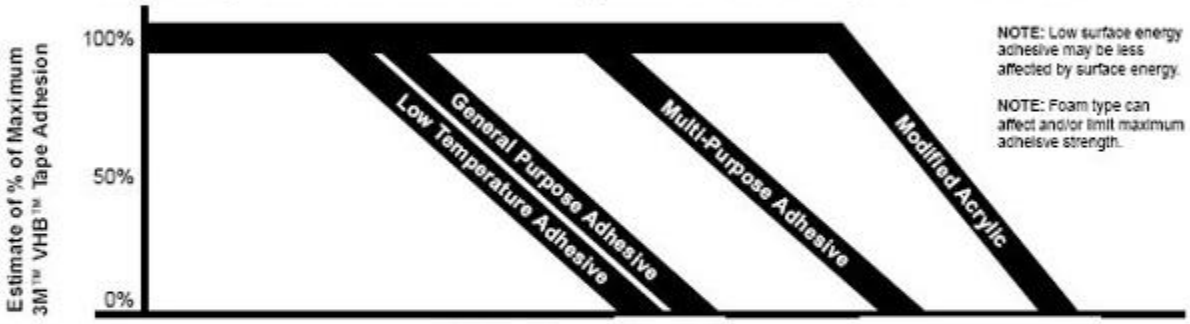
Low Temperature Appliable Adhesive
Bonds to high surface energy substrates and some medium and medium high surface energy materials. (Used on 4951 family tapes)

Low Surface Energy
Bonds to some low surface energy substrates and smooth surface in the other categories. (Used on 4952 family tapes)

Below are general groupings of materials into surface energy categories. Note that this should be treated only as a guideline as many general plastic types (e.g. ABS) can have a wide range of surface energies depending on the additives. Mold releases or surface oils can also significantly shift the surface energy. Adhesion to a particular substrate type should always be confirmed through testing.

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

Relationship of Adhesion and Surface Energy for 3M™ VHB™ Tape Adhesive Families



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

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

Use the right thickness of tape

The necessary thickness of tape depends on the rigidity of the substrates and their flatness or irregularity. While the 3M™ VHB™ Tapes will conform to a certain amount of irregularity, they will not flow to fill gaps between materials.

• For bonding rigid materials with normal flatness, consider use of tapes with thickness of 45 mils (1.1 mm) or greater.
• As the substrate flexibility increases thinner tapes can be considered.
• Thinner tapes can be used to bond small rigid parts.
• Large parts where a higher degree of expansion and contraction is expected might need thicker tapes.

• As a guideline, the 3M™ VHB™ Tapes can allow up to 3 times their thickness is differential substrate movement in the shear direction (300% shear strain).

Consider the use of conformable or very conformable foam types to increase the contact area and reliability on rigid substrates.

Consider the Environment of Use

Temperature

3M™ VHB™ Tapes should provide good performance in typical ambient temperatures from about 200 F down to -40 F and below, provided there is a good adhesive bond to the substrates. While we do not see low temperatures to be a limiting factor in most applications, we do suggest that a thorough evaluation be conducted by the end user at actual use conditions on applications where high impact stress is expected at low temperatures. Some tape types are suitable for longer periods of time at temperatures up to 300 F and are capable of handling temperatures up to 500 F for short periods of time such as could be experienced in a paint process.

Moisture

The 3M™ VHB™ Tapes maintain excellent performance in high humidity and high water contact conditions. Tape bonds showed excellent integrity and adhesion levels after submersion in water and salt water for 10 years. Long term submersion or exposure to moisture or water submersion can have the effect of making the polymer more resilient and tolerant of high elongation. Drying of the 3M™ VHB™ Tapes and bond lines will show this effect is reversible, and that the bond will return to the original dry stiffness and strength.

Solvent and Chemical

The 3M™ VHB™ Tapes have excellent solvent and chemical resistance. For solvents and chemicals that have a more significant effect on tape performance occasional splash contact is generally suitable. The tapes can withstand regular contact with solvents or chemicals that have less effect on performance. Continuous submersion in solvent or chemical solutions is not recommended. When performance has been affected with solvent exposure the tape will show swelling at the edges. Contact with strong acids when the tape is bonded to metal substrates should be avoided.

UV

All 3M™ VHB™ Tapes have excellent UV resistance.

Use the right amount of tape

Because 3M™ VHB™ Tapes are viscoelastic by nature their strength and stiffness is a function of the rate at which they are stressed. 3M™ VHB™ Tapes behave stronger with relatively faster rate of stress load (dynamic stresses) and will tend to show creep behavior with stress load acting over a long period of time (static stresses).

Static Stresses

As a general guideline, approximately four square inches of tape should be used for each pound of weight to be supported in order to prevent excessive creep. (0.25 lb/in2 load factor). This includes a general safety factor. Static load can include dead load weight the tape is holding, or memory or recovery of one of the substrates if there is a "spring back" situation or if fit is less than ideal.

Dynamic Stresses

The dynamic performance characteristics provided in the data page should be useful for general applications, factoring in the appropriate safety factors. For panel to frame applications, design strength of 60 lb/in2 is commonly used (45 lb/in2 for 5952 family). This is derived from the simulated 1 minute peak wind load. A safety factor of 3 to 5 would typically be applied depending on the application.

Mechanical assistance (fasteners, setting a panel on a ledge or setting block) is sometimes included in a design to reduce or eliminate the static stress on the tape while taking advantage of excellent dynamic strength. The effects that this has on expansion/contraction allowance or dynamic strength

should be considered when designing.

Application Techniques

For successful application of 3M™ VHB™ Tapes it is important to have clean and dry surfaces, to provide adequate pressure to make contact with the substrates, and to insure application temperature is sufficient to build adhesion. 3M™ VHB™ Tapes will build adhesion with time. Adhesion promoters can be used to increase adhesion, to speed bond build or to improve durability on select materials.

Clean

Most substrates are best prepared by cleaning with a 50:50 mixture of isopropyl alcohol (IPA)* and water prior to applying 3M™ VHB™ Tapes. **Exceptions to the general procedure** that may require additional surface preparation include:

- **Heavy Oils**
  A degreaser or solvent-based cleaner may be required to remove heavy oil or grease from a surface and should be followed by cleaning with IPA/water.
- **Abrasion**
  Abrading a surface, followed by cleaning with IPA/water, can remove heavy dirt or oxidation and can increase surface area to improve adhesion.
- **Adhesion Promoters**
  Priming a surface can significantly improve initial and ultimate adhesion to many materials such as plastics and paints.
- **Porous surfaces**
  Most porous and fibered materials such as wood, particleboard, concrete, etc. need to be sealed to provide a unified surface.
- **Unique Materials**
  Special surface preparation may be needed for glass and glass-like materials, copper and copper containing metals, and plastics or rubber that contain components that migrate (e.g. plasticizers).

* NOTE: These cleaner solutions contain greater than 250 g/l of volatile organic compounds (VOC). Please consult your local Air Quality Regulations to be sure the cleaner is compliant. When using solvents, be sure to follow the manufacturer's precautions and directions for use when handling such materials.

Pressure

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. Typically, good surface contact can be attained by applying enough pressure to insure that the tape experiences approximately 15 psi (100 kPa) pressure. Either roller or platen pressure can be used. Note that rigid surfaces may require 2 or 3 times that much pressure to make the tape experience 15 psi.

Temperature

Ideal application temperature range is 70ºF to 100ºF (21ºC to 38ºC). Pressure sensitive adhesives use viscous flow to achieve substrate contact area. Minimum suggested application temperatures:

- 50ºF (10ºC): 4950, 5952, 4910, 4952, 4611, 4622 tape families
- 60ºF (15ºC): 4941, 4945 tape families
- 32ºF (0ºC): 4951 tape families

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 3M™ VHB™ Tapes it is important to ensure that the surfaces are dry and free of condensed moisture.

Time

After application, the bond strength will increase as the adhesive flows onto the surface. At room temperature approximately 50% of ultimate bond strength will be achieved after 20 minutes, 90% after 24 hours and 100% after 72 hours.

- This flow is faster at higher temperatures and slower at lower temperatures.
- Ultimate bond strength can be achieved more quickly (and in some cases bond strength can be increased) by exposure of the bond to elevated temperatures (e.g. 150ºF (66ºC) for 1 hour). This can provide better adhesive wet out onto the substrates.
- Abrasion of the surfaces or the use of primers/adhesion promoters can also have the effect of increasing bond strength and achieving ultimate bond strength more quickly.

Adhesion Promoters

Adhesion promoters or primers are used to:

- Increase adhesion to otherwise difficult to bond surfaces
- Develop a faster, stronger bond
- Seal non-unified surfaces such as wood or concrete
- Increase bond durability and stability to substrates such as glass and copper
- Provide a barrier from migrating materials such as those found in rubber or plasticized vinyl

Consult the 3M™ VHB™ Tapes Technical Bulletin "Surface Preparation for 3M™ VHB™ Tape Applications" for a suggestion of possible adhesion promoters or primers for each situation.

Note: It is important for the user to determine the suitability of the 3M™ VHB™ Tapes, primer and application process and compliance with local Air Quality Regulations.

Removal

The 3M™ VHB™ Tapes are intended for permanent applications. However, there are a variety of removal techniques that can be considered for breaking a bond and cleaning the adhesive residue from the substrate surfaces.

- Because the 3M™ VHB™ Tapes stay soft and resilient the foam can be cut with a variety of tools, from a textured piano wire to a 3M SMART Tool. Because the 3M™ VHB™ Tapes are sticky all the way through use of a lubricant, such as soap, will make the job easier.
- With small bonds the strength of the tape can be overpowered by prying or twisting. Removing at slower rates or at higher temperatures is generally easier.
- The residue can be removed by abrasion such as with a 3M™ Stripe Off Wheel, can be softened with a variety of solvents, or can be baked off with high temperature.

For details, consult the 3M™ VHB™ Tapes Technical Bulletin "Disassembly of 3M™ VHB™ Tapes Bonded Materials and Removal of Residue Adhesive". For applications that require regular removal the 3M Dual Lock Reclosable Fasteners with 3M™ VHB™ Tapes adhesive should be considered.