

**Silicone Adhesives**  
An answer to gentle skin adhesion

# Joining



# Forces



# Silicone Adhesives

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## Introduction

The goal, when adhering to skin, is to hold the device in place until it is time to remove it and to not damage the skin, either during wear or at the time of removal. Using methods developed for determining the surface energy of plastics and other materials, the surface energy for human skin has been measured in the low twenties [dynes/cm] – in other words, skin is as difficult to stick to as untreated polyolefins or even fluoropolymers.

Low surface energy, as a property of human skin, is generally great for most of the things skin is expected to do, such as easy removal of contaminants with simple soap and water. The downside is that tapes must balance between adequate adhesion levels for the majority of users – the middle of the bell curve – and the ends of that curve. When the adhesion is too low, the device may not stay in place long enough for the full therapeutic effect, and if it adheres too well, the tape may cause some mechanical trauma at removal.

Medical silicone adhesives have been designed to excel at that balancing act, achieving adequate adhesion levels to a wide range of skin types during device attachment, yet causing low mechanical trauma during removal. Until recently, there have been limited choices for skin-safe medical silicone pressure sensitive adhesives even though their gentleness and adhesion to skin profiles are often considered the “gold standard” for device attachment.

Substrate	Surface Energy [dynes/cm]
Aluminum	840
Polyester [PET]	43
Polyurethane [PUR]	43
Polycarbonate [PC]	42
Polystyrene [PS]	36
Polyethylene [PE]	31
Polypropylene [PP]	29
Human Skin	25
PTFE	18

Table: 3M Converter & Health Care Markets Data

## Selecting Silicone Rationale

Pressure sensitive silicone adhesives tend to be the highest priced alternative, but do have some special properties that may make them worth the extra price for select applications. Among those desirable qualities is low trauma adhesion to skin. Mechanical irritation to some degree is usually the outcome of taping to the skin surface. Even the most careful caregiver, using the best technique possible, will remove some hair and surface skin cells when peeling most tape products from skin. Skin condition/health, wear time, device location, climate, etc. all have an impact on the level of adhesion during the time the device is attached.



The therapeutic need for holding devices to the skin, often for several days, may offset often relatively minor discomfort. Silicone adhesives are well known to exhibit low negative impact to the skin surface – they do not stick very well to hair follicles, so silicone adhesives rarely pull out hair when removed – one of the “pain points” for tape removal. They also exhibit a low affinity to attract dry or dead skin cells that populate the surface leaving the skin area intact, possibly lowering the chance of infections that can occur when the upper layer or layers of skin are stripped away with the tape. This can be a very important factor when designing devices for the very old, the very young and other populations who have delicate or compromised skin.

## Skin Health Benefits

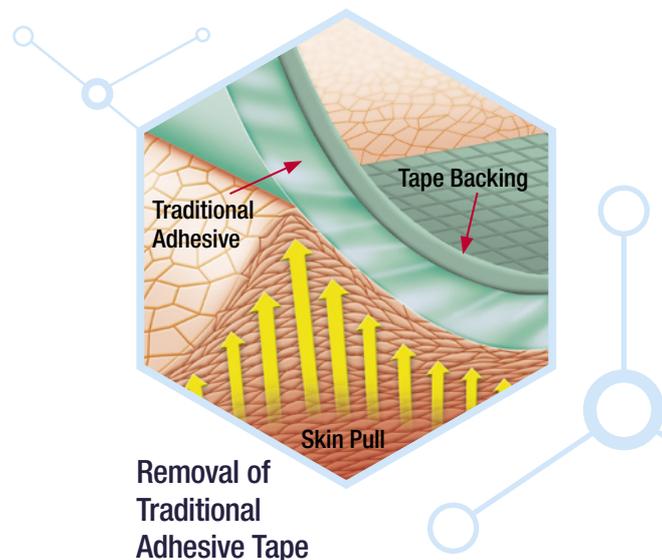
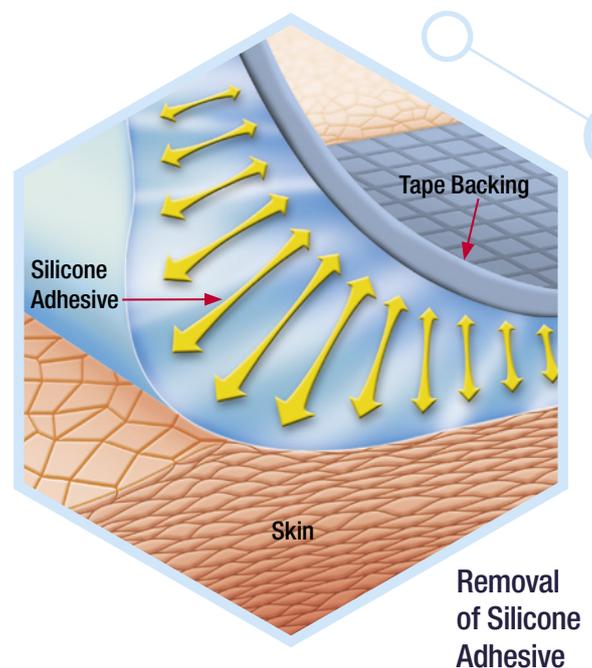
Upon removal from skin, silicone adhesives are less likely to become contaminated with hair follicles and skin cells that would normally interfere with reattachment of the tape to the skin. A contaminant-free surface often results in a tape or device that can be removed and repositioned several times, on some skin types, without replacing the adhesive contact surface. Caregivers may then be able to adjust placement, check under a device or even remove a device, clean the area and then attach it again without having to use a new device or piece of tape. These factors can also help maintain the health of the skin under the device.

## OEM Converting Considerations

New formulations of silicone pressure sensitive adhesives are emerging that allow OEM device manufacturers to put an industrial style roll on a station of their converting line and cut custom parts. The adhesive parts can then be used as components for assembly of specialty drapes and other devices for fragile skin areas of patients, who will appreciate the special qualities that silicone adhesives can provide. Manufacturers should consider a few things when working with silicone adhesives, other than just the price differential. Converters may want to have dedicated rotary dies and be careful to wrap any adhesive contact points with low release sheeting or tape, to avoid any type of change-over residue or “sticking” points. **Designers and engineers should also remember to review their choices of release liners when working with these adhesives.** They should not expect to be able to insert one of the usual silicone release liners when working with these tapes – silicone adhesives require special release surfaces to work correctly and this effect may only become evident after ageing studies.

## Summary

Taking all these factors into account, silicone pressure sensitive adhesives have an important niche to fill in the medical device industry by providing gentle, secure adhesion to skin for specialty applications. By innovators, design engineers and converters being aware of these properties and planning for them, new devices with improved compliance and less trepidation on the part of caregivers and the end users may be possible.





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