

BONDING LOW SURFACE ENERGY MATERIALS

***Die-Cut Adhesive Solutions to
“Stick to the Unstickable”***



SECTION 1:

INTRODUCTION

Engineered plastics and thermoplastics such as Thermoplastic Polyolefin (TPO), Polypropylene (PP), and Polyethylenes (e.g. HDPE) are being used now more than ever to reduce weight, improve performance, durability and aesthetics, and control costs in consumer and industrial products.

These polymers are flexible, durable, and resistant to moisture, heat, and solvents. Yet, due to a phenomenon referred to as low-surface energy, they are difficult to stick to—a trait which can create assembly challenges for product design engineers who prefer adhesives to mechanical fasteners.

This paper will discuss the benefits of adhesives, highlight the importance of surface energy, dive into the science of adhesion, and introduce some pressure sensitive tapes and adhesives that have been designed specifically for low surface energy (LSE) applications.



SECTION 2:

ADHESIVES VS. MECHANICAL FASTENERS

When joining materials made of low surface energy plastics, product designers have several choices.

While mechanical fasteners have long been a go-to solution, they add unwanted weight and bulk to the finished product, and add stress at the joint that can lead to cracks, premature failure, and other aesthetic blemishes. Adhesives, on the other hand not only bond effectively, they do so without the added weight, bulk and joint stress.



When compared to mechanical fasteners, pressure sensitive adhesives have a variety of benefits.

Among other things, they

- Reduce weight
- Distribute loads evenly, reducing joint strain
- Resists vibration, impact, flexing, shock, and heat
- Fill surface gaps
- Minimize corrosion by sealing joints
- Reduce the need for skilled labor
- Increase productivity
- Can be laminated to other materials such as foams, felts, flocks for added benefit
- Can be die cut into the exact size and shape needed for your application

SECTION 3:

ADHESIVE BONDING: THE BASICS

To receive the full benefits associated with pressure sensitive adhesives, however, it is important to choose the right adhesive for the substrate. This is the only way to achieve a proper bond. It is also where surface energy comes into play.

Bond strength is a permanent chemical attachment that is achieved when the adhesive wets out the substrate.

Standard adhesive formulations easily wet out and bond with High Surface Energy (HSE) surfaces such as ABS plastic or metal, but can't bond with LSE plastics such as polypropylene and polyethylene. In order to achieve full wet out, the surface energy of the adhesive must be as low or lower than the surface energy of the substrate to be bonded. There are two main ways to ensure this:

1. Raising the surface energy of the substrate
2. Using a low surface energy adhesive

WETTING

Wetting is the ability of liquids to form interfaces with solid surfaces. To determine the degree of wetting, the contact angle (θ) that is formed between the liquid and the solid surface is measured. The smaller the contact angle and the smaller the surface tension, the greater the degree of wetting.¹



Wetting

Adhesion Forces > Cohesive Forces

Spreading of the liquid on the surface of the solid.

Contact Angle θ : $0 < \theta < \pi/2$

¹ Adhesives.org, The Physics Behind Wetting,

<https://www.adhesives.org/adhesives-sealants/science-of-adhesion/wetting>

SECTION 3:

ADHESIVE BONDING: THE BASICS CONT.

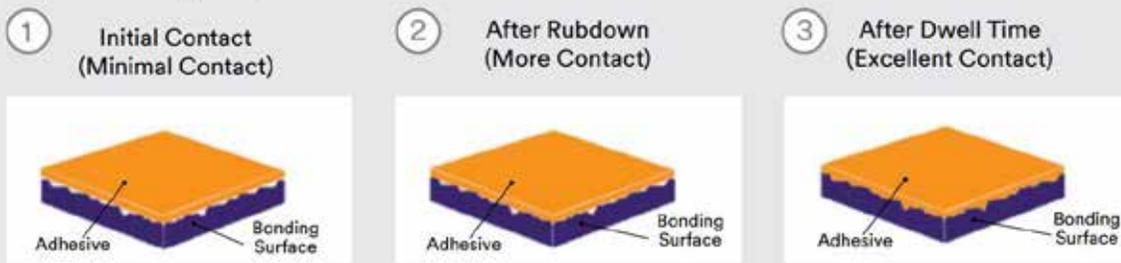
There are several methods that can be used to raise the surface energy of a substrate including priming, flame treating, and plasma treating. However, these methods have serious disadvantages:

- Increased cost
- Longer production time
- Added complexity
- Flame and plasma treatments may only be effective for a short period of time
- Primers come with many EHS regulations

Low surface energy tapes and adhesives achieve the same objective without adding cost, engineering complexity, or production time.

SECURE BONDING

Applying firm pressure to the bond increases adhesive flow and contact for more secure bonding. Time and temperature will typically further increase contact and adhesion values.



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SECTION 4:

SURFACE ENERGY

Surface energy—excess energy on the surface of a solid—is a physical property of the surface of a material that determines whether an adhesive will make intimate contact with a substrate.

On a material with high surface energy, a liquid will spread out and fully “wet” the surface; on a material with low surface energy, the liquid will resist flowing and bead up.²

To illustrate the point, imagine pouring water onto the hood of a car. The high surface energy of the hood will cause the water to spread out and cover as much of the hood as it can. Now, imagine the same scenario, but with a hood with wax on it. The wax brings the surface energy of the hood lower, which causes the water bead up on the hood rather than spilling off or covering the surface.

3M VHB adhesive tape works with the lowest category of surface energy.

For more information read:

CATEGORIZING SURFACE ENERGY

ENERGIZED BY SURFACE ENERGY²



Solid surface has high surface energy; Liquid will spread or “wet out” the surface.



Solid has low surface energy; adhesive Will bead up on the surface.

Adhesives function like liquids. When they come in contact with low surface energy materials, they fail to wet out and fully cover the surface. Instead, they bead up, prevent the adhesive from forming a strong bond, and create the aforementioned design challenges.

² 3M, Energized by Surface Energy,

<https://multimedia.3m.com/mws/media/19342000/energized-by-surface-energy-article-pdf.pdf>

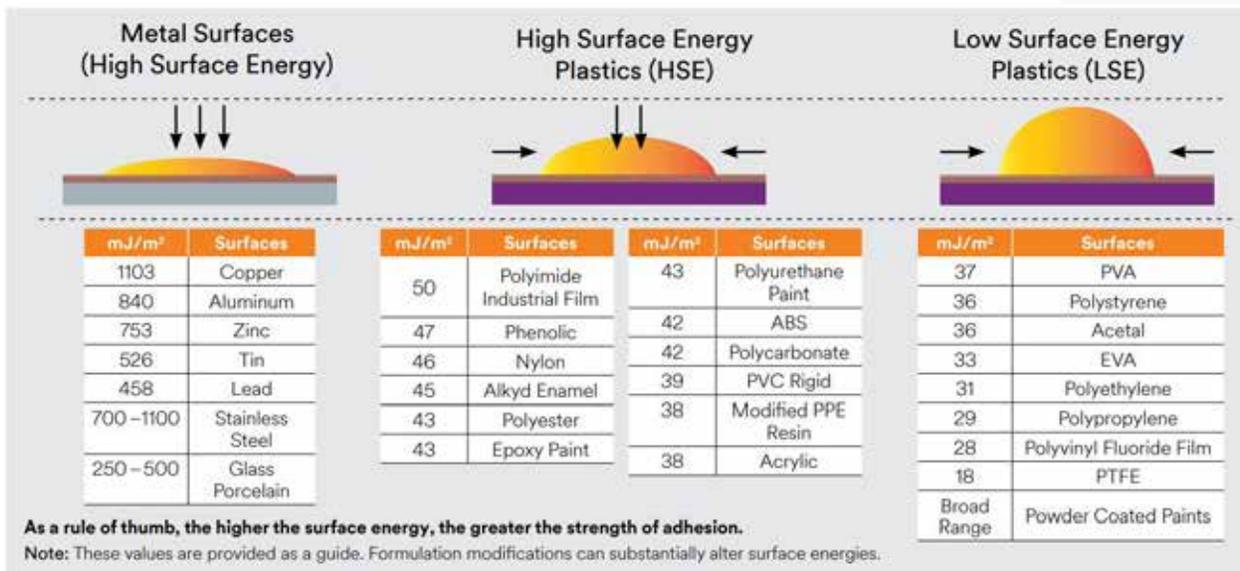
SECTION 4:

ADHERING TO LOW SURFACE ENERGY MATERIALS

In order to bond properly, an adhesive must be 7 to 10 dynes/cm lower than the surface energy of the plastic.

Pressure-sensitive adhesives that have a surface energy level of 20 dynes/cm will easily wet out LSE plastics that are 30 dynes/cm or more. The graphic below shows the categorizations of plastic materials based on the level of surface energy.

SURFACE ENERGY ON PLASTICS



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SECTION 5:

3M LOW SURFACE ENERGY ADHESIVE SOLUTIONS

The easier, simpler, and more cost effective way to connect LSE plastics is to lower the surface energy of the adhesive, rather than raising the surface energy of the plastic surface.

Developed specifically for bonding and joining low surface energy substrates such as plastics, powder coated paints and lightly oiled metals, 3M's low surface energy tapes and adhesives provide a true bond without the need of primers or promoters.

3M™ VHB™ TAPES

When you need a permanent, flexible bond

The 3M™ VHB™ Tape LSE Series is a double-sided acrylic foam tape developed for LSE substrates

3M Thin Bonding Tapes

For low profile applications

300LSE Low Surface Energy Acrylic adhesive offers 300°F (149°C) short-term heat resistance and outstanding adhesion to LSE substrates

Bondline thickness: 0.6 to 1.6mm	Bondline thickness: .05 to .20mm
Provides a flexible bond that allows for thermal expansion up to three times its thickness	Offers high initial bond and shear strength
Resistant to heat, moisture, and solvents	Seals out water, dust, and chemicals
Bonds composites and LSE plastics, creating a long-lasting, high strength bond without the use of a primer or promoter	Provides a thin, clean bond line
Dampens noise and vibration	Available in double coated tape and transfer tape formats for maximum flexibility

Made with solventless technology

Joins dissimilar materials

Can be die cut to match the custom size and shape specifications of your unique applications

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SECTION 5:

CUSTOM DIE-CUTTING & CONVERTING FROM JBC

Whereas 3M is an expert in tapes and adhesives, JBC Technologies is an industry leader in converting those tapes and adhesives into custom parts.

Our range of flexible materials converting equipment includes high-speed, tight-tolerance rotary presses, hot and cold melt laminators, and narrow and wide web hydraulic press machines.

For the last 30 years, we've put our engineering expertise to work transforming rolls of foam, insulation, adhesive tape, plastic film, melt-blown fabric, and even metal foil, into custom die-cut parts that have helped thousands of manufacturers solve critical design challenges.

What sets JBC apart from the crowd is that we never stop looking for ways to do things better. Whether that's through better materials selection, better part design, better part presentation, better assembly options, or better manufacturing processes, we're here to help you simplify your assembly process, increase value, and satisfy your end customer.



For more information about JBC Technologies and 3M adhesive tape, please visit our website at www.jbc-tech.com or call [440.327.4522](tel:440.327.4522) to speak to a member of our staff.



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