SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings

Release system information guide

DOW

Contents

General information

SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings are based on 100 percent solids reactive vinyl-functional siloxane polymers. When combined with their respective hydride functional crosslinkers and catalysts, these polymers form coatings that cure via an addition reaction in the presence of heat.

- Vinyl-functional silicone polymers contain these chemical groups: (Si-CH=CH_2).
- Hydride-functional crosslinkers contain these chemical groups: (Si-H).

Different release coating combinations can be selected to meet different performance requirements such as curing temperature, release force, bath life, etc.

Features

- Toolbox approach including several components to meet customer process and release requirements
- 100 percent solids; solventless processing
- Choice of inhibitor systems to meet different processing and substrate requirements
- A wide range of cure speeds, temperatures and release forces possible
- Food-contact-approved coating options available

Physical properties

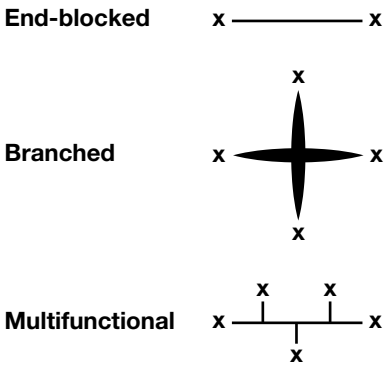
SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings are based on 100 percent solids silicone fluids. They are designed to be applied to paper and film substrates using industrial coating equipment and then crosslinked (cured) to give a silicone elastomer. They are available in a range of viscosities suitable for processing with equipment typically used for solventless silicone coatings. They are clear to slightly hazy and yellow in color.

Applications

- Release liners for pressure sensitive adhesive labels and tapes
- Industrial release papers and films
- Release liners for graphic arts
- Release coating systems for porous papers
- Release coatings for filmic substrates
- In-line, double-sided and differential release applications

Polymer structure

Both end-blocked, branched and multifunctional polymers are available in a variety of molecular weights:



In general, high-molecular-weight end-blocked polymers yield softer, more elastic coatings with easy release at low peel speeds and higher release at high peel speeds. Low-molecular-weight and multifunctional polymers, on the other hand, yield harder, less flexible coatings with less differentiation between high- and low-speed release force values.

For multifunctional polymers, the number of pendant reactive sites on the polymer chain can also affect bath life, cure, adhesive compatibility and release behavior (see Table 1).

Inhibitor systems

SYL-OFF™ Solventless, Platinum-Catalyzed Silicone Release Coatings use a process of controlled catalyst inhibition to optimize bath life and cure time within defined temperature ranges. Two different inhibitor systems are available:

Inhibitor system 1

- Good cure at standard oven temperatures
- Excellent thin-film stability
- Excellent cure-rate retention over bath age

Inhibitor system 2

- Facilitates cure at lower web temperatures
- Fast cure with low Pt catalyst level
- Excellent bulk bath life (stable viscosity over bath age)

Table 1. End-Blocked vs. Branched vs. Multifunctional Polymers

End-Blocked	Branched	Multifunctional
Longer bath life; slower cure	Faster cure, low Pt cure	Fast cure
Softer cured coating	Harder cured coating	Harder cured coating
Easy release at low peel speeds; higher (tighter) release at high speeds	Easy release at high peel speeds; higher (tighter) release at low speeds	Easy release at high peel speeds; higher (tighter) release at low speeds

Product range details

Most of the SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coating products listed below are available worldwide and meet the majority of global industry requirements. However, they represent only a portion of Dow's silicone release technology. Contact your Dow representative for information about additional, locally available product options.

Base coatings:

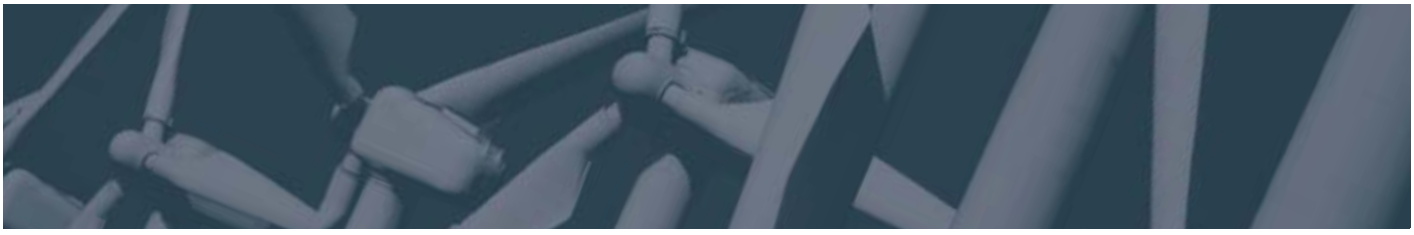
SYL-OFF™ SL 160 Coating	A 100% active solids silicone polymer containing a low/medium-viscosity, vinyl-functional polymer. Provides fast cure and low release force at low peel speeds and a moderately flat release profile.
SYL-OFF™ SL 161 Coating	A 100% active solids silicone polymer containing a low/medium-viscosity, vinyl-functional polymer. Provides fast cure and low release force at low peel speeds and a moderately flat release profile. Formulated for use at high process speeds.
SYL-OFF™ SL 181 Coating	A 100% active solids silicone polymer containing a medium-viscosity, vinyl-functional polymer. Provides fast cure and low release force at low peel speeds and low release at high peel speeds.
SYL-OFF™ SL 183 Coating	A 100% active solids silicone polymer containing a low-viscosity, vinyl-functional polymer. Provides fast cure and low release force at low peel speeds and low release at high peel speeds. Good anchorage against a range of paper based substrates.
SYL-OFF™ SL 184 Coating	A 100% active solids silicone polymer, featuring low release force at both low and high peel speeds as well as excellent mist reduction at high line speeds.
SYL-OFF™ SL 200 Coating	A 100% active solids silicone polymer containing a medium-viscosity, vinyl-functional polymer. Provides fast cure, low release force at low peel speeds and an inclining release profile.
SYL-OFF™ SL 201 Coating	A 100% active solids silicone polymer containing a medium-viscosity, vinyl-functional polymer. Provides fast cure, low release force at low peel speeds and an inclining release profile. Formulated for use at high process speeds.
SYL-OFF™ SL 351 Coating	A 100% active solids polymer designed to be used on porous substrates. It provides low release force at low peel speed and high release force at high peel speed.
SYL-OFF™ SL 400 Coating	A 100% active solids silicone polymer containing a medium-viscosity, vinyl-functional polymer. Designed to cure at very low platinum levels and facilitate line speeds up to 1,300 m/minute with minimal misting when used with SYL-OFF™ SL 11 Crosslinker. Provides fast cure and low release force at low peel speeds and a moderately flat release profile.
SYL-OFF™ SL 411 Coating	A 100% active solids silicone polymer containing a medium-viscosity, vinyl-functional polymer. Designed to cure at ultra-low platinum levels and facilitate line speeds up to 1,300 m/minute with minimal misting when used with SYL-OFF™ SL 11 Crosslinker. Provides fast cure and low release force at low peel speeds and a moderately flat release profile.
SYL-OFF™ SL 800 Coating	A 100% active solids silicone polymers designed to provide flat release for high speed converting. Offers fast cure and excellent bath life with low platinum levels.
SYL-OFF™ SL 585 Coating	A 100% active solids silicone polymer containing a low-viscosity, vinyl-functional polymer. Provides fast cure and low release force at low peel speeds and low release ay high peel speeds. Good anchorage against a range of paper based substrates. SYL-OFF™ SL 585 Coating includes platinum.
SYL-OFF™ 9106 Coating	A 100% active solids silicone polymers designed to provide stable anchorage on polyester substrates.

Catalysts:

SYL-OFF™ 4000 Catalyst	A reactive organo-platinum complex (higher concentration) dispersed in polysiloxane. May be used to reduce cure temperature when coating temperature-sensitive substrates.
SYL-OFF™ SL 3000 Catalyst	A reactive organo-platinum complex (lower concentration) dispersed in polysiloxane. A dilute form of the standard SYL-OFF™ 4000 Catalyst. Recommended for use in SYL-OFF™ Formulations where low catalyst levels are used.

Crosslinkers:

SYL-OFF™ SL 7028 Crosslinker	A 100% solids silicone crosslinker that is suitable for use with most SYL-OFF™ Solventless and Solvent-Based Coatings. Recommended where optimum anchorage to substrate is required.
SYL-OFF™ 7048 Crosslinker	A 100% solids silicone crosslinker that is suitable for use with most SYL-OFF™ Solventless and Solvent-Based Coatings. Recommended where optimum anchorage to substrate is required.
SYL-OFF™ 7682-000 Crosslinker	A 100% solids silicone crosslinker. Suitable for use with most SYL-OFF™ Solventless Coatings. Recommended where a combination of good cure and anchorage is required.
SYL-OFF™ 7682-055 Crosslinker	A 100% solids silicone crosslinker that is suitable for use with most SYL-OFF™ Solventless and Solvent-Based Coatings. Provides a good balance of cure and anchorage at low temperatures.
SYL-OFF™ 7678 Crosslinker	A 100% solids silicone crosslinker that is suitable for use with most SYL-OFF™ Solventless and Solvent-Based Coatings. Recommended where fast cure performance is required.
SYL-OFF™ SL 8 Crosslinker	A 100% solids silicone crosslinker. Suitable for use with most SYL-OFF™ Solventless Coatings. Recommended where a combination of good cure and mist reduction is required.
SYL-OFF™ SL 9 Crosslinker	A 100% solids silicone crosslinker. Suitable for use with most SYL-OFF™ Solventless Coatings. Recommended where a combination of good anchorage and mist reduction is required.
SYL-OFF™ SL 11 Crosslinker	A 100% solids silicone crosslinker. Specifically developed for ultra-low platinum levels when used in conjunction with SYL-OFF™ SL 400 Coating or SYL-OFF™ SL 800 Coating. Provides fast cure and excellent anchorage to many paper substrates.
SYL-OFF™ SL 12 Crosslinker	A 100% solids silicone crosslinker. Specifically developed for low to medium platinum levels when used in conjunction with SYL-OFF™ SL 400 Coating. Provides a balance of good cure and anchorage for low-temperature substrates.



Release modifiers:

SYL-OFF™ SL 10 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. Olefin-free. Recommended for moderate release modification.
SYL-OFF™ SL 20 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. It contains olefin. Higher efficiency modifier.
SYL-OFF™ SL 40 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. It contains olefin. Highest efficiency.
SYL-OFF™ SL 80 Release Modifier	A 100% active solids release modifier compatible with vinyl- functional polymers. It contains olefin. Higher efficiency modifier.
SYL-OFF™ SL 25 Release Modifier	A 100% active solids release modifier designed for efficient low speed release and low high speed release. Olefine-free.
SYL-OFF™ SL 35 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. Designed for highly efficient modification of release and formulated without olefin.
SYL-OFF™ SL 51 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. Olefin-free. Recommended for moderate release modification. Formulated with Platinum.
SYL-OFF™ SL 71 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. Contains olefin and anti-mist additive for very high speed operations.
SYL-OFF™ 7612 Release Modifier	A 100% active solids release modifier resin compatible with vinyl-functional polymers. Formulated with catalyst. Offers stable release and good bath life. Recommended for moderate release modification.
SYL-OFF™ 7780 Release Modifier	A 100% active solids release modifier resin mixed with mono-olefin. Compatible with vinyl-functional polymers. Formulated with catalyst. High efficiency modifier with good bath-life performance. Recommended where high modification of release is required.
SYL-OFF™ SL 9156 Release Modifier	A 100% active solids release modifier compatible with vinyl-functional polymers. Designed to provide stable anchorage for polyester substrates.

Additives:

SYL-OFF™ SL 9176 Anchorage Additive	Additive designed to improve anchorage of silicone release coatings to unprimed polyester films.
SYL-OFF™ 297 Anchorage Additive	Recommended for use where improved anchorage to substrate is required.

Product handling information

Substrates

SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings have been successfully applied to parchment; glassine; super-calendered, clay-coated and poly-coated krafts; plastic films and metal foil.

The suitability of a substrate for use with the chosen release coating should be evaluated before commercial application.

Application equipment

SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings are designed to be applied using precision coating equipment such as three-roll offset differential gravure and multi-roll smooth roll coaters.

Solventless coatings may also be blended with aliphatic solvents to a desired solids concentration and then applied using conventional solvent coating equipment.

Coat weight

Without experimentation it is difficult to establish precise recommendations for the correct amount of silicone coating to be deposited on the substrate. Deposition values are dependent on a combination of the viscosity of the coating formulation, the coating equipment used, equipment operation and substrate.

A recommended starting point is 1 g per m^2 (0.62 lb per 3,000 sq ft ream); this can be adjusted to meet substrate and end-use application requirements. Coating trials should be conducted for each substrate and coating formulation used.

Bath life

Coatings containing the Inhibitor System 1 have an average static bath life that exceeds 8 hours under normal ambient conditions. In practice, the actual useable bath life will be significantly shorter due to actual process temperatures and loss of inhibitor through atmospheric exposure. It is recommended that formulated coating baths be used within 4-6 hours.

Coatings containing the Inhibitor System 2 also have an average static bath life that exceeds 8 hours under normal ambient conditions. In practice, the actual useable bath life will still be significantly shorter due to actual process temperatures and loss of inhibitor through atmospheric exposure, but superior to that of the Inhibitor System 1. It is recommended that formulated coating baths containing the Inhibitor System 2 be used within 4-6 hours.

Bath life can vary significantly depending on the coating formulation and the test method used. Bath-life trials should be conducted for each formulation.

Formulation advice

Crosslinker: Coating ratio

Good cure can be achieved with crosslinker:coating ratios (calculated and represented as moles SiH:moles Vi or “SiH:Vi ratios”) ranging from 1.3:1 to 2.6:1. In some cases where anchorage or cure cannot be achieved within this range, it may be desirable to use higher SiH: Vi ratios, though this is also dependent on the type of vinyl polymer used. See the “Formulation Suggestions” section.

Catalyst

Two catalysts are available in two different Pt concentrations: SYL-OFF™ 4000 Catalyst and SYL-OFF™ SL 3000 Catalyst. See the instructions under “Bath preparation” and/or consult your Dow technical service representative for additional information.

Release modifiers

Release modifiers may be added to increase the peel force required to separate the release liner from the adherent. The greater the amount of release modifier added, the greater the increase becomes. Actual results will vary depending on the exact formulation used and other factors such as adhesive and substrates. For more details, see the section on “Release Performance”.

Bath preparation

Equipment should be clean and dry. Stainless steel equipment is preferred for handling solventless silicone release coatings.

The components should be mixed in the following order and then stirred for 20-30 minutes (in total) to ensure homogeneity:

1. Blend coating and release modifier; mix thoroughly.
2. Add crosslinker; and mix thoroughly.
3. Add catalyst (if needed) while mixing; mix thoroughly.

NOTE: The platinum catalyst is sensitive to contamination to a large range of compounds containing nitrogen, sulfur, tin, phosphorus, arsenic, antimony, selenium, tellurium and by some residual solvents and monomers. To prevent catalyst poisoning and inhibition of cure, good coater hygiene must be maintained. A more complete list of inhibiting agents is available from Dow.

Application information

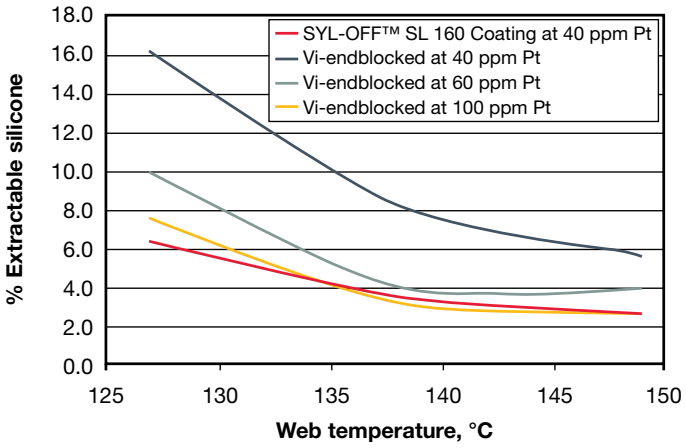
Cure performance

Polymer structure, inhibitor system, time, temperature, type and age of substrate, catalyst level, coat weight, and degree of surface penetration can all affect the cure performance of SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings. Due to the large number of variables involved, it is difficult to predict the temperature and machine speed settings required to achieve good cure of the silicone for any specific coater.

A key feature of SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings is the reduced level of platinum catalyst they require for good cure compared to older product technologies. Conventional solventless coatings combined with conventional crosslinkers typically require levels of 100 ppm platinum catalyst to achieve sufficient cure performance under normal production conditions. SYL-OFF™ Solventless Silicone Release Coatings based on branched polymers combined with conventional crosslinkers will cure at platinum catalyst levels as low as 40 ppm. An additional development of SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings is a crosslinker structure that improves cure performance still further and enables cure of the release coating at platinum catalyst levels as low as 25 ppm.

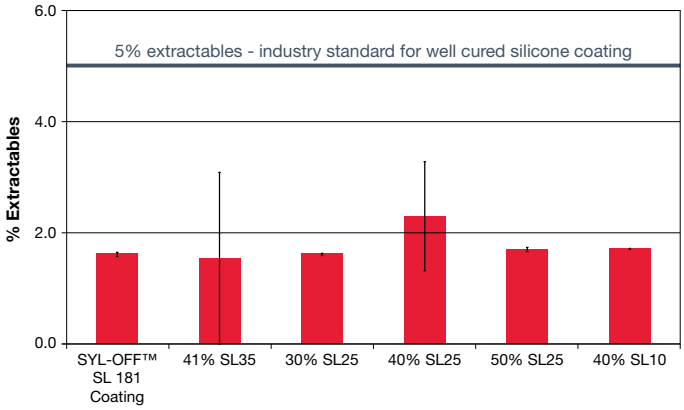
Figure 1 compares the cure performance of a SYL-OFF™ Release Coating with that of a conventional solventless coating at different levels of platinum catalyst. Both release coatings were formulated using conventional crosslinkers. The graphs show that the cure performance of a formulation based on the SYL-OFF™ SL 160 Coating at a catalyst level of 40 ppm is almost equivalent to the cure performance of a conventional solventless system at a platinum catalyst level of 100 ppm.

Figure 1. Impact of platinum catalyst level (ppm) on the cure performance of SYL-OFF™ Coating vs. a conventional solventless coating.



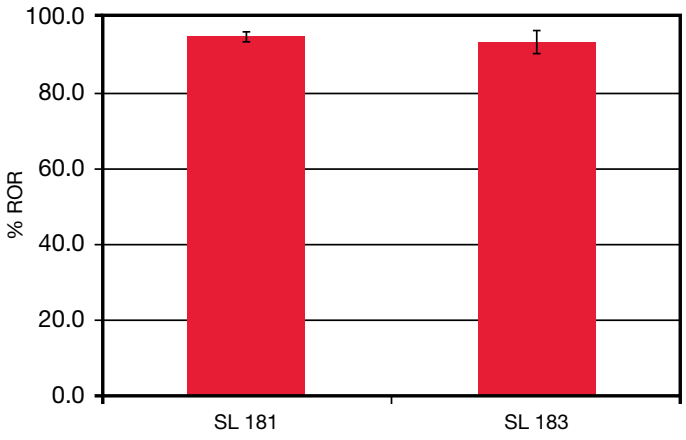
Low high-speed release coating with various release modifiers
Some of our newer release coatings have been designed to provide lower release higher peel speeds. These new release coatings can be used with a range of release modifiers and deliver good cure performance. See for example figure 2 which shows cure of SYL-OFF™ SL 181 Coating with various modifiers and different levels of crosslinker.

Figure 2. Comparison of % of extractables of SYL-OFF™ SL 181 Coating mixed with various release modifiers and with SYL-OFF™ 7682-055 Crosslinker. Cured at 160°C exit web temperature and 5 sec. dwell time.



We have developed new release coatings systems that cure with low Pt with good cure and anchorage performance. Very good anchorage is achieved (>90%) with both systems.

Figure 3. Comparison of rub-off resistance (ROR) of SYL-OFF™ SL 181 Coating and SYL-OFF™ SL 183 Coating, cured at approx. 145°C exit web temperature and 3 sec dwell time.



Overcoming Cure Inhibition

Some additives used in the manufacture of films and clay- and poly-coated krafts as well as the pre-coat found on most glassines and super-calendered krafts can adversely affect cure by inhibiting or, in some cases, “poisoning” the performance of the platinum-based catalyst.

Furthermore, when using offset roller systems to apply platinum-catalyzed coatings, care should be taken with the choice of rubber used for the coated rubber rolls. Materials used to vulcanize the rubber may also inhibit the cure of the silicone coating by influencing the performance of the platinum catalyst.

In some cases, where the effect on the platinum catalyst is only minor, this cure inhibition may be overcome through the use of higher levels of SYL-OFF™ 4000 Catalyst. However, before attempting to remedy such problems by adding more catalyst, it is recommended that the process and raw materials be analyzed to determine the source of the inhibition and whether it can be overcome or minimized through other means. Addition of extra catalyst should only be used as a “last resort.”

Release performance

Different coatings in the SYL-OFF™ Solventless Silicone Release Coating family can be selected for different applications, depending on the release performance required. In general, the higher the molecular weight of the polymer, the higher the release force at high peel speed. Figures 4 and 5 show the differences in the release profiles of the different SYL-OFF™ Polymers (with a 40 ppm platinum catalyst level) when evaluated against a hot-melt PSA and a water-based acrylic PSA. As a reference point, the figures also include release performance data on a conventional, vinyl end-blocked-only polymer.

Figure 4 illustrates how the lower molecular-weight branched polymers (and lower-viscosity polymers) tend to give a “flat” release profile compared to the higher molecular-weight branched polymers. They also show how SYL-OFF™ SL 200 Coating yields a similar release profile to that of a vinyl end-blocked-only polymer. The differences are generally much smaller for the water-based acrylic PSA than for the hot-melt PSA, but this is a typical observation for these kinds of adhesives.

Figure 4. Comparison of release profiles of a hot-melt PSA from different SYL-OFF™ Unbranched Polymers and a vinyl end-blocked-only polymer (for reference).

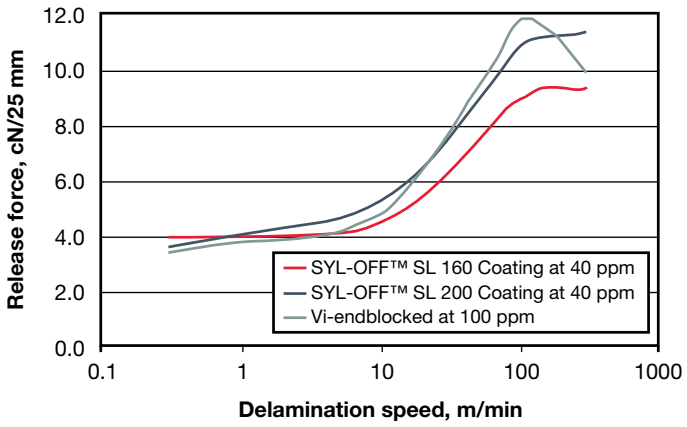
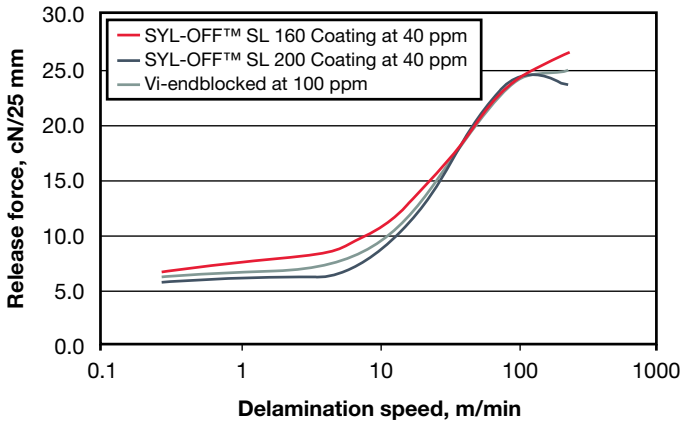


Figure 5. Comparison of release profiles of a water-based acrylic PSA from different SYL-OFF™ Branched Polymers and a vinyl end-blocked-only polymer (for reference).



Effect of release modifiers

The different release modifiers in the SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coatings family fall into two basic types: standard release modifiers offering moderate release modification, optimum cure performance and ease of handling; and high-efficiency release modifiers offering very high release modification. The choice of modifier type should depend on the level of release modification desired. Figure 6 shows the difference in performance for the two release modifier types when laminated against a hot melt PSA.

The desired release performance can be achieved by the correct selection of the release modifier in the release coating formulation. A range of release forces at low and high peel speed can be achieved. See Figure 7 as an example.

Figure 6. Comparison of the release performance of different types of release modifiers from a hot melt PSA (at a delamination speed of 0.3 m/min).

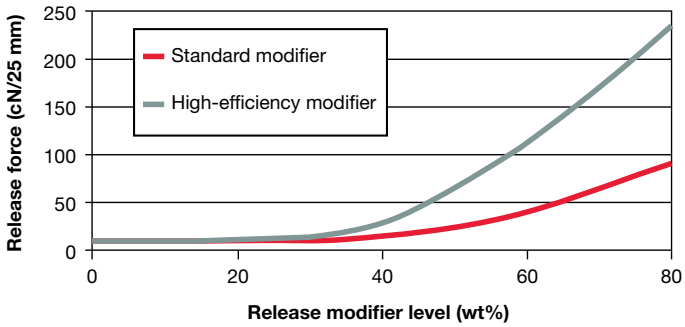
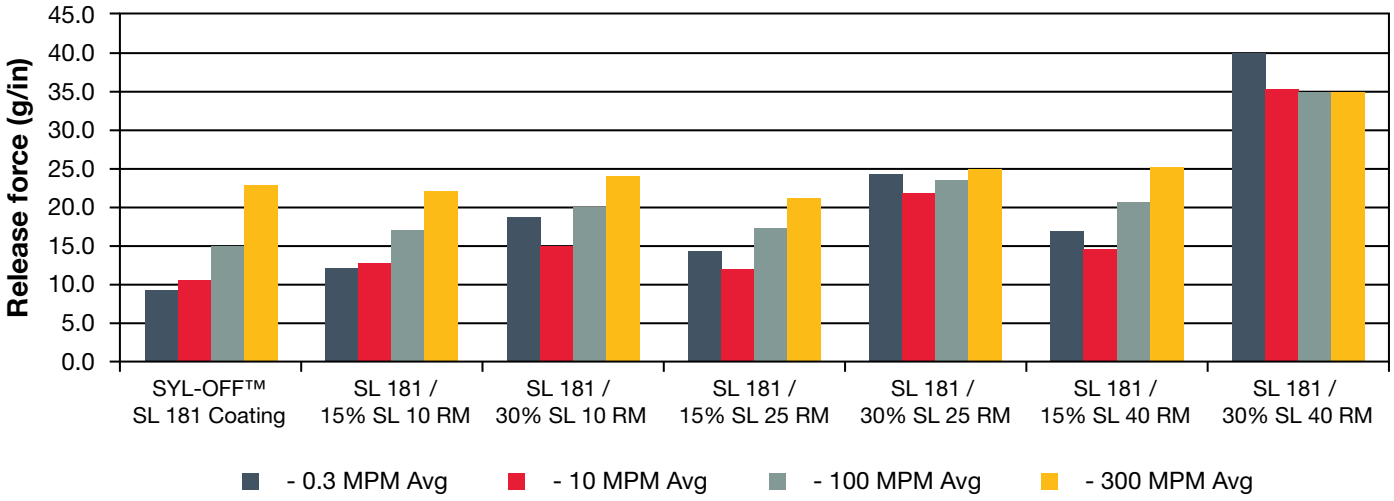


Figure 7. Release force at different peel speed with several Release Modifiers. SYL-OFF™ SL 181 Coating with several Release modifiers and levels, cured at approx. 145°C exit web temperature and 3 sec dwell time.



Formulation suggestions

Formulations

SYL-OFF™ Solventless, Platinum-Catalyzed Vinyl Silicone Release Coating components can be combined and adjusted in several ways to meet various process and performance requirements. The formulations provided in the following tables are intended merely as reference points for further optimization and discussion. Dow does not warrant their merchantability, fitness for use, performance, efficacy, safety or freedom from patent infringement. It is your responsibility to thoroughly test any formulation before use.

The choice on whether to use the low-temperature inhibitor system or extended bath-life inhibitor system depends on a combination of process conditions and substrates. The extended bath-life inhibitor may be the preferred option under difficult process conditions; but if low curing temperatures are required, the low-temperature inhibitor is the best option. The two inhibitors should NOT be mixed. For specific formulation advice, contact your Dow technical service representative.

Table 1: Typical formulation information

	Formulation (all with SYL-OFF™)	(A) Moderately flat release	(B) Easy release formula	(C) Ultra-low Pt formulation	(D) Flat release	(E) Moderate low peel speed release	(F) Flat release on difficult to adhere to substrates	(G) Moderate low speed release modification, flat release	(H) Tight release formula, 50% modifier	(I) Modified release with Pt in coating and modfier	(J) Release formultion for porous substrates. ultra low Pt
Coatings	**SL 160 or SL 161**	91.0				69.6					
	SL 200 or SL 201		91.2								
	SL 400			90.7							
	SL 181				91.3			71.4	44.3		
	SL 183						90.2				
	SL 351										93.0
	SL 585									69.6	
Release Modifiers	**SL 25**							17.8			
	SL 40								44.3		44.3
	SL 10					23.2					
	SL 51									17.4	
Crosslinkers	**7682-055**	4.2					9.0	10.0	10.4		
	7488				7.1						
	SL 11			6.0							4.6
	SL 12									13.0	
	7028 or 7682-000 or 7048		4.0			6.3					
Catalysts	**4000**				0.8	1.0	1.0	1.0	1.2		
	SL 3000	4.8	4.8	3.3							2.4

Numerical values refer to parts (by weight) per 100 parts of coating, release modifier or additive as supplied.

In general, the ratio of SiH:SiVi recommended here is in the range of 1.5:1 for multifunctional polymers and 1.75:1 for end-blocked polymers. Increasing SiH level will improve cure performance, but may have a negative impact on the release performance (particularly for some crosslinkable acrylic PSAs). Conversely, decreasing the level of SiH will improve release stability to some extent, but may also have a negative effect on the cure performance.

For information and assistance

For product data sheets, selection guides and an overview of Dow's comprehensive line of products and services for the pressure sensitive industry, visit **www.dow.com/psi**.

Food contact information

Certifications available upon request. For specific details, please contact Dow as regulations vary from country to country.

Limitations

These products are neither tested nor represented as suitable for medical or pharmaceutical uses.

Health and environmental information

To support customers in their product safety needs, Dow has an extensive Product Stewardship organization and a team of Health, Environment and Regulatory Affairs specialists available in each area. For further information, please consult your local Dow representative.

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