

HOW TO FIND THE RIGHT RELEASE LINER FOR YOUR APPLICATION WITH OUT COMPROMISING ECONOMICAL ASPECTS. AN OVERVIEW ABOUT SILICONE COATED LINERS AND THEIR APPLICATION FIELDS IN THE TAPE INDUSTRY.

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When making tapes it is all about the adhesive and the carrier. Yet, in most cases, you need another material for production that is often underestimated: The Release Liner. While many people spend a lot of time on development of adhesives, it is mostly felt that the liner, as a throw away product, shouldn't be invested too much time and money on. However, the release liner can have a major impact on your whole company if it doesn't work properly. Studies show that in the year of major disruptions in the supply chain, by quality or service reasons, there is not only a loss in sales and profit, but an increase in costs and inventory.

Overall when doing business the goal should be to create a reliable partnership amongst all parties of the supply chain by increasing confidence and trust in each other to achieve sustainable success. In an approach to reach that goal the expectations between the procurement and the engineering & product development teams are often different. Procurement is usually looking for a financially stable source that provides cost effective products with short lead times and on time in full deliveries (OTIF). Often preferred is also a local source, while with the ongoing globalization and modern communication tools even an overseas supplier might be giving you benefits such as 24hour lead time and availability. Product development on the other hand wants a supplier with high technical knowledge, ideally specialized in your application field, offering a wide variety of products and an even higher willingness to develop new liners if special requests come up. Fast and small trial options are essential to move your projects around quick. Summarized these points, your whole team is looking for a reliable partner with 0 negative impact on the company to minimize risk and additional workforce, resulting in a satisfied team.

This should be a good reason to invest a bit more time in choosing the right release liner for your application. The market currently offers a wide variety of different base papers and films, as well as silicones. There is almost an endless amount of combinations possible. On top you have to be in compliance with the industry you are supplying to. The following pages should give you an overview about the majority of products available in the release liner industry and how to choose the best fitting liner for your application without compromising economical aspects.

Base papers and films

Super Calendered Kraft Papers

Super Calendered Kraft papers are one of the highest runners in the tape industry. There are two major products that fall into this category: SCK and Glassine. In general you could say that the so called SCK papers are the US standard, while Glassine is the European standard.

This paper type is undergoing a treatment directly at the machine after the paper making process in order to later give it the ability for a good coatability and anchorage of the silicone. The fiber composition is a mixture of short and long fibers on both alternatives, but then the finish is slightly different. Glassine is finished with PolyVinyl Alcohol (PVA) while SCK is commonly finished with starch. The PVA enhances a better silicone anchorage over a long time. Once leaving the paper machine both varieties undergo a so called calendering process where the paper is going through multiple heated cylinders that compress it. In easy words comparable to ironing. Glassine has a higher grade of calendering which results in slightly less strength since more of the long paper fibers are destroyed during the calendering process. On the other hand the higher compression makes it a harder paper which gives better slitting results, especially important for those who want to use it in die cutting. The higher compression further results in a smoother and glossier surface finish beneficial to lower silicone penetration and better coverage when using the same amount of silicone compared to SCK's. In general Glassine & SCK papers are relatively stiff and provide high mechanical strength and high density.

Both grades are available in a variety of different weights ranging typically from 25#/40gsm to 98#/160gsm. Multiple colors are available. The majority of manufacturers in Europe would choose an 80gsm or 90gsm Glassine in white or yellow. In the US the 60# white SCK is still very popular. While there is also a 60#/100gsm glassine available you might want to check if the 55#/90gsm glassine is an option for you as well. The reason for that is very simple. In Europe the 60# glassine is more of a specialty grammage than the standard and broadly used 55# glassine. Thus the sourcing costs are higher in relation to paper weight and a switch would give you a price advantage. Following an overview on the most commonly used paper weights for tape manufacturing in Europe and USA in comparison to each other on basis weight and overall thickness:

	Basis weight lb/ream	Basis weight grams/ m²	Thickness/ Caliper, mils	Thickness/ Caliper, Micron	Colors
60# SCK	53 - 61	86 - 99	2.9 - 4.1	74 - 107 µm	white, natural
100gsm Glassine (60#)	60 - 65	102 +/- 4	3.2 - 3.8	90 +/- 8 µm	white, blue
90gsm Glassine (55#)	54 - 59	92 +/- 4	2.7 - 3.4	78 +/- 8 µm	white, natural, havana, blue, green
80gsm Glassine (50#)	48 - 52,8	82 +/- 4	2.4 - 3.0	69 +/- 8 µm	white, natural, havana

Machine Glazed Kraft papers - MGK

For less demanding applications you can also use a MGK. This is a kraft paper finished of the paper machine. It gets its final touch by running over a so called Yankee cylinder. It can be described like an oversized heated roller and gives the paper a smooth surface on the side that has been in touch with the Yankee cylinder. The smooth surface side is perfect for silicone coating while the open reverse side is not. If you are looking for a two side coated product, the reverse side could only get some sort of impregnation, while a lot of silicone has to be used to achieve a somewhat coverage due to the roughness of the open and not finished side. This will drive the costs up again. The nature of this paper is to be soft and being less sensitive against humidity. MGK papers are usually manufactured in lower

grammages and only white as a color. Typical applications include envelope manufacturing or hygienic products and it is not commonly used in specialty tape applications.

Clay Coated Kraft Papers - CCK

CCK papers are finished with a clay coating on top. There are various versions available, such as single clay coat, double clay coat, coating on one or both sides or alternative finishing's on the back side, such as a moisture barrier. CCK has its advantages in the good lay flatness and lower sensitivity against moisture. It is a soft paper with a closed surface that allows less silicone to penetrate into the sheet. However the clay coat has an impact on the silicone anchorage over longer periods of time and is therefore not recommended on critical applications. Due to the short fibers and clay coating this paper shows more slitting dust than SCK or PCK and is therefore not very popular in converting applications. CCK is available in wide variety of different paper weights and manufactured in white only. Main uses can be found in graphic arts (plotter films), certain tape applications or hot melt packaging.

Polyethylene Coated Kraft Papers - PCK

PCK is very popular when looking for a paper with excellent moisture stability and layflatness. It is either available as single side PE coated version or double side PE coated version. Of course best properties are reached with a two side PE coating. It should be considered that a single side PE coated kraft can only be impregnated with silicone on the open reverse side, similar to the MGK described earlier. It is no problem to silicone coat both sides of a double sided PE coated kraft though. While layflatness and moisture stability are excellent the disadvantage lies in the heat stability. Once you hit a mark of approx. 110°C you risk blisters in the liner.

PCK is manufactured with a matt or gloss finish. Standard on double side PCK is matt/gloss, but also gloss/gloss or matt/matt can be chosen. Depending on what type of silicone coating and amount of silicone is used you might end up with a glossier finish also on the matt side. Main application fields are tapes, graphic arts or medical products.

Films –Polyester (PET), Polypropylene (PP), Polyethylene (PE)

Filmic liners definitely have certain advantages over paper grades. They come with a higher strength even when a very wet adhesive is applied. Though this can also be a disadvantage if the carrier needs to absorb a certain degree of moisture from the adhesive during the drying process. Filmic liners provide a very smooth surface and are judged as a cleaner product with the majority of end users, especially in medical applications. Other advantages of filmic liners might be the color variety. While with paper you are often limited to white, unbleached/ natural, Havana and some blue, green or bright yellow there is an almost endless selection of colors available when using a filmic liner. Of course it all comes down to volumes and a proper check of newly used colors for potential inhibiting effects on the silicone coating. Disadvantages of using a film is clearly the heat stability and risk of static charging during processing. On top the silicone anchorage over a longer period of time is not as good as in comparison to certain paper grades such as Glassine & SCK. There are mainly 3 used types of filmic liners in the Tape industry:

PET: Harder film, high strength, up to 150°C heat stability recommended

PP: Softer than PET, heat stability up to 110°C recommended, can be thermoformed slightly if using a certain thickness, available as biaxial oriented version (BOPP) or mono-axial oriented version

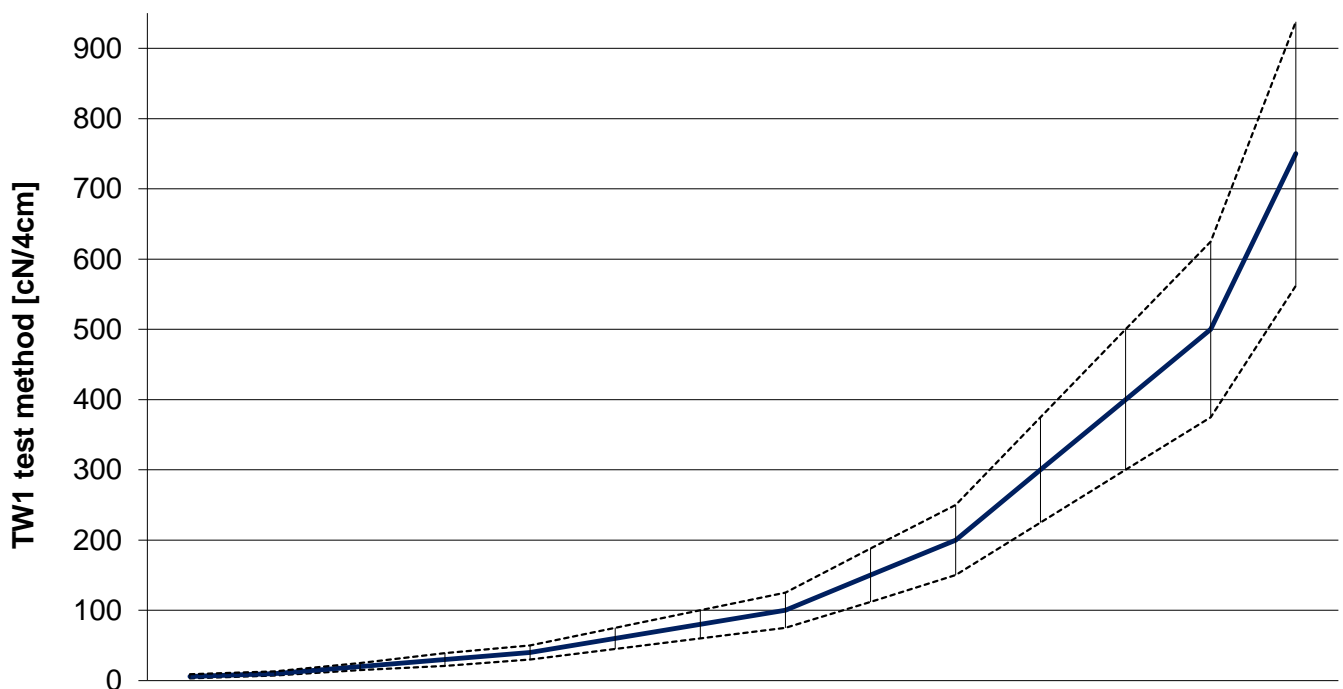
PE: available as low, medium or high density Polyethylene film (LDPE, MDPE, HDPE). The higher the density the harder does the film get and the higher is the heat stability. PE films are often used cause of their cheaper pricing or if a soft film is needed.

Silicone coating

While there is a variety of different systems available such as solvent based, solvent less, emulsion, UV cured, etc they all need to fulfill the one task. They need to release at the right time!

There is multiple ways to influence the release of a liner though. The most common is chemically by adding a release modifier to the silicone mixture. The higher the number of parts of controlled release additive the higher is the release level, means the more force do you need to peel the liner of the adhesive. It needs to be taken into account that the +/- tolerance increases with the tightness of the release level. This of course means that there can be overlapping release levels specified when choosing a very narrow release differential. It is the responsibility of your supplier to make sure that even when a narrow differential is ordered there will definitely be a differential delivered. Otherwise the product will fail and result in confusion within your process.

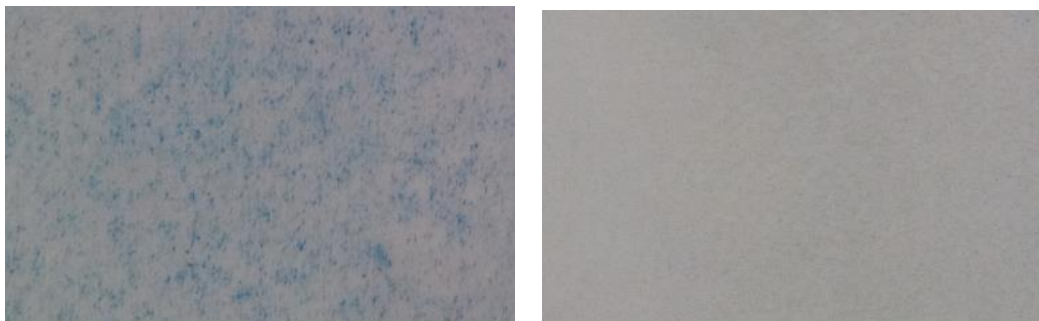
Behaviour of release tolerances in conjunction with increasing release level by adding a release modifier.



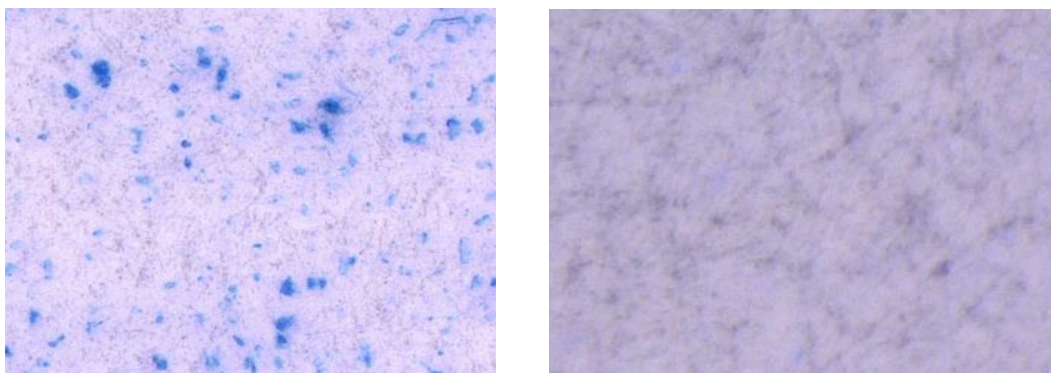
Another influence factor is the silicone coating weight applied, respectively the grade of coverage. It is very common in the liner industry to not coat a fully closed silicone surface, leaving pinholes in the silicone. Depending on the aggressiveness and viscosity of your adhesive this can lead to adhesive picking or occasional tight release. On the other hand it might be helpful to coat a lower silicone coating weight if just a chemically influenced release is not tight enough. Examples for that would be more of a low tack resin type rather than standard adhesives. Nevertheless there are certain applications that actually require a lower coverage for less friction or simply do not need extra silicone, as this is also a matter of costs. Especially adhesives with high viscosity are less critical to pinholes. In return with very soft and aggressive adhesives it is essential to have a proper silicone layer. It might even make sense to coat an extra thick layer to enhance the easy release. In order to create a stable product it is essential to implement coverage tests into the routine testing of release papers. Since also paper mills have a certain specification tolerances it can happen that one batch is slightly rougher than the other, thus needs a minimal amount of extra silicone to maintain the same degree of coverage and guarantee the functionality of the liner.

The degree of coverage can be judged by doing a stain test. With that test you put the paper into a bath of died water. Recommend colors are for example methylene blue, malachite green or new fuchsin. After 1-2 minutes take out the sample, clean it with fresh water and wipe the water off with a cloth. The higher the degree of coloring, the more pinholes the release liner has and the less coverage of the paper fibers. Each colored spot is a mark where the dye penetrated through the silicone.

Pictures of stain test done with white Glassine; left is lower silicone weight comparable to industry standard; right is fully closed silicone surface with an approx. coating weight of 1.8 gsm



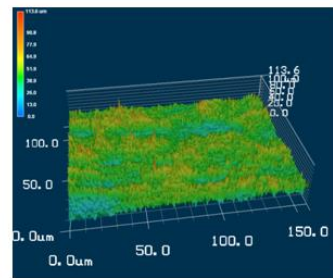
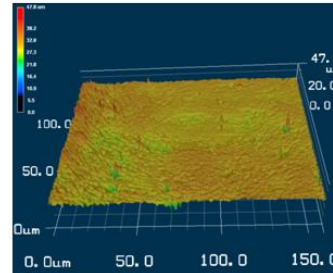
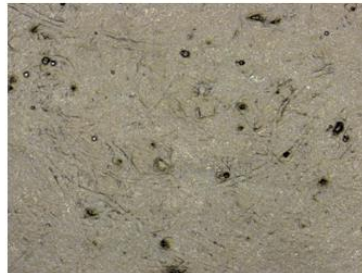
Microscope pictures of the same paper samples at a 40 times enlargement.



While the majority of adhesives prefer a closed silicone surface and a release influenced chemically with controlled release additives, there are some masses that have such a low tack that the release needs to be influenced with another factor: The Paper roughness. Especially with very low tack masses it might make sense to combine a very rough paper with a tight release system and a low silicone coat weight to still create a good anchorage between the low tack mass and the liner.

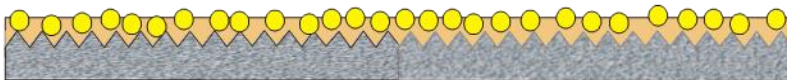
Surface structure

*Glassine (upper pictures)
in comparison to Kraft
paper (lower pictures)*



A rougher paper surface combined with lower silicone coating weights will also influence the level of friction with solvent less silicone specifically. The higher the coating weight the more rubbery the surface will feel. This can have a good advantage on release level, however provide in some cases a disadvantage with runability during production or depending on application also with the application itself. A good example is end tabbing tapes for the paper industry. A sticky silicone surface leads to the operators “burning” their hands while applying the liner backed tape to the roll and sliding their hands fast across the surface. A solution to this could be adding an additive to the silicone to provide a low coefficient of friction.

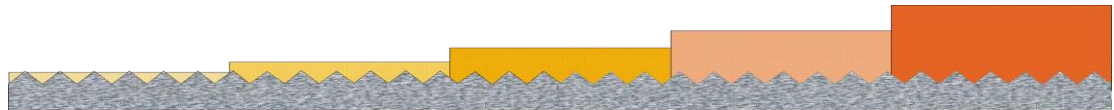
Low Coefficient Of Friction (COF)



Depending on application you could also choose a fully closed silicone layer on the adhesive coating side and a lower coverage on the reverse side to improve runability on the machine. The chosen base carrier further defines by the smoothness of its surface how much silicone will be needed.

There are also a few adhesives out there that might react with the used controlled release additive resulting in tight or zippy release, worst case up the point of blocking. For such instances there are several solutions. The easiest if possible is to choose a different silicone system overall that does not show the reaction. There are also systems available that show tighter release levels without adding controlled release additive at all. Another option is to initiate a differential by applying a thin silicone layer on one side and a very thick on the other side. The thin layer side in that case will be the tight side = your coating side.

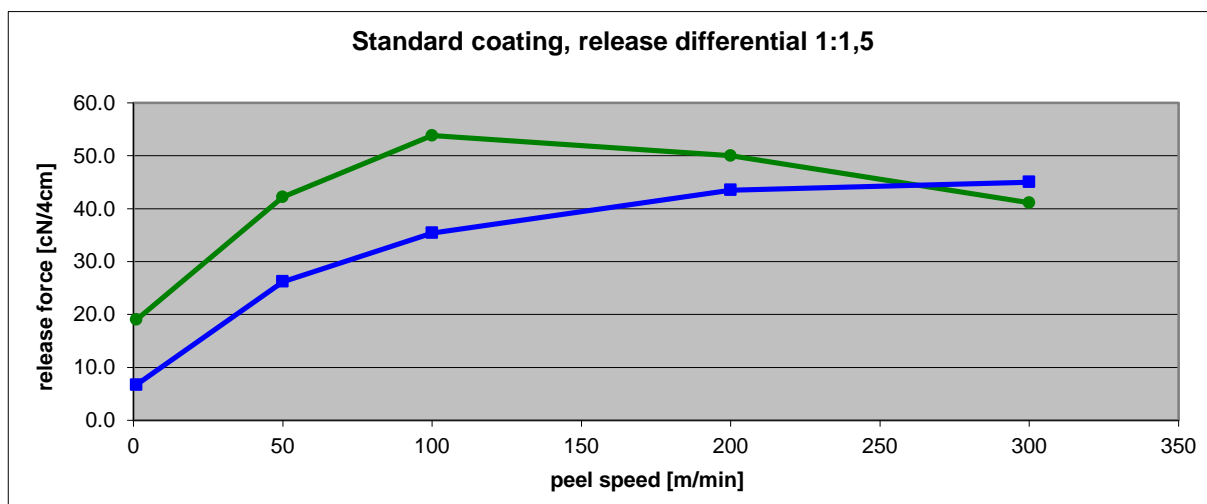
Different degrees of coverage by using x amount of silicone. Differences in silicone consumption between paper types and films.

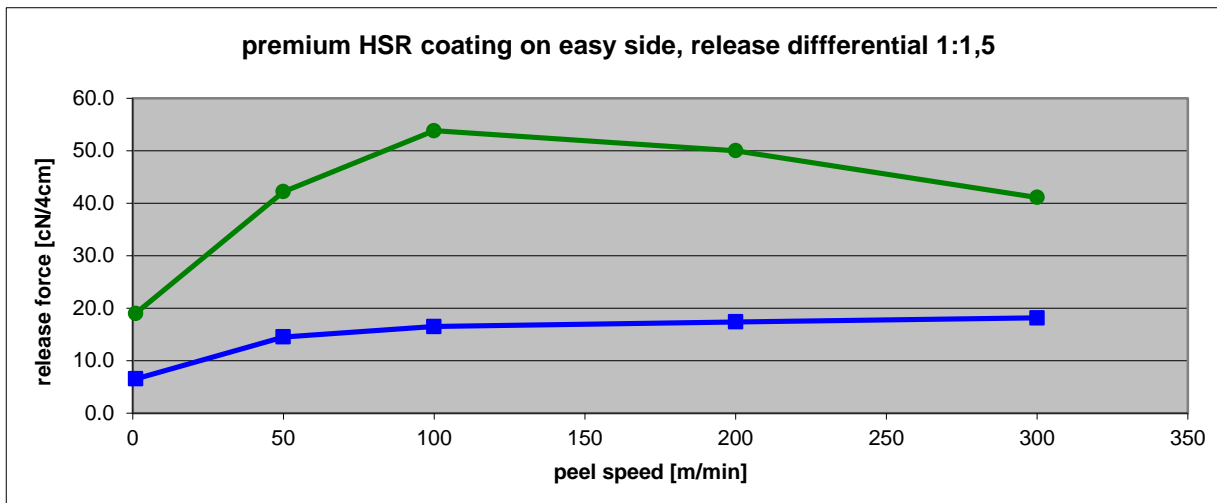


Glassine	min. 0,7	full covering approx. 1,8	min. 1,8	min. 2,3	min. 3,2
Film + PCK	min. 0,4	min. 1,0	min. 1,4	min. 1,8	min. 2,3
CCK	---	full covering approx. 2,0	min. 2,3	min. 2,8	min. 3,5

In addition to the standard silicone coatings, there are some special products you can choose. Often these come of course at a higher cost.

For example one of the biggest problems with today's increasing machine speeds, to achieve higher productivity, is the increasing release of the easy side in combination with a decreasing release of the tight side during high speed applications. Especially with low double sided differential that means at a certain speed eventually the release forces of both sides will cross and lead to confusion. In order to prevent this situation you can choose a premium high speed silicone release that stays flat even during faster delamination up to 300 meters a minute.





Other specialty silicone systems could be premium release coatings against acrylic adhesives. Release systems to prevent zippy release with Butyls. Or special silicones that are non-fluoro but still release against certain silicone adhesives or gels. With an endless amount of “specialties” it is essential to let your supplier know what challenges your adhesive give you in order to make the perfect recommendation.

Extras to personalize the liner to your application

Now that you have chosen the right base material and a silicone coating it is time to think about the extras your liner should bring to the application. And there are many of them. One very popular extra is of course the branding of the liner to identify it is your product. Most commonly this is done by printing the liner either on the reverse side or under silicone. It is essential to use a silicone system and printing color that will prevent from ghosting, which is basically the printing logo to show later in the adhesive.

Another form of extra is to use a colored liner. There are many ways of achieving a certain color. Majority of filmic products can actually be ordered in all kinds of different colors. However it is essential to test upfront when using a new color that the pigments do not have an inhibiting effect on the silicone coating. Some paper liners are also available in colors. Other options are to use a colored silicone, do a full covering print or tint the PE coating with PCK’s. With these last options it needs to be taken in account that the actual edges will still be white, as the used paper fibers.

Printing is also a common way to identify the coating side for machine operators. Commonly used is a square print while another popular and cheaper method is to use a marker and draw a black line underneath the silicone. This however bears a high risk of rub off on that exact line as most pens used for that have an inhibiting effect on the silicone coating. Therefore this method is only recommended if you do not coat over the drawn line. In order to save costs and minimize risk it might make sense to instead ensure to always get the same winding direction on your range of release liners and to train your operators on how to identify the coating side. With a single sided siliconized liner that is very easy. Just use a pen and try to draw on the paper. If there is a good wetting than this is the non coated side, while bad wetting is the silicone coated side. You could also use a post-it or any other not too sticky substance.

If you can release it then this is the silicone side. With double sided liners a piece of adhesive tape stuck to both sides and then removed by hand is usually the simplest way to identify the coating side. Of course that only works with medium and tight differentials.

Other additional extras may include antistatic finish, print receptive coatings, random perforation of the PE side or one of multiple slitting finishes. For example spool wounding, skip slitting/ line perforation in machine direction, round discs and sheets. In addition to specific finishing, there is a huge amount of laminates or specialty base available. Examples for that are paper/film laminates, PET/PE laminates or paper grades that are wet proof or made of 100% recycling products.

Information needed for a good recommendation

With so many options to modify a liner to your needs it is essential to know as many details as possible on the requirements the liner should fulfill. Basic information given to your supplier for a good product recommendation considering also economical affects should be the following:

- Required base material: paper, film or laminate
- Grammage, thickness, color of the base material
- Silicone coating: single or double sided, desired release levels
- Roll sizes and estimated volumes
- Final application/ product and production process
- Adhesive used
- Problems observed with current liner (if you are looking for a replacement)
- Trial size desired and time frame
- And of course if you are open to trial alternative liners as cost out options

Common application fields

On the following pages you will find a short overview on some application fields, the liners mostly used and the special requirements that they are faced with.

Transfer Tapes

The majority of transfer tapes are usually manufactured with soft and aggressive adhesives, most times acrylic based. It is essential to choose a release liner that shows stable release even throughout different production runs. A fully closed silicone surface is preferred to enhance that. It will also help to provide adhesive picking and minimize the risk of confusion. Differentials should be in the lower to medium range. Often a super calendered kraft paper in 55# or 60# is used (Glassine in 90gsm or 100gsm). Popular colors are white and natural in the US while in Europe also Havana is a big runner.

Consumer market

For the consumer market the most important feature is to combine a cost effective liner with a branding to recognize the company who made it. Most popular when it comes to branding is the company logo. In that market segment lower paper weights are popular to take costs out of the final product. Easy

handling is desired by the end-user. Therefore difficult initiation, tight or zippy release up to the point of liner splitting is a no-go and can result in an image loss.

Medical

Tapes going into the medical industry are mainly used for the manufacturing of dressings, general wound management, clinical necessities or stoma products. Only very few of them require a so called medical certification/ registration though. FDA and DMF is usually then the minimum requirement, while in Europe a BfR certification is beneficial as well.



Risiken erkennen – Gesundheit schützen

to the health of consumers by

The Federal agency for risk assessment (Bundesanstalt für Risikobewertung) is responsible for scientific counseling to the federal government in terms of food safety, product safety, contamination in the food chain, animal welfare and sanitary consumer protection. With this work the institute should make a contribution

to the health of consumers by making food, substances and products safer. So called “recommendations” are

originated out of this.



radiation. This is valid for products manufactured in the USA, as well as for imported products.

The Food and Drug Administration is the regulatory food inspection and pharmaceutical admission office of the United States of America. Their responsibility is to ensure the safety of public health in the USA. The FDA controls the safety and effectiveness of medication used in human and veterinary medicine, biological products, medical products, food, and equipment that emits

DMF

information available about our product.

A Drug Master File is a document where the pharmaceutical production and quality assurance of a drug is documented against a drug administration regulation for certification purposes. In our DMF 10968, Laufenberg provides information about used components and our production process to the American Authority.

Our customers refer to this DMF, where the Authority then has all necessary

The actual tape manufacturing, later going into additional production steps, is often made on 55# or 60# white super calendered kraft liners (Glassine 90gsm or 100 gsm) or on PET 50 µm or 75 µm. Especially with PET, the thickness is very stable as an essential need for die cutting applications and then also the patients rate a PET as a cleaner liner compared to paper. In addition some clean room manufacturing is critical when it comes to fiber material out of cores, packaging or the liner itself.

Automotive

In the automotive industry the most important requirement on a release liner is that it should never undergo a change, as funny enough requalification in automotive applications is most of the times more difficult than with aerospace. Thus a liner and silicone combination should be chosen that is long term available and ideally dual sourced on the base material side. Most popular liners in automotive are 55# & 60# super calendered krafts (Glassine 90gsm & 100 gsm) and CCK. All liners used for automotive industry need to have a superb silicone hold out to withstand certain so called lacquer tests. Special silicone systems are available that show better results than the standards.

Paper Industry

Tapes manufactured for the paper industry need a liner that has 2 major extras. It should have a low coefficient of friction and the ability to be repulped. How to influence a low CoF has been explained previously, please take a look at the section “silicone coating”. The repulpability then can be influenced by the paper type chosen and the type and amount of silicone. The lower the silicone coating, the better are the result in a test for repulpability. The following pictures are made with a two side fully covering silicone surface.

*Repulpability of a water soluble paper, a SCK and a glassine paper (pictures in that order) according to **TAPPI UM 213A**. Sample tested had comparable silicone coat weights. After producing handsheets the samples were judged in transmitted light.*



Aerospace

For aerospace applications the most important topic is silicone transfer. A liner with optimal silicone hold out, also over long periods of time, should be chosen. Ideal and popular are Glassine liners, which on top should show low extractable results. The most common test method for that is the so called Atomic Absorption Spectrometry (AAS). A sample of a defined size is submerged in Methylsobutylketone (MIBK) for at least 24 hours. The silicon content of the MIBK solution is determined with AAS. Together with the silicone coat weight you then can get the percentage of extractables. A good value is anything in the range of < 5% directly after silicone coating. Testing after a few days these results will be even lower. The extractable result depends a little bit on the substrate and the silicone coating as well. Especially very tight release formulations give higher results, while it is a commonly held misconception that the silicone coating weight influences the extractables. Special silicone systems to show low extractable results are available.

Building and Construction

Tapes manufactured for the building and construction industry are often butyls. Due to its sticky nature and behavior in different climate conditions, for example being stored in a car in the summer, release is one of the most important features the chosen liner should bring. A fully closed silicone surface, eventually combined with a special premium silicone system against zippy release will make sure that the product can be handled properly. Even if stored for a longer period of time or under higher heat and then being used immediately. While filmic products or PCK grades are very popular due to their moisture resistance they might not be the optimal choice for the manufacturing process. It might bring an advantage to choose a thicker paper liner in order to be able to apply more heat and therewith run

faster to increase productivity. An ever popular add on to the release liner is a perforation in machine direction. This allows the end user to apply the product easier by taking only have the liner off, tape the stripe where desired and then take off the second half.

Converting

For tapes that go into converting applications the major importance lies in a consistent product thickness. Changing thicknesses throughout production batches means a constant adjustment of the cutting equipment is needed to ensure a stable slitting & cutting quality. Stability is also a must have when it comes to the release level. If it is too loose the parts might release too early and are all over the place and if too tight won't come off at all. Popular liners are glassine that provides a good cutability due to its high density and of course PET for its consistent thickness. Some applications require a colored PET when optical sensors are used.

Acknowledgement

Many thanks to my colleague Dr. Roland Wilberger who helped me adopt so much knowledge about release liners and applications and even after many years of being my technical counterpart out on the road is never tired of answering my questions.