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RELEASE LINERS

WORLDWIDE SPECIAL REPORT

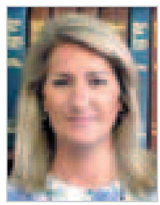
AWA Alexander Watson Associates

A PRIMEDIA Publication

Wanted: *A Better Knowledge Base*

A leading specialty converter explains why we need more education on release liners.

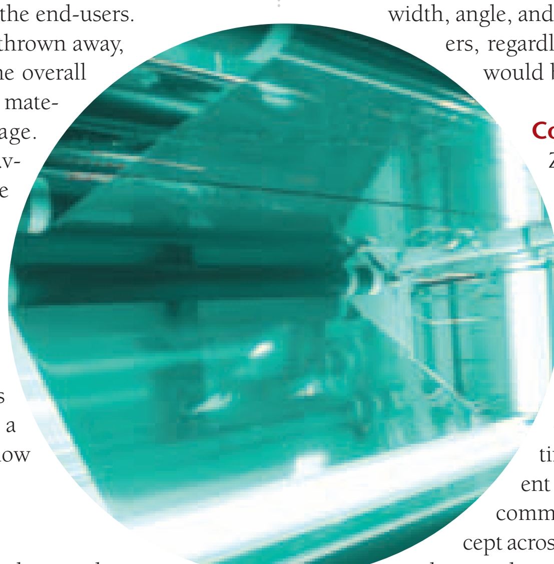
By Ann Hirst-Smith ***AWA Alexander Watson Assoc.***


S. Zaccone

Suzanne Zaccone, past president of Tag & Label Mfrs. Inst. (TLMI) and president of Graphic Solutions Inc., spoke at the recent North American Release Liner Conference organized by AWA Conferences. Her topic was "Release Liner Applications from a User's Viewpoint," and her message was unequivocal: "Converters are not as educated as they should be regarding liners. And their education, in my opinion, is key to working at solving problems at the converter and end-user level."

Zaccone came to this conclusion following a series of interviews with her own production staff and managers and with about 30 TLMI converter members, in which she asked for input on the challenges they have faced both in converting self-adhesive laminates and in working with their customers, the end-users.

She says, "Even though the liner is thrown away, converters believe it is as critical to the overall performance of the end product as the material and inks that provide the message. Good die-cutting and stripping are heavily dependant upon the ability to cut the face and adhesive cleanly without nicking the surface of the liner. Having a very uniform, dense surface (the anvil effect) to cut against is critical. The release level is also critical to good converting and dispensing, and building good silicone holdout into the liner is paramount. Consistency of release to a converter and an end-user is essential: low release can be as bad as high release."



Sticky Situations

Many problems faced by converters today are the result of their end-user customers' demands for lower-cost labels—and their own efforts to replace high-performance laminates with lower-cost constructions that simply cannot meet the die-cutting and stripping criteria. Such compromises only can be achieved successfully from a good knowledge base—and as far as release liners are concerned, converters do not have that.

Zaccone cited a number of instances of release liner "problems" that resulted in product failure, and in some cases shut down packaging lines for days. Solving the problem on hand can be a challenge in itself, due to the complicated nature of the self-adhesive laminate—it is not always apparent to a converter where the problem lies—and identifying the cause can involve the laminator, release liner supplier, and even *their* suppliers. It can be a major cost to the converter, since there is a trend toward end-users levying fines on suppliers responsible for downtime on production lines, as well as the cost of reprinting or re-converting the job.

However, this is not the main cause for concern: Large end-user companies have a choice in the labeling or product decoration technologies they employ, and any major or recurring failure in self-adhesive label performance could lead them to switch. Today, there are plenty of alternatives to the "traditional" self-adhesive laminate: direct print, linerless labels, shrink sleeves, and in-mold.

Two of the major technical problems that were highlighted by Zaccone will be familiar to readers: silicone skip (resulting in poor label dispensing from the liner), and its opposite, over-coating of silicone (resulting in label movement on the web, poor converting, and poor dispensing). Several converters no longer specify anything other than polyester liners for high-speed labeling applications; and when, for any reason, polyester liners are unsuitable, converters increasingly are specifying glassine for its enhanced die-cutting, stripping, and application properties compared to super-calendered kraft.

The actual silicone system employed on a liner is also something of a mystery—but essential if a converter is to make an informed decision on the laminate required for a particular application. The attributes of the various systems are completely different—but again, the industry makes it difficult for the converter to compare them, since no two companies use the same testing and measurement methods. Says Zaccone, "The same size, width, angle, and adhesive should be used to test all liners, regardless of supplier. A good plan of attack would be to develop industry standards."

Collaboration and Communication

Zaccone says her company, Graphic Solutions Inc., likes the challenge of "something strange, challenging, or untried," and in addition to self-adhesive labels, converts aluminum nameplates, polycarbonate panels, PCBs, electroluminescent lamps, RFID antennae, and thin and flexible batteries. Many of these are leading-edge technologies, and she says, "the ultimate success of these seemingly different challenges hinges on collaboration and communication." She extrapolates this concept across the whole of the supply chain and emphasizes the need for converters to be able to see "the big picture" in order to do their jobs to their own satisfaction—and that of their customers.

Her message to the self-adhesives industry is clear: "If the silicone liner supplier, adhesive supplier, material supplier, converter, and end-user work closely together, ask a lot of questions, and develop specifications that meet everyone's requirements and abilities, then everyone wins."

Editor's Note: AWA Conferences' first North American release liner conference was held September 9 at the Hyatt Rosemont Hotel in Chicago, IL. The program attracted good attendance and contained something of interest for every level of the value chain. A two-and-a-half day global release liner conference is scheduled for May 1–3, 2003, at Hilton Head, SC.

Label Stock Liners: *Issues & Trends*

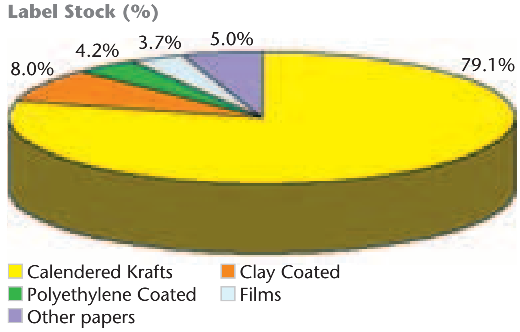
Some pointers from the recent AWA North American Release Liner Conference.

The self-adhesive label stock market is changing in response to the purchasers' increasing demands for product innovation and higher levels of service, without any increase in costs. To maintain profitability, paper and film manufacturers, self-adhesive laminators, and converters are realigning in the face of raw material price increases they cannot pass on and heavy pressure on margins.

Those in the middle of the value chain in the release liner market are experiencing pressures, too, and it is here there will be a major focus for change over the next five years as consolidation—already well established at raw material and silicone coating levels—takes hold. Price pressures are accentuated by the high levels of capacity available in the silicone coating market: In-house coaters currently are using only 55% of capacity, commercial coaters 65%. As state-of-the-art conversion machinery comes onstream, old capacity is not being "retired"—compounding the problem.

At the recent North American Release Liners Conference in Chicago, Corey M. Reardon, principal of AWA Conferences, had strong words of caution to the release liner manufacturers. "In this business environment, the prime need is to drive down costs and not margins in order to maintain a competitive long-term pricing structure that will enable you to remain in business," he said.

Main Materials Used
Label Stock (%)



Source: ©AWA Alexander Watson Assoc.

Film Liners

Film release liners represent the most dynamic sector of the release liners market today. While polyvinyl chloride, polyester (PET), polypropylene, and polystyrene all are used, it is the PET and polyethylene (PE) films—high-density PE, low-density PE, linear low-density PE—that are showing the greatest growth. The films market is, however, also experiencing overcapacity, the effects of globalization, and changing competitive advantages due to energy costs. While supply/demand balance is forecast for 2003–2004, the tight resin market is expected to mean higher prices.

Where release liner performance is a critical factor—especially for high-speed label application—films still must remain the ultimate choice. With around 55% of the world's consumption of film release liners concentrated in self-adhesive label stock, they demonstrate exceptional performance characteristics in terms of adhesive coat weight control, the layflat and consistency of the web, print and converting quality, and dispensing properties. Manufacturers of film release liners are expected to continue to develop market-led and research-driven specialty product streams, both for polymer technology and for coating technology. Average annual growth in film liners is 8%–10%.

Paper Liners

There are still enormous opportunities for paper-based liners. Growth in North America from 1997–2001 showed a compound annual growth rate of 4%, and 2002 growth is forecast at between 2% and 4%.

North America's preference for super-calendered kraft (SCK) liners slowly is being eroded by glassines, which offer a more comprehensive range of performance characteristics for high-speed label conversion and application. SCK still remains the cost leader, and any product innovation should not jeopardize that advantage. For lamination to film facestocks, PE-coated krafts represent an alternative to film.

Coating and Converting Issues

As new silicone technologies, coating enhancements, and converting standards develop, release base performance is becoming an increasing focus—whether paper or film. High-speed silicone coating has made misting on the production line a major issue in coating, since it can affect both conversion and dispensing performance adversely.

Release Liner as Packaging Waste

The prospect of classifying release liner as packaging waste is a reality in parts of Europe, and the likelihood is this will impact the North American label market—possibly to the detriment of self-adhesive technology and in favor of other product decoration methods. US-based Channeled Resources, with its increasing base of MaraTech subsidiaries around the world, sets an example to the industry by demonstrating how non-traditional reuse/recycling of release liners can be achieved successfully. The company currently salvages approximately 65% of its waste intake—both paper and films—for reuse, with the balance going to thermal recycling for energy creation.

Market Characteristics

Raw material prices continue to move upward, and competitive pressures increase as the value chain continues to consolidate at all levels. The self-adhesive label market is characterized by a trend toward smaller orders, delivered more quickly so customers can maintain their productivity—whether they are laminators, label converters, or label users. Technical performance of label stocks depends very much on the qualities of the release liner, and the boundaries continually are being pushed back. Facestock improvements have been the focus of self-adhesive laminators in recent years, and present standards probably represent the limit of capabilities in many respects, such as caliper reduction.

Success in Today's Business Climate

Reardon offers advice to players in the market for release liners in this difficult environment: "To be successful, you need to improve your profitability by finding new market growth opportunities. You need to provide added-value materials and services—and take non-added-value complexity out of the supply chain. Demand will continue to grow for performance-oriented materials and, conversely, for the lowest total cost offering the best possible effect.

"Don't wait to invest in new technologies. Players who invested earlier—maybe without making money at the beginning—have acquired expertise…and you won't be able to catch up with them."

The Market for Release Liners

A look at North American trends and opportunities in a global context.

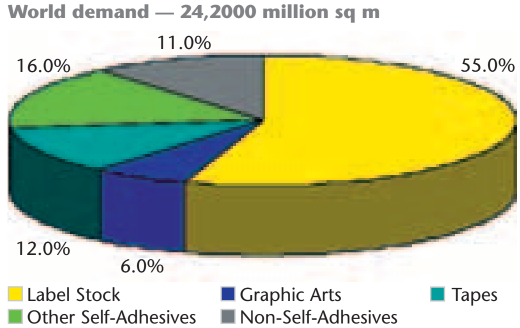
by Corey M. Reardon ***AWA Alexander Watson Assoc.***

In 2001 the worldwide market for release liners totaled an estimated 24,200 million sq m of silicone-coated papers and films—a lower than expected level of demand. The softening of the US economy during the last quarter of 2000 and its impact on the global economy was the main driver. However, there is optimism the US economy may strengthen in 2002 and beyond, and the economies in Europe, Asia, and parts of South America—already showing moderate growth—should follow.

Of the five major application categories in the market—label stock, graphic arts, tapes, other self-adhesive, and non-self-adhesive applications—self-adhesive applications account for 89% or 21,538 million sq m worldwide. The other segments—film casting, bakery and food liners, and industrial non-self-adhesive applications—account for the remaining 11% (2,662 million sq m).

Worldwide Market by Application

World demand — 24,2000 million sq m



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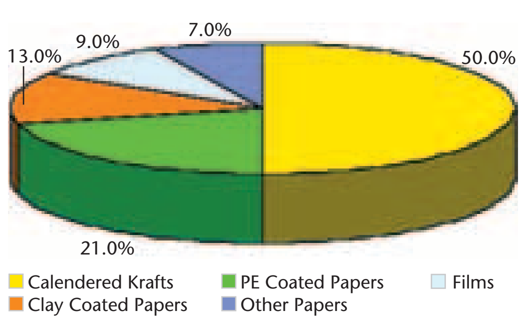
In the global market, North America continues to dominate demand, accounting for about 42.6%. Europe takes second place with 31.4%, and Asia Pacific now represents a sizable 22%.

Release Liner Substrates

Overall, substrate demand is dominated by calendered kraft papers, with polyethylene-coated papers in second place, but this generalization is subject to significant regional differences, which (as in Asia Pacific) may be influenced by such basic factors as climate. In North America and Europe, calendered krafts predominate, though each region has its own specific preferences.

North America favors super-calendered kraft (SCK) papers, where Europe prefers glassines. PE-coated papers take the highest share in Asia Pacific (particularly Japan).

Worldwide Market by Substrate



Source: ©AWA Alexander Watson Assoc.

Film liners currently achieve a 12% level of penetration both in North America and across the globe and are growing fast, both in self-adhesive and non-self-adhesive application areas.

The North American Market in Detail

Based on the AWA North American Release Liner study published last year, the total North American market for release liners was quantified at 9,719 million sq m of silicone-coated papers and films—across all applications. Worldwide, self-adhesive applications claim the main usage, approximately 89% of the total. Of that total, 45% is in-house silicone coated, driven largely by the label stock and graphic arts segments.

The North American market share of commercial silicone coating companies (55%) will decrease slowly due to the dominance of self-adhesive (in-house coated) applications but will lead in all markets other than label stock and graphic arts materials.

Of release liners used in label stock applications, 80% are produced by in-house silicone coating by major self-adhesive concerns such as Avery Dennison and MACtac. In the highly competitive self-adhesive markets, in-house coating provides a valuable opportunity to minimize costs and increase margins.

There are a number of suppliers of paper release base in North America, including IP, Stora Enso, Westvaco, Wausau-Mosinee, SAPPI, Fraser, and Schoeller.

Some key suppliers for film grades are Saint Gobain, Tredegar Corp., Mitsubishi Polyester Films, DuPont Teijin, UCB, Phoenix Films, and ExxonMobil. Growth in films manufacture has been driven by the requirements of end-users for lower downtime on the packaging/filling line due to liner web breaks, by the relatively low costs of film manufacturing, and by the growth in market segments such as medical, building/construction, and tapes.

Commercial silicone coaters represent more than half the North American market today, and in a business arena of change, divestment, and acquisition, the top five companies today are Akrosil, CPFilms, Douglas Hanson, Eastern, and Loparex. Of these, only two are global players (Akrosil and Loparex) with production capacity in different regions worldwide.

The supply of silicones in North America is, in contrast to the other raw materials, concentrated among a small number of global suppliers—Dow Corning, GE Silicones, Degussa Goldschmidt, Rhodia Silicones, and Wacker-Chemie.

The changing profile of the industry, at all levels, will lead to higher capacity usage as consolidation, acquisitions, rationalization, and liquidations continue. Undoubtedly, fewer companies will account for a larger share of the business, but there are also good prospects for small specialist suppliers of niche products.

While overall market demand in North America remains buoyant (without enjoying the same growth rates as historically), there has been softening due to economic conditions. Forecast demand continues to rise, and an annual increase of 4% is expected looking forward. This growth is driven by self-adhesive applications.

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The Future for Release Liners in North America

The broad range of applications for release liners makes them a relatively secure niche in the world's converting industry. However, demand is softening—especially in the mature markets of North America and Europe—and they no longer can be relied upon to drive real growth, particularly the double-digit or near-double-digit growth seen in the past.

North America is not traditionally a main exporting region in the world for release liners, but there are opportunities for North American producers that are positioned to exploit such export opportunities, particularly in the economically expanding regions of Asia Pacific and South America. Reducing tariff barriers and international trade agreements such as GATT, NAFTA, and ASEAN can contribute to the attractiveness of such business.

In terms of market segments, the ethical and over-the-counter pharmaceutical markets—as well as nutraceuticals, medical disposables, and other medical and quasi-medical devices—are expected to benefit significantly from the demographic shift caused by the aging baby boomer generation—not just in North America but also in Europe.

AWA's in-depth market research in North America has led to projections of a 4% average growth for the release liners industry through 2003, an average that conceals considerable differences in the various market segments, as the chart below shows.

Markets Prospects—North America

Markets	Million sq m 2000	2001	2002	2003	% Change
Self-Adhesive					
Label Stock	4,985	5,185	5,390	5,610	+ 4.0 %
Graphic Arts	681	695	710	725	+ 2.1 %
Tapes	1,179	1,240	1,300	1,365	+ 5.0 %
Healthcare, Medical & Hygiene	733	760	785	810	+ 3.5 %
Building & Insulation	857	940	1,020	1,110	+ 9.0 %
Decorative Vinyl	50	45	40	35	- 5.0 %
Miscellaneous	238	235	230	225	- 1.5 %
Subtotal Self-Adhesive	8,723	9,100	9,475	9,880	+ 4.3 %
Subtotal Non-Self-Adhesive	996	1,000	1,005	1,010	+ 0.5%
Total	9,719	10,100	10,480	10,890	+ 4.0%

Source: ©AWA Alexander Watson Assoc.

There can be no doubt the market in North America is well-positioned to achieve continuing healthy growth in the medium term, supported by consumer goods' manufacturers demands for more—and more innovative—primary product labels; high growth rates in the building and insulation market and others; and an established and primarily domestic raw materials supply base.

Corey M. Reardon has more than 15 years of management experience in the converting and laminating industry with leading companies such as Rexam and Avery Dennison. Today he is a principal of international market research and consulting firm AWA Alexander Watson Assoc., a company that specializes in supporting the coating, laminating, and converting industries with multiclient and private market studies and industry-specific supply chain conferences. For more information contact AWA at +31 20 676 20 69; info@awa-bv.com; awa-bv.com.

Medical/Healthcare Use

Disposables demand will grow, but on a changing base.

North American demand for release liners for healthcare and medical applications is expected to grow 3.5% during 2002, from 760 million sq m in 2001. Together these applications make up the fourth largest segment—and one that continues to benefit from increasing demand and continuing innovation.

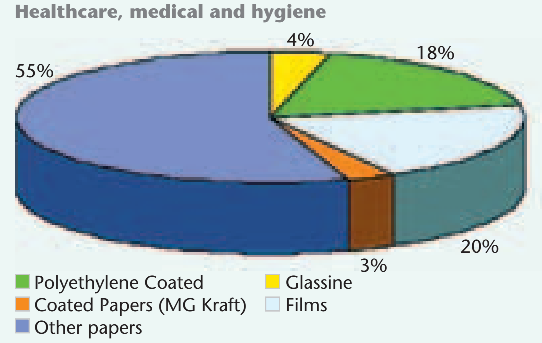
Key requirements are often a fiber-free surface, the ability to withstand sterilization (ETOX or gamma radiation), FDA approval, and sometimes a thermo-formable capability. Film liners can satisfy many of these requirements. Many of the liners used are silicone coated, but other options are polyethylene-coated papers or embossed polyvinyl chloride or PE films without a silicone release coating.

Liner Material and Applications

Film liners represent a 20% share of the market at 143 million sq m. They offer the greatest opportunity for growth. PE, polyester, and polypropylene all are used, and PE usage is forecast to grow by the greatest percentage. A mix of paper liners makes up the remaining 80% of the market.

Main Materials Used

Healthcare, medical and hygiene



Source: ©AWA Alexander Watson Assoc.

The majority of liners actually are featured on final products as a protective backing for a pressure-sensitive adhesive. However, a high proportion are used for film, foam, and adhesive casting or processing during manufacture. Material waste, particularly in the conversion of die-cut products such as ostomy pouches, can be high.

Market Structure

The market is served by a large supplier base, including custom coaters supplying large multinational healthcare and medical product producers. The majority of liners are supplied by commercial silicone coating companies. Many adhesive coating companies have developed a specialized market "know how" that extends well beyond the boundaries of self-adhesive technology into the realms of medical science.

Some of these supplier companies also extend their activities into the manufacture of the final converted product. Increasingly, the trend is toward global product manufacturers in the medical and healthcare markets. Many companies also specialize in just a few products of low volume but high value, such as single-use medical transducers and transdermal drug delivery patches. Today's trend toward non-invasive surgery and medication is driving growth in this sector.

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The Hygiene, Medical, and OTC Personal Care Markets

The hygiene market is the major segment in the total healthcare and medical market, representing about 79% of release liner usage, mostly papers. Healthy growth in this sector is expected to continue in response to demographic factors such as population increase through immigration, greater growth in the senior citizen age group (the aging baby boomer population), the growing importance of personal care, and forecasted modest birth rate gains.

In the medical market, three major segments use a self-adhesive laminate featuring a separate silicone-coated release liner: wound care dressings, surgical drapes, and medical devices. Of release liner materials used in medical applications, 49% are films.

Wound care represents the largest single usage, embraces a variety of release liner types, and is a focus for innovation as clinical healing techniques evolve. Growth is strong in this market. In the stable retail/over-the-counter (OTC) market, demand for wound care dressings and similar products remains anchored on "traditional" healing methods. Only demographic factors will create growth here. Film liners are an increasingly popular choice for hospital and retail products.

Drapes for use in surgical procedures require an adhesive-coated edge strip, protected by a liner. Industry sources identify 200 different "sets" of drapes, with 6–7 "universal" sets meeting the majority of requirements. The function of the release liner is basic, so the choice is typically a lower-cost, silicone-coated, bleached kraft paper.

Other tape applications are in the manufacture of components for devices, using double-sided tapes, foams, or transfer adhesives.

Applications on disposal medical devices include ostomy pouches, specialty bandages, medicated skin patches, and transdermal drug delivery systems. In many applications, the release liner of choice is either an embossed film or a PE-coated paper. As single-use medical disposables become a global standard for hygiene and containment of post-procedure infections, they are becoming the focus of global trading, a factor that may affect future manufacturing strategies.

It should be noted that both stoma care products and surgical drapes are expected to experience reduced demand for release liners in response to the trend toward less invasive surgery.

Personal care products that utilize the technologies developed for the ethical medical market are today a feature of the retail market. Examples are cosmetic patches: acne, moisturizing, and nose pore strips and anti-wrinkle pads. Other stick-to-skin OTC applications include allergy-testing patches and foot-care products.

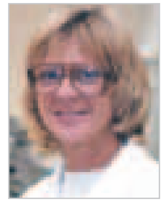
The Future

Release liners have a finite—but critical—role to play in these markets and represent a major segment. Opportunities for increased volumes are particularly strong for film liners, as in other market sectors. Demand for medical disposables is forecast to grow overall but on a changing product base, as medical science develops new techniques that require different care regimes. The market for personal care products such as facial strips is expected to grow in parallel: The high unit cost per product is not important for such small-pack retail products.

Suppliers to makers of healthcare and medical disposables are expected to develop a knowledge base outside traditional industry boundaries that will enable them to develop a competitive advantage.

Globalization is affecting the North American market. An expanding base of multinationals at all levels of the value chain is a fact of life: As North American labor and other costs increase and competition intensifies, manufacturers look to other geographic locations to reduce manufacturing costs—and ultimately maintain their profitability.

Reducing Silicone Mist



Using a high-speed cross-linker is a cost-effective solution to reduce mist.

by Loretta A. Jones and Paul C. Vandort

Paper Industry Group, Dow Corning Corp.

In the early 1980s, machines that applied silicone release coatings ran at speeds of 300–600 fpm (100–200 mpm). While they could produce mist, it was not a regular occurrence. Some of these coaters are still operating, and with upgrades, can run at 700–1,000 fpm (230–330 mpm). Many newer coaters are running at 1,500 fpm (500 mpm), and the latest can achieve 2,000–2,500 fpm (650–800 mpm). It is virtually impossible to configure equipment so it does not produce mist at these speeds.

Mist Generation and Measurement

The primary application methods for silicone release coatings are multi-roll coating heads—typically five-roll, smooth roll—and three-roll differential offset gravure (OSG). Both produce mist.

While OSG dominated early installations, most high-speed coaters installed recently have been outfitted with five-roll, smooth roll coating heads. When it comes to mist generation, neither method has an advantage. The phenomenon of mist generation occurs at points of film splitting under high shear: The higher the line speed, the more mist is generated. Clouds of fine mist can be seen billowing from the nip between the applicator and backing roll, where the web is traveling between them. This mist often can be seen following the web path into the ovens—where it creates oven dust—as well as spraying outward horizontally. This is the mist that usually is referred to and can cause issues with worker exposure and equipment contamination. Not so obvious is the spray of (usually larger) mist particles from the back of the coating head setup. It can deposit on the backside of the liner and cause problems with subsequent converting operations.

As this problem has become more of an issue, the ability to measure it has evolved. While it is necessary to minimize contamination of equipment and materials, worker exposure is the primary concern. There are no established regulations specifically regarding silicone mist exposure, but a generally accepted guideline is that used for airborne contaminants.

Several techniques have been used to assess the amount of mist generated. The values obtained, and the methods to measure them, differ from the Industrial Hygiene guideline and accepted methods for measuring worker exposure. Every method has shown some utility but also some limitations. Each attempts to distinguish mist by particle size, since those particles of 5 microns and smaller are considered respirable and thus pose the highest risk to coater operators.[1]

During early explorations, the PC-2 Air Particle Analyzer[2] was used. Generally referred to as a cascade impactor, its guiding principle is the separation of particles by size by depositing them on different crystals connected to a mass sensor, providing valuable comparative measurements. It has been invaluable in evaluating silicone systems, but in the field, some difficulties are encountered.

The Aerosizer DSP[3] also has been used. It operates on the principle of aerodynamic time-of-flight analysis. However, it, too, can yield misleading data collected in an environment of dense mist.

Another technique used for trials is Industrial Hygiene air monitoring. Air is pumped through a cyclone device that draws it through a filter at a calibrated rate. The filter is pre-weighed, and the change in weight from the various operators' devices is compared to a blank device placed in a similar environment. This method can be used on stationary points on coating equipment and via a personal detection device. Workers wear a small plastic canister attached near the head, connected to a hand-sized pump attached to their belt, for eight hours as they move through their day. Attachments can be used to collect data on total or respirable mist. This method is accepted by Industrial Hygienists worldwide.

"Controlling" Mist

There are four options at an operation's disposal to control mist that can and are used in various combinations. Three are aimed at reducing mist at the point of source, while the fourth is designed to remove generated mist. The removal or extraction of mist from a silicone coating head—while successful at reducing worker exposure—only moves the mist in another form to a different area. Exhaust tubes or channels placed at the coating head route the mist through filters and into the plant or outdoors. The filters can become clogged in areas of heavy mist and must be changed often to be effective. This method is not to be discounted, however, as supplemental to other methods when mist already is reduced greatly.

Large enclosures are added to contain mist within a reduced area, and operators spend little time in these areas. Walls, ceiling, and floor of the enclosure rapidly become coated with silicone, so this approach does not solve the problem of equipment or web contamination or slipping hazards.

Equipment manufacturers have attempted to design coating heads less likely to generate mist, but with wider coaters and higher line speeds, this becomes more difficult without compromising quality and efficiency.[4] Experiments have been conducted to determine the impact and relative importance of silicone coat weight, line speed, roll ratios, and nip impressions on the amount of mist generated. While there are conditions that help minimize mist generation, line speed is the overriding factor.

For new installations, larger-diameter rolls go a long way toward reducing the line speed at which mist generation will begin.

The selection of a silicone system primarily is dictated by the desired release force and then tailored by formulation to meet cure requirements. Dow Corning set up an enclosed station to generate and study mist, using a two-roll mist generator[5] and the PC-2 analyzer for measurement. Lab studies showed the relationship between mist generation and silicone polymer viscosity, which was later correlated on pilot and production coaters. This data not only shows higher viscosity polymers probably will generate more mist at a lower line speed, but even very low viscosity polymers eventually will mist under certain conditions.

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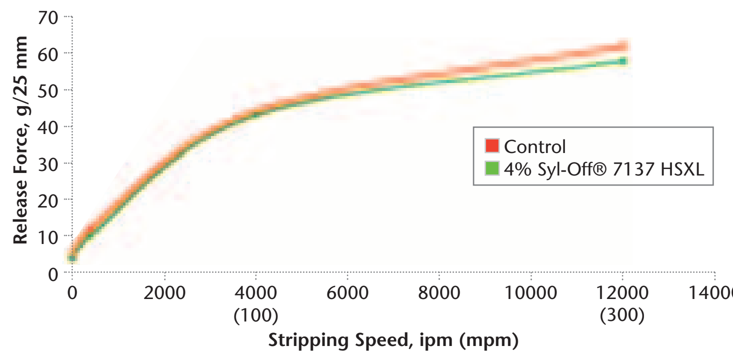
In order to offer a range of products to meet a wide spectrum of customer and industry requirements, Dow Corning chose to approach mist reduction through the development of an additive.

The first-generation product, introduced in 1995, dramatically reduced the amount of mist generated. In practice, however, it proved to have a negative impact on other performance properties. After laboratory and pilot coater evaluations, Dow Corning began to work with customers in 2000 to evaluate second-generation materials on coaters. Syl-Off 7137 HSXL and Syl-Off 7138 HSXL have been in commercial use for about 12 months now.

Release Force Profile with tesa 7475 Acrylic Tape



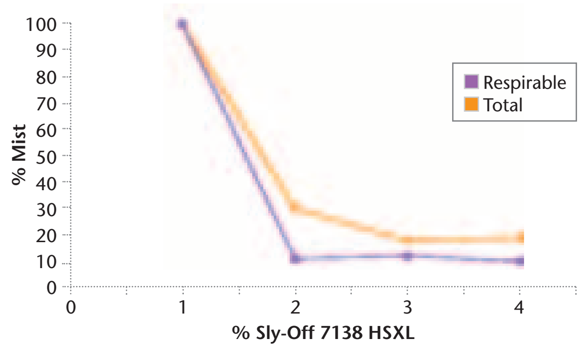
Source: ©AWA Alexander Watson Assoc.

Product Characteristics and Performance

The two materials represent both types of silicon hydride cross-linkers used in paper release coatings today. Syl-Off 7137 HSXL is based on a homopolymer, while Syl-Off 7138 HSXL is based on a copolymer cross-linker. The recommended use level is 1%–4%, with typical use levels expected to be in the range of 1%–2% to reach the desired level of mist reduction (see graph below).

Mist Reduction as a Function of Addition Level of Syl-Off 7138 HSXL

Trial run on a laboratory coater at 2,000 fpm (150 mpm)

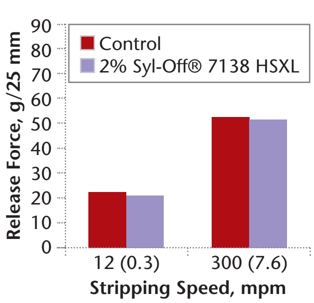


Source: ©AWA Alexander Watson Assoc.

For formulating purposes, additional standard cross-linker is recommended to reach the desired silicon hydride/vinyl ratio.

Laboratory and pilot coater studies have been conducted to evaluate the effect of the use of these products on various performance properties. For the purposes of evaluating the effect on cure and pot life, the high end-use level (4%) was tested. The results showed that no impact was observed on either cure or pot life.

Release Force with tesa 4651 Tape



Source: ©AWA Alexander Watson Assoc.

Since the main function of these coatings is to provide release, it is imperative the impact of the high-speed cross-linker on release is understood. There is an almost infinite number of combinations of release coating formulations and adhesive types, substrates, silicone and adhesive cure, and storage conditions that could be considered. For this reason, however, standard tapes are used for testing release. The graph at left shows no change in release was observed when tested at 12 ipm (0.3 mpm) and 300 ipm (7.6 mpm) stripping speeds, with 2% Syl-Off 7138 HSXL. Although no difference was observed in this testing, it is important each customer evaluates materials and constructions to determine if formulation adjustments are necessary.

Additional testing at a wider range of stripping speeds also was done with the acrylic tape. A slight difference was noted at the highest stripping speed, but this was only with the highest recommended level of high-speed cross-linker (see graph above).

A Cost-Effective Solution

Productivity and cost reduction will continue to drive new products and new technology in the self-adhesive industry, and the use of a high-speed cross-linker is a cost-effective solution to reduce mist during the application of silicone release coatings, without affecting other key performance properties. The impact is observed at the coating head but also is characterized by reduced operator exposure to mist, improved coater hygiene around the coating head, and reduced requirement for cleaning ovens and other equipment. As a result, productivity can be increased and waste decreased.

Lori Jones graduated from Bowling Green State Univ. of Ohio with a bachelor of science degree in chemistry. Since 1985 she has held a Technical Service and Development role at Dow Corning serving the Paper Industry Group in the areas of pressure-sensitive adhesives and release coatings.

Paul Vandort received bachelor of science degrees in chemistry and biology from Hope College in 1988. He then worked for three years at the GE Corporate R&D Center. In 1997 Paul received a Ph.D. in organic chemistry from Purdue Univ. and joined the Paper Industry Group of Dow Corning Corp.

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EB/UV Curing & Drying

A layman's explanation of how these technologies are applied and how they differ.

by G. Freelin and T. Hohenwarter
Degussa Goldschmidt Chemical Corp.

Recent years have shown an increase of interest in the use of electron beam and ultraviolet light for curing/drying inks and coatings. The advantages of reduced emissions, lower energy costs, and increased speed have fueled this interest.

Electron Beam (EB)

The electron beam (e-beam) is generated in the same manner as a picture is generated on your television tube or a computer cathode ray tube (CRT) screen but at much higher voltages.

In a CRT electrons are emitted from a heated cathode in the electron gun. They are accelerated and focused to strike the luminescent screen as a fine point. Between the electron gun and the screen, deflecting plates or deflecting coils control the up-and-down and left-to-right motion of the beam. The beam of electrons thus can be made to sweep horizontally across the face of the tube.

With an industrial e-beam, the principle of operation is the same. However, the voltages employed are much greater, and a thin metal foil (usually titanium) acts as a window that allows the electrons to pass through and strike the coating or film (replacing the luminescent screen mentioned above). When these high-energy electrons strike the coating, they can break and form new chemical bonds, resulting in a cured coating. How far these electrons penetrate into the coating depends upon the potential difference between the cathode and anode—i.e., how high the voltage is set. The greater the difference, the faster the acceleration and the greater depth of penetration.

This ability to penetrate to various depths, together with insensitivity pigments and high throughput, has made e-beams particularly useful in curing both highly pigmented and thick coatings. It also has been used successfully in the processing of radiation-curable silicones for release coatings. In this case, however, a lot of the energy is "wasted" as it passes through the thin coating (usually 1 micron). Recent advances in the industry have allowed EB units with lower voltage to be produced.

Depth is not the only important factor in EB cure; dose also must be controlled. Dose refers to the amount of electrons delivered over an area (the term is "megarad"). This is controlled by the current (amps) used to run the equipment. In the case of thick coatings, it is normal to use 4–6 mR. There are applications in film cross-linking and specialty laminations where this dose is much higher. In the case of thin films, such as silicone release coatings, a lower dose will give sufficient cure—usually 1.75–2.5 mR.

EB equipment, due to simple design, is best suited to long-run, high-throughput applications. Highly pigmented systems can be radiation cured only by this method. Speeds more than 1,000 mpm have been achieved. A lot of stops/starts tend to shorten the life of both the window and the gun due to thermal stress of heating and cooling.

A byproduct of EB emission is the creation of x-rays. The equipment is designed to shield and contain these, and they are monitored constantly. The x-rays are caused as the extra electrons pass through the coating, substrate, etc., and strike the back plate. The higher the voltage, the more likely this is to occur.

Ultraviolet Light (UV)

Ultraviolet is defined as electromagnetic radiation with wavelengths between 4,000 angstrom units (Å), the wavelength of violet light, and 150 Å, the length of x-rays. Often it is divided into further categories based on wavelength, UV-A (400 nm to about 315 nm), UV-B (about 315 nm to about 280 nm), and UV-C (about 280 nm to 150 nm).

In the coatings industry, this energy normally is created through the use of mercury vapor bulbs. Mercury in the bulb is excited through the use of electrical energy until it "glows." As it relaxes, it gives off the UV light we are looking for. The electrical energy can be applied directly by creating an arc between the two ends of the bulb. Alternatively, it can be used to create microwaves that are directed through the bulb and excite the mercury.

For most applications the "arc" and "microwave" lamps can be used interchangeably. However, some differences can be seen in thin coatings (1 micron or less) at higher speeds (>300 mpm). This is especially true in coatings with fewer reactive groups such as silicone acrylates (used in release coatings). Arc lamps seem to be more efficient at the higher speeds with these types of compounds.

There are some other differences between the two systems. Arc lamps need to warm up for a few minutes in order to create the arc. Microwave lamps need no warm-up time to create the microwave energy.

Of course, the choice of photoinitiator is the determining factor for cure. They actually convert the UV energy into chemical reaction. There are many choices, and many factors—including absorption characteristics of substrate and coating; how well it mixes with the coating in question, out-gassing properties, etc.—determine that choice. Bulbs also can be doped to shift the output wavelengths when necessary.

In comparison to EB, UV equipment design seems better suited for shorter runs and many formulation/substrate changes. Speeds in excess of 400 mpm are common in production, and it is possible to achieve much higher speeds. Price is another difference, with EB being in the order of 5x or more costly. However, the new, low-voltage EB will change this considerably.

Applications in Silicone Release

Our expertise is, of course, the silicone chemistry used for release coatings. We have seen both EB and UV successfully used for the cure of these materials. There are some geographic differences, with EB cure capturing a much larger share in the North American market than in Europe. The general worldwide trend is toward UV, probably due to versatility and cost issues. Also, importantly, UV equipment now is readily available with an inerted module, which is necessary to cure silicone acrylates (oxygen inhibits the cure). This inerting improves the consistence of silicone epoxy cure by controlling moisture levels in the cure chamber.

EB and UV also have different effects on release properties. EB, having much higher energy input, tends to create a much different cross-link structure. Cure is not limited to the acrylate groups, as the electrons also can abstract hydrogen from the chain itself or even cause chain scission/recombination. The resulting release levels tend to be much higher than similar formulations cured by UV.

UV is a much "gentler" cure, specific to the acrylate groups. The UV energy is used indirectly, with the photoinitiator being cleaved by the resulting radicals actually initiating the reaction. Resulting release levels are, therefore, lower and tend to become more consistent with aging. Cure, as defined by Subsequent Adhesion, can vary depending on formulation and equipment differences but normally will be greater than 90%. Another measure of cure is to look for extractables. The exact method for this test still is extremely variable, but good processing should result in 3% or less extractables.

As mentioned above, new EB technology with lower voltage is more readily available. Initial testing shows the effects to be more UV-like—lower release levels and more consistent aging. This makes sense, as dose can be better utilized: The electrons are not penetrating as much due to lower voltage potential. Further studies are underway.

Since 1989, Thomas Hohenwarter has worked in the Radiation Curable Technical Service group at Goldschmidt Chemical Corp., Hopewell, VA. He was technical service manager and currently is market manager for Radiation Curable Silicones. Hohenwarter graduated with a BS in biology from Elizabethtown College; he also attended the Graduate School for Organic Chemistry at Shippensburg Univ.

Gary Freelin is the technical manager for Degussa Goldschmidt Chemical Corp. and has been with the company for the past five years.

NORTH AMERICAN MARKET IS STUDIED

The North American release liners market, with particular reference to the self-adhesive industry, is profiled in detail in a new research study from AWA Alexander Watson Assoc. Covering both silicone-coated papers and films, the report examines the subject from an industry perspective, assessing volume data and providing a detailed market segmentation. Setting its content within the context of global market developments likely to impact trading and commercial activity, the report outlines material trends and the changing structure of the business.

After assessing demand, key demand influences and drivers, and the future demand outlook, the report moves on to document the self-adhesive market segments served by release liners, the non-self-adhesive market segments, and material trends. Raw material prices and environmental issues also are discussed in the context of the materials used for release liners. The structure of the North American release liners market and trends in its capacity are discussed in detail over the entire value chain—from raw material suppliers, paper producers, and film manufacturers to silicone suppliers and commercial silicone coaters.

The report concludes with individual company profiles on major industry players, including Douglas Hanson, Eastern Fine, Loparex, and Wausau-Mosinee, and series of appendices that provide economic indicators.

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Release Liners: *Packaging Waste?*

An opinion shift that release liners are packaging rather than process waste will have consequences across the supply chain.

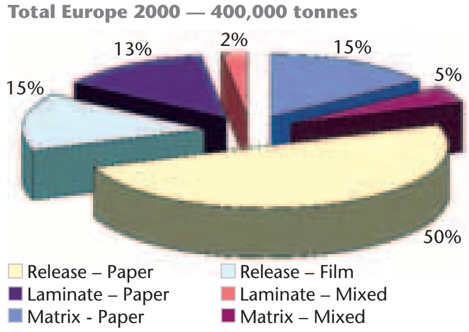
There can be no question release liners constitute an essential part of the production and application process for self-adhesive labels—but afterward they are thrown away. Whether release liners are classified as "packaging"' waste or simply as "process" waste, there is undoubtedly an ethical issue in relation to their disposal. They are high-value items and often highly engineered, and today—when globally we are concerned with making the most of the world's dwindling resources—it may well be considered unacceptable that they simply go into landfill.

European Legislation

Europe is ahead of other global regions in addressing this issue and has taken the route of legislation. In 1994 the European Union (EU) issued its first Packaging and Packaging Waste Directive, aimed first at reducing the amount of landfill and incineration without energy recovery (two major global environmental concerns) and second at driving down the levels of waste in the packaging industry as a whole. The directive encourages minimization of the amount of material used in packaging applications, re-use of components, recovery, and recycling. That "encouragement" has consisted of a series of targets for recovery and recycling, coupled with financial penalties for non-compliance.

Secondary Materials from the Label Production Chain

Total Europe 2000 — 400,000 tonnes



Source: Estimates ©FINAT/EPSMA

U.K. Milestone Ruling on Release Liners

Until this year, release liners were classified as process waste, but current thinking is moving toward the idea they are, indeed, packaging waste. The British government already has taken this route, which could have serious implications for the U.K.'s roll-label industry, as it attempts to compete with European neighbors while shouldering the financial burden of responsible liner waste disposal. The U.K.'s decision undoubtedly will affect thinking across Europe and the world as a whole. France is indicating it is likely to take the same stance as the U.K.

This shift will have consequences across the supply chain in relation to release liners. The release liner manufacturer and laminate manufacturer necessarily create waste during production. The label printer creates waste during conversion—offcuts and trim. The packaging manager is left, after label application, with release liner for disposal. All may be held responsible for the liner waste at their premises.

New Recovery/Recycling Targets in Pipeline

A revised set of EU recovery and recycling targets is due later this year. They will be much more severe than the originals, yet many countries in Europe still fail to comply with the original requirements. While the EU targets apply across all member countries, implementation is the responsibility of the individual countries.

Waste Management Infrastructures

FINAT, the international self-adhesive labeling association based in the Netherlands, along with the European Pressure Sensitive Mfrs. Assn., is spearheading an initiative to "wake up" the individual EU countries to the need to develop waste management infrastructures—matrix, release liner, and unused laminate. FINAT is active in helping the industry in Europe find companies able to collect, recycle, and recover label by-products and in providing technical assistance in setting up such schemes.

A few EU countries, particularly Germany, have strong, established waste management networks across the whole packaging industry, including the self-adhesive label industry in relation to release liners. However, most countries have taken few or no steps toward implementation. Many countries do not even have fully-established waste management infrastructures to enable recycling and recovery, let alone documentation of levels achieved.

Proposed EU Targets

Discussions affecting the packaging industry as a whole go on in the European Parliament, and there is no consensus on what the revised targets should be. Current proposals involve 55%–80% recovery of all materials—including release liner where it is classified as packaging waste—and different recycling targets for glass (60%), paper (60%), metals (50%), and plastics (22.5%). Agreement on a final legally binding document is not expected before year end.

Environmental Responsibilities

Environmentalists argue there is no good reason why the self-adhesive label industry should delay in positioning itself to meet the challenge of the EU legislation. The fact remains there is no need for release liner disposal in landfill sites or by incineration without energy recovery. Legislation like the EU Packaging and Packaging Waste Directive, with its attendant financial penalties, has driven change in Europe's packaging industry, but it also could be considered the moral responsibility of the industry, both in Europe and across the globe, to face the issue fairly and squarely on its own.

Some schools of thought say the benefits would be twofold. First, it would be environmentally responsible to put in place a Europe-wide waste management infrastructure that would optimize the reuse and recycling of release liners. Second, such an industry-specific initiative could create a "level playing field" in the European self-adhesive business arena and help maintain a platform for profitability in an industry where margins are heavily under pressure.

The Bottom Line

The bottom line is profitability for the whole supply chain—and it is worth remembering that waste management firms like US-based Channeled Resources and its MaraTech subsidiary, as well as Ahlstrom Werk in Germany, have proved it is possible to recover, reuse, and recycle film and paper release liner—and to make a profit while doing so.