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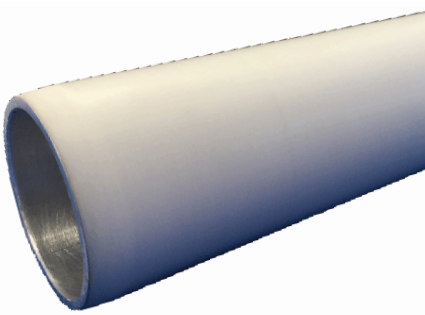

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Giving the Green Light

Angel Morris
Editor

As cliche as it may be to say, it ain't easy being green, and the converting industry is not immune from the challenge. Increasing legislative requirements and demand from retailers for sustainable and recyclable packaging brings increased production pressures and parameters. At the same time, consumers are becoming more wary of brands claiming to be green, a skepticism that might be traced as far back as Biblical times, when the Pharisees were accused of falsely conveying tombs that were beautifully painted white on the outside but quite a different story inside.

This "whitewashing" misrepresented what one should expect, a type of hustle that was infamously brought to light by Mark Twain in *The Adventures of Tow Sawyer*, when his lead character deceived his peers into believing painting a fence was fun. According to a summary from *SparkNotes*, "Tom convinces Ben that whitewashing a fence is great pleasure, and after some bargaining, Ben agrees to give Tom his apple in exchange for the privilege of working on the fence. Over the course of the day, every boy who passes ends up staying to whitewash, and each one gives Tom something in exchange. By the time the fence has three coats, Tom has collected a hoard of miscellaneous treasures. Tom muses that all it takes to make someone want something is to make that thing hard to get."

In today's world, finding products that claim to be green isn't that hard. Finding things that are actually sustainable, is another story, and, instead of whitewashing, some brands are being accused of greenwashing — making false claims toward how environmentally sound their products truly are. This month, we look at ways companies can more successfully validate their sustainable packaging claims using third-party certifications to prove products are, indeed, responsibly made. The feature shares how some industry leaders are stepping up to improve the recycling infrastructure of the U.S., and what other strides are being made to that end.

Our cover story reiterates how, in regard to flexible packaging, there is more to sustainability than recyclability. Three options — post-consumer recycled content, renewable materials and compostable materials — all have a role to play toward increasing package sustainability. In this issue we also complete the final installment of our three-part series on material properties, explaining how to apply tensile testing knowledge to improve your process. From consistent material quality to truly sustainable products, it may not be easy, but industry leaders are giving the green light to continued improvement efforts.

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Sustainability Beyond Recyclability

By **Nathan Klettlinger**, Global Marketing Director for ProAmpac

More brand owners are setting sustainability targets and greener legislative initiatives are on the rise making more sustainable flexible packaging a core decision for many brands and retailers. By adding sustainability to the essential packaging requirements of cost, machineability of material, barrier requirements and shelf appeal, converters are navigating an increasingly complex environment.

Even though recyclable films are an option in some applications, it is not a universal fit. For example, traditional cosmetic web (PET/PE/foil/PE) and paper/poly/foil/poly structures offer good stiffness, barrier and filing on high-speed machines, but are challenging to make recyclable. Also, high residue products or products that require a barrier such as foil to meet shelf-life requirements are not currently eligible for recyclability through existing streams. Fortunately, there are other options to suit end-product requirements while supporting customers' sustainability goals.

Post-Consumer Recycled Content

One of the simplest ways to increase sustainability of a package is by including post-consumer recycled content (PCR). There are two primary types of PCR: mechanical recycled PCR and chemical recycled PCR. Mechanical PCR is the most readily available and can be used at various percentages in film layers.

During the mechanical recycling process, polymers are reduced in size via grinding, then they are melted, pelletized and mixed with virgin resins during extrusion. Both PET-PCR from water and soda bottles, as well as PCR-PE from milk jugs are available for films. PCR-PET can be added at relatively high levels to film and performance and appearance is nearly unaffected. PCR-PE can also be added at varying levels but may be more noticeable in films at higher levels due to the presence of small gels in the product.

Resins recycled via chemical or advanced recycling offer properties far superior to mechanically recycled resins. During the chemical recycling process, polymers are broken down chemically into simpler molecules. Though more limited in availability, investment in chemical recycling is growing. Chemically recycled resins are ideal for applications where the packaging use is sensitive to the appearance of gels or inclusions, or where strength cannot be compromised.

Renewable Materials

Another option for sustainable packaging is that made of bio-based renewable materials. Paper is the most widely recognized renewable material, but bio-based polymers are also available. By incorporating a renewable material, packaging users can reduce fossil-fuel-based plastics while often reducing their carbon footprint. The reduced reliance on virgin polymers helps support sustainability goals without sacrificing product protection. If a customer does pursue a renewable resin alternative, a Life Cycle Assessment should be performed to quantify the carbon reduction.

Bimbosan's infant nutrition pouch from renewable resin.

Compostable Materials

Compostable materials are a well-known alternative to conventional films where the

ProActive PCR High Barrier Rollstock fabric roll halfside.

end-product would render recyclability unavailable. Available in both paper-based and film-based versions, compostable materials are ideally suited for high-speed machines that require stiffness or which have high residue like food waste that would render the product non-recyclable. Compostable structures can be designed with standard and high barriers and can either be designed to compost in industrial composting facilities (136oF) or in home composting bins. Since industrial composting facilities and home compost are suited to hold the organic residue left with some end-products, this material is an ideal alternative for food and lawn care brands with specific sustainability goals. Also, compostable packaging can be ideal for high-speed machines which require stiffness to ensure performance on high-speed filling machines.

In all, material science continues to innovate sustainable alternatives to conventional laminated films to ensure end-products that are ineligible for recyclability can still be packaged to help customers achieve their goals. With the emergence of new technologies, packaging is becoming more sustainable without sacrificing product protection. However, the key to optimal sustainability initiatives is to ensure the packaging material selected suits the end-product to ensure that the two are compatible for the ideal end-of-life disposal scenario. ■

ABOUT THE AUTHOR

Nathan Klettlinger leads the ProAmpac strategic marketing team whose goal is to promote profitable growth and align company objectives with customer needs. Nathan held roles in product development, product management and market segment management. He has a Bachelor of Science in Chemical Engineering and an MBA from the University of Akron.

MATERIAL PROPERTIES, TESTING & APPLICATIONS: PART 3

By **Neal Michal**, Principal, Converting Expert, LLC

Practical Applications with Real World Examples

This month we will complete the final installment of our three-part series on material properties. In April, we discussed tensile testing and how your material properties relate to common customer complaints. In May we discussed 12 aspects that will directly impact your tensile testing results. Today we will discuss how you can apply this knowledge to improve your process and deliver quality to your customer.

Convert to Intrinsic Units

Now that you have valid tensile data it is time to put it to work. Convert both elastic limit (EL) and ultimate tensile strength (UTS) to intrinsic units of force/width: PLI (# force per inch of width) or newtons per meter.

For example, a common hygiene 15gsm Spunbond (SB) has an elastic limit of 0.55 PLI (96N/m) with an ultimate tensile strength of 3.5 PLI (613 N/m). As you monitor your process, consider these important values.

Set Target Tension

Recall the rule of thumb is to set tension to 10-25 percent of the elastic limit. If you export the load versus elongation data, you can determine the force at the elastic limit. If you only have data for elastic strain and modulus, you will need to calculate the tension at the elastic limit (EL) which is known as yield stress. Refer to **Figure 4** for reference equations.

For example, Polymethyl methacrylate (PMMA) has a yield stress of 8,700 psi with a modulus of 300 ksi. If you elect to run at 25 percent of the elastic limit, set your tension to 218# for a 10" wide web with a thickness of 10 mil. (Target Tension = 8700 psi x 25% x 10" x 0.010" = 218#.)

Adjust Tension Based on Width

The benefit of calculating target tension in intrinsic units of N/m or PLI is that it facilitates adjusting tension based on web width. Assuming the same PMMA, you would set tension to 109# for a 5" web.

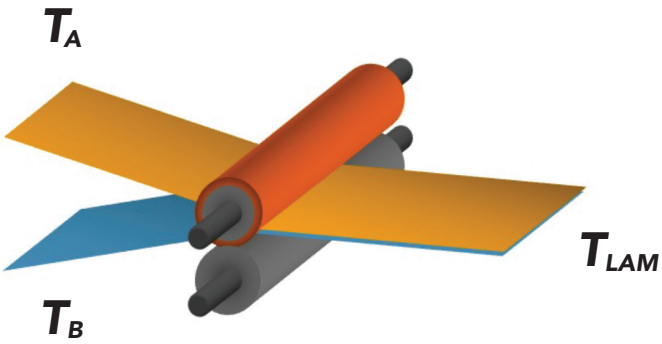
Adjust Tension Based on Thickness

Many processes run the same type of web but with different thickness. Take one more step to calculate tension based on force/width/thickness. Recommended units are [N/m/µm] or [#/in/mil] where a 'mil' is 0.001." For example, the recommended tension for

PET is 9.5 N/m/µm (1.4 PLI/mil). This approach will allow you to determine target tension for any web with the same physical properties.

Correct Laminate Curl

Curl is a result of a strain difference between two plies in a laminate. Given thickness and modulus for two webs to be laminated, one must calculate the tension ratio to produce a flat laminate. **Figure 1** shows the general equation; **Figure 2** provides a sample calculation for PET and OPP. Despite being half as thick, the PET web should be tensioned five times higher than the OPP because of the 10:1 difference in modulus.



T_A	Tension Ply A
T_B	Tension Ply B
t_A	Thickness Ply A
t_B	Thickness Ply B
E_A	Modulus Ply A
E_B	Modulus Ply B

$$\frac{T_A}{T_B} = \frac{t_A E_A}{t_B E_B}$$

Figure 1 - General Equation

PLY A
Oriented Polypropylene (OPP)
t_A=0.001"
E_A=50,000 psi (OPP)
$t_A E_A$=50 PLI

PLY B
Polyester (PET)
t_B=0.0005"
E_B=500,000 psi (PET)
$t_B E_B$=250 PLI

$$T_A/T_B=(50PLI)/(250PLI) = 1:5$$

Figure 2 - Example

Understand Failure Modes

It is important to understand the failure mode for your most important grades. You will benefit from conducting the tensile tests personally. Watch the sample during the test to detect any visual clues as it is stretched beyond the elastic limit (EL). You may detect a visual defect long before the sample fails. For example, the Meltblown component in SMS is brittle compared to the Spunbond. Watch the coupons for pin holes to appear adjacent to the bond points. Make note of the tension when a visual defect occurs. Recently a customer was experiencing high waste on a face mask machine. The 10gsm SMS would weave for 60s after a zero-speed splice. They did not have any load cells installed. Pin holes were noted on the remaining butt roll. The tension spike was damaging the web. The initial decel rate was reduced for the first 50ms before returning to their normal settings. This minor change, based on the visual defect, virtually eliminated the high waste.

Exceptions to the Rule

Some materials require tensions that are outside of the recommended 10-25 percent rule of thumb. It is common to run nonwovens on high-speed converting lines close to the yield stress to overcome air drag and pull out any bagginess. The "rule" would suggest 0.06 – 0.14 PLI for the earlier 15gsm SB example. Actual good run settings are 0.45 PLI which is 81 percent of

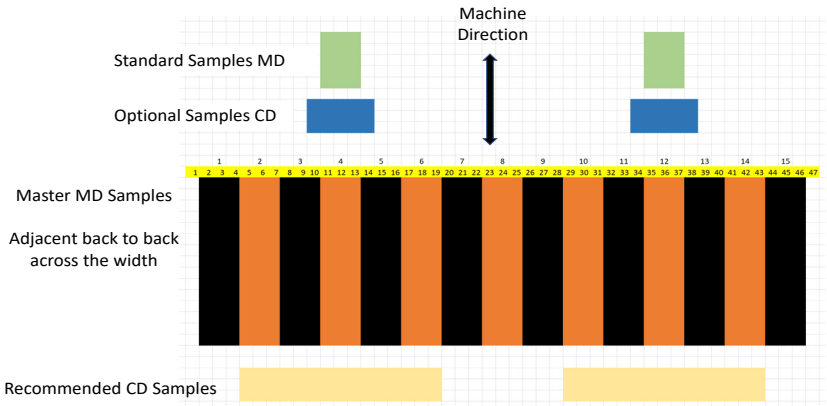


Figure 3 - Master Test Template

the elastic limit.

High modulus webs often run significantly lower tensions as compared to the "rule." A recent customer winds a unique fiberglass laminate with a modulus of 30GPa (4.53 MPsi) and elastic limit of 2 percent; 10 percent of the elastic limit would be 87 PLI for a 10-gauge web (!). The winder runs best starting at 19pli with a linear taper to 12pli.

When in doubt, install a load cell to determine the best tension for your process. A calibrated load cell is an important addition to any web process.

Develop Master Tests

Last month we discussed the benefit of larger length to width ratios (L/W) for the coupons you test. Online release tests often use small coupons with short L/W for convenience. High value webs benefit from the development of "master tests" using larger coupons.

Figure 3 provides an example for a 47" wide process. The green coupons represent "standard" samples at 3x5". The black and orange samples (15 @ 3x15") are taken

Modulus = Stress / Strain
Stress = Modulus x Strain
Stress = Load / (Width x Thickness)

Strain = Stress / Modulus
Strain = Tension / (Modulus x Width x Thickness)
Tension = Stress x Width x Thickness

1 PLI = 175 N/m
1 PLI / mil = 6.89 (N/m) / micron

Figure 4 - Reference Equations

back-to-back across the width of your process. The brown samples are recommended CD samples. You should weigh the master coupons before testing them.

This proven technique will allow you to document cross deckle basis weight profile and the associated tensile properties. It is ideal to conduct this test once a day. This high-resolution data will enable you to analyze your process health and to answer any future questions your customer may have.

Conclusions

Tensile tests are the last line of defense to insure you provide consistent material quality to your customer. Pay attention to the details. Thank you for following along. ■

ABOUT THE AUTHOR

Neal Michal of Converting Expert is a well-known authority in web handling, process design and optimization. He worked with the Web Handling Research Center for 20 years. Currently serving as a technical advisor with AIMCAL, he can be reached at neal@convertingexpert.com or through www.convertingexpert.com.

Third-party Certifications Can Validate Sustainability Claims

By **Justine Hanlon**, Global Marketing Manager for Flexible Materials, H.B. Fuller

Sustainability is going mainstream

A 2021 global analysis[1] commissioned by the World Wildlife Fund (WWF) and conducted by the Economist Intelligence Unit (EIU) revealed that the popularity of internet searches around the world for sustainable goods has increased by an unprecedented 71 percent in just five years.

As consumer knowledge increases, there is a growing backlash against "greenwashing" (i.e., making misleading statements or claims about the sustainability of a product or service) and a call for brand transparency. This is leading to brands looking for reliable third-party certifications that capture and explain their sustainability claims.

These certifications tend not to be cheap, and the best certifications take a lot of time, money and technical requirements to fulfill. As the market shifts toward more rigorous testing requirements, there is some concern that an over proliferation of certifying bodies will lead to consumer confusion and decision fatigue. The certification groups will eventually need to consolidate or lead with one voice or risk being ignored by groups that provide clarity.

Groups such as Cradle to Cradle[2] promise one global standard for products that are safe, circular and responsibly made. They use five guiding tenants to drive their holistic approach to certification, including material Health, Product Circularity, Clean Air and Climate Protection, Water and Soil Stewardship, and Social Fairness.

Cradle to Cradle seems like a sensible way to move forward, versus a patchwork of certifications, but unless there is widespread adoption, they will face the same roadblocks as traditional certifying bodies.

Although standards to reduce greenwashing exist, there are terms that, while technically correct, can still lead to misinformation or representation. For example, ecologically, there are benefits to materials derived from renewable materials, but consideration must be given to how a raw material is sourced. Raw materials derived from animal sources, such as casein adhesive, are less sustainable than plant-based starch, however both are considered renewable resources.

More importance is being given to the end-of-life scenarios of all materials – not just certifications that only look at a small part of products' impact on the environment. The greater shift to life cycle analysis (LCA) methodology will hopefully lead to a decrease in the high cost of LCA and increase in acceptance, especially if certifying bodies and accreditation is tied to such a time consuming and currently expensive, but worthwhile, calculation.

Continued need for infrastructure and consumer education

Much has already been written about the lack of recycling processing infrastructure in the U.S., but recent investments show that the plastics industry is willing to step up and contribute to the complicated issue. In 2020, Nestle invested[3] $30 million in Closed Loop Partners' private equity funds to help upgrade U.S. recycling infrastructure and give the company better access to food-grade recycled plastics.

Another recent example is the Recycling Partnership's launch of the Polypropylene Recycling Coalition, an industry collaboration to improve polypropylene (PP) recovery and recycling in the U.S. and further develop the end market of high-quality recycled PP. However, the speed of investment by both government and industry needs to increase. Failure to do so could lead to the wrath of a public that is quickly becoming more sophisticated to sustainability claims and misdirection.

Only 12 percent of plastics were recycled in the U.S. in 2020, while the rest were landfilled, incinerated or exported. Some work has been done around instore collection at drop-off bins. According to How2Recycle, 225 million pounds of recyclables have been collected through their initiatives – a small part of the $183 billion dollar market.

Film producers and packaging converters don't want mono-material going to landfills or incinerators. Polyethylene, from which a majority of film, wraps and bags are made, is a valuable recyclable material driving the American Chemistry Council's Plastics

Division decision with a goal for 100 percent of plastics to be "recyclable or recoverable" by 2040.

Low volume or complex products, such as multilayer films or packaging contaminated with food residue, will need further infrastructure improvements or product redesign to meet such ambitious goals. Companies that move too slowly in their sustainability reviews run the risk of having their decisions dictated to them by patchwork government initiatives.

Adding complexity to the issue is the ambiguity and "wish-cycling" around the recyclability of plastic film, bags and wraps. Allowing said material to end up in curbside bins can have the disastrous consequence. Plastic films and wraps have been the bane of many curbside recyclers, due to the damage inflicted on equipment.

Hope for the future

Although there are many difficult sustainability challenges facing the film and coating industry, the great news is that many people are working together across multiple facets of the industry to create a roadmap that helps the environment, consumers, brands and the suppliers. And adhesives play a critical role as an enabler and a must-have technology that makes the world, as we know it, work.

They also help to lay the foundation of a new era of industrial design and manufacturing under resource constraints. Due to its innovation, versatility and flexibility — not only in selecting technologies and raw materials — the industry now has many options that contribute positively to the way products are conceived and manufactured, reused or recycled. ■

[1] https://www.worldwildlife.org/publications/an-eco-wakening-measuring-awareness-engagement-and-action-for-nature

[2] https://www.c2ccertified.org/

[3] https://www.fooddive.com/news/nestle-invests-30m-in-closed-loop-fund-to-expand-sustainable-packaging-use/584872/

ABOUT THE AUTHOR

Justine Hanlon works with brands across the value chain to ensure that adhesives help improve compostability, recyclability and a circular economy. Since 1887, H.B. Fuller has been a leading global adhesives provider focusing on perfecting adhesives, sealants and other specialty chemical products to improve products and lives.

A game-changer for web manufacturing

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In contrast to conventional tension monitoring systems with a force sensor at each end of the roller, the FMS-segFORCE features multiple independent force sensor segments that monitor the smallest tension deviations from segment to segment. It allows you to measure the tension of individual, parallel web sections in your slitter/rewinder. Or in coating applications, you're able to see the tension profile across the entire width of your web.

It provides flexibility in terms of overall length of the roller as well as the number, width and position of segments. It can measure up to 50 tension values across the web.

The sensitive and sophisticated monitoring that the FMS-segFORCE offers is especially valuable when processing elastic, sensitive or high-value materials such as high-end foils, adhesive tapes, battery separator foil and capacitor foil. It allows machine operators to spot variations in tension as they arise and address issues right away to protect quality and productivity while reducing waste.

Spotting slitter/rewinder issues in real time

When using secondary slitter/rewinders, operators have no way of measuring material tension in individual web sections. Deviations in the thickness and elasticity of the material in the parent roll as well as environmental influences, mechanical parameters and component wear can all lead to wide variation in tension between sections. This in turn can cause a range of defects in the finished product.

That all changes with the FMS-segFORCE. It enables operators to precisely measure the tension of up to 50 individual web sections, even with very thin and elastic materials. As a result, they can spot the smallest of deviations – all in real time.

Improving coating results

To achieve excellent results in coating lines, it is vital that the tension across the web of the different substrates is stable, especially when processing extremely sensitive materials. This is often made difficult by inconsistency in the raw materials or damage in transport or storage. In addition, temperature and humidity fluctuations in the plant can greatly alter substrate behaviour.

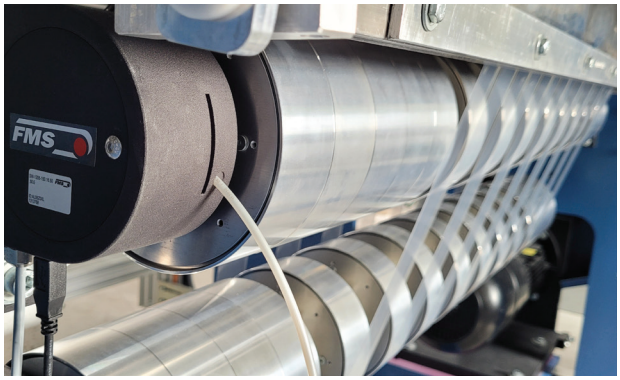


Figure 1: The FMS-segFORCE features up to 50 independent force sensors that monitor the smallest tension deviations from segment to segment. It is especially valuable when processing elastic, sensitive or high-value materials.

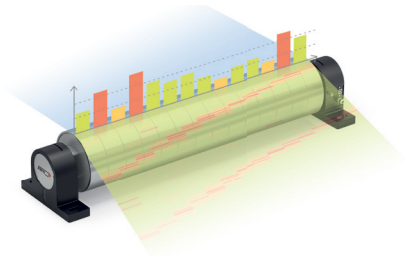


Figure 2: Fully equipped segment measuring roller for tension profiles monitoring across the entire web width.

With up to 50 measuring points along a measuring roller, the FMS-segFORCE displays the material tension of the individual segments in a high-resolution tension profile that maps tension across the entire width of the material web. Any irregularities in the quality of the raw material or problems in the manufacturing process can be identified at a glance and resolved quickly.

Maximising machine productivity

The FMS-segFORCE is the latest in a long line of high-end solutions produced by FMS since 1993 for machine builders and plant operators in a range of industries.

Utilising the latest technology, high-quality components and unrivalled engineering know-how, the Zürich-based firm helps customers maximise the productivity of their machinery.

Learn more about the FMS-segFORCE
www.fms-technology.com/en/our-solutions/web-tension/segmented-tension-roller

Labeling and Product Decoration Trends Report

By **Mark Morris**, Contributing Writer

Editor's note: The following summation is based on data from Alexander Watson Associates' 2022 edition of the Labeling and Product Decoration Annual Review. It is the first of a four-part series, beginning with an analysis of World Label Volumes.

Pressure-sensitive labels offer features that make them almost uniquely suited to variable information printed (VIP) label applications. Consequently, VIP labels account for about 49 percent of total pressure-sensitive label volume. Removing this volume and looking at just the primary application shows a shift in market shares of the different labeling technologies, and at the same time offers a more balanced view of the market space in which these technologies compete.

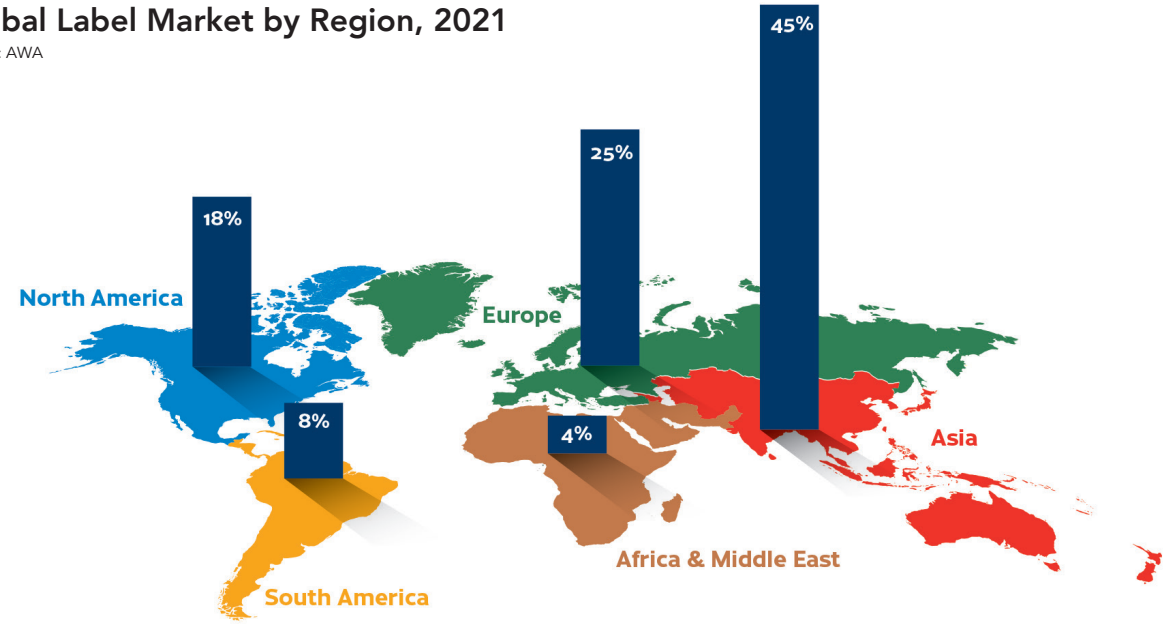
The global volume growth for label products in 2021 was estimated at 3.8 percent. This reflects a pickup in the global growth rate compared to 2020. Historically there has been a strong relationship between global label market growth and global GDP growth. However, the label industry did not experience the same economic effect due to the global pandemic. Instead, it demonstrated the significant role the label industry plays in the worldwide manufacturing and supply chain.

Although recent supply chain issues are hampering potential market growth, global growth is expected to continue at a similar rate with a CAGR percent of 3.4 percent in 2021-2024. This is primarily driven by the continued high demand for VIP labels due to increased transport/logistics and e-commerce activity.

During the pandemic, e-commerce accelerated growth for VIP labels. Consumers realized the convenience of online shopping and a proliferation of home delivery platforms catered to demand. Both by regional markets and by label format, growth in label demand showed variations. In early 2020, the market was forecast to slow down by 2021 after experienc-

Global Label Market by Region, 2021

Source: AWA



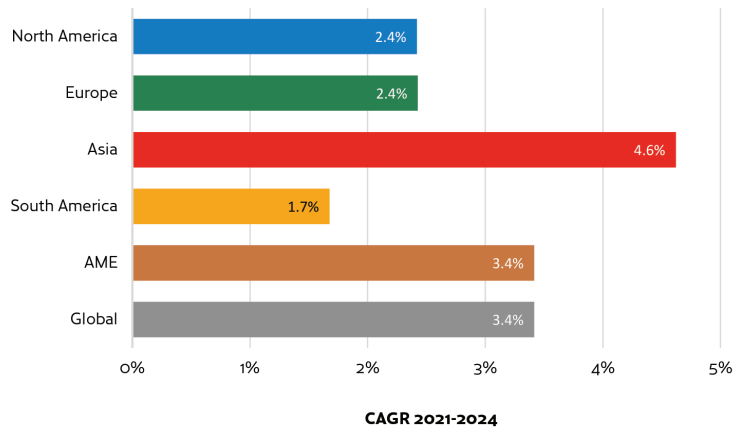
ing strong growth in Q2, 2020. Contrary to that forecast, the global label market continued strong growth driven by high demand in transport and logistic segments and recovery in industrial segments such as automotive, consumer durables and industrial chemicals.

Although supply chain issues continue to be the main concern for companies across the value chain, ongoing effects of COVID-19 on supply, demand and labor, a particularly cold year in the Northern hemisphere and a series of force majeures have caused many industries to feel the strain through growing lead times and rising prices.

Looking at the regional market, China, the biggest label market within Asia, recovered and returned to positive GDP growth in 2021. However, there were concerns regarding China's zero-tolerance approach — shutting down transmission routes when COVID issues arise and ordering mass testing programs. In the case of the more infectious Omicron variant, this would impact the country's economic growth and further disrupt China's supply chains.

Global & Regional Label Market CAGR, 2021- 2024

Source: AWA

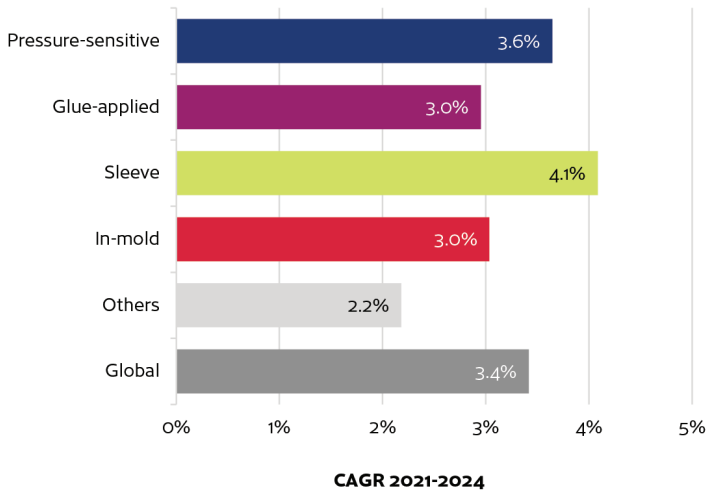


Similarly, other advanced economies in Asia managed to contain the outbreak more successfully and were more likely to recover quickly upon vaccine roll-outs. Asia continued to drive growth; despite being lower than the historical growth rate, its rate was still higher than other regions. Consequently, Asia continued to gain an increasing share of the global label market, with an estimated growth rate of 4.6 percent in 2021.

Within established markets, Europe experienced a growth of 4.2 percent in 2021, driven by strong growth of the pressure-sensitive label market. Whereas the North American market experienced a relatively stable growth of 2.8 percent, AWA forecast Europe and North America to continue growing at a CAGR

Label Market Growth Rates by Label Technology, CAGR% 2021-2024

Source: AWA



percent of 2.4 percent between 2021-2024. Overall South American label demand remained consistent at 1.6 percent. A positive outlook for growth in this emerging regional market for labels continues at 1.7 percent in the period 2021-2024.

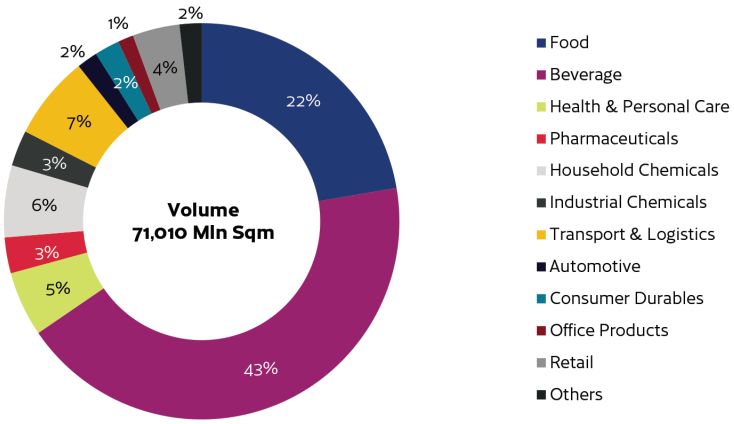
Growth patterns for individual label formats in the developed markets continue to show:

- Pressure-sensitive labels maintain market position, with an estimated growth of 4.9 percent in 2021, primarily driven by recovery seen in the initial hard-hit countries such as Spain, France, Italy and other Eastern European countries.
- Pressure-sensitive labels offer features almost uniquely suited to VIP label applications. In 2021, VIP labels continued to experience growth as a proliferation of home delivery platforms catered to growing consumer demand. Overall pressure-sensitive label CAGR percent between 2021-2024 is estimated to be 3.9 percent. Demand is expected to stabilize at a slightly lower rate in the coming years.
- In 2021, glue-applied label volumes experienced a positive growth compared to 2020, dominating food and beverage end-use segments because of large volumes used in labeling beers, mineral waters, soft drinks and canned foods. With the hospitality sector opening up after experiencing another wave of infections caused by Omicron, glue-applied is expected to experience a relatively stable growth rate on an annual basis. In terms of sub-technologies, wraparound labels continue to grow higher than cold wet glue-applied labels.
- Heightened competition

between label formats seeking a share of the market. Sleeve labels continued to provide the main source of competition to pressure-sensitive and glue-applied labels in the beverage and health/personal care market segments and IML formats in household chemicals. However, pressure-sensitive label growth is partly driven by VIP labeling applications, where other labeling technologies are barely used. In growing markets, pressure-sensitive labels continued to show strong positive growth given their ease of conversion, the broad choice in base materials and the flexibility for relatively low cost in available application technologies.

Global Label Market by Enduse Segment, 2021

Source: AWA



Even though, in 2020 and 2021, pressure-sensitive labels appeared to be the fastest-growing labeling technology, when we talk about the competitive environment created by alternative label formats, data shows that pressure-sensitive labeling has achieved an "equilibrium" and continues to deliver stable or improved growth.

Emerging geographic label markets are also the driver for overall global volume growth in more traditional cold (wet) glue-applied formats. In developed regional markets, this format showed modest growth rates, particularly as traditional beverage labeling methods came under pressure and in the face of alternative methods of product decoration – including the emerging direct digital print format. Despite delayed shipment, price increases and relatively uncertain demand, sleeve label markets continued to perform relatively well in all regions. In the Asian market, beverage products were still the most significant application. Even though the beverage market was hard-hit by the lockdown, it maintained the biggest market for the sleeve.

In 2021:

- Both regional and global label market growth rates were relatively stable compared to last year. The exception was the European region, increasing from 2.8 percent in 2020 to 4.2 percent in 2021 with a forecast growth rate of 2.4 percent for 2021-2024, while North America experienced a stable growth of 2.8 percent in 2021 and a 2.4 percent 2021-2024 growth forecast.
- Rising costs continued to be a significant challenge. Companies faced price pressure from raw material suppliers due to limited capacity or supply chain issues. Container shortages led to increased freight rates, coupled with increasing fuel prices. The ultimate impact on the end product continued to escalate.
- Globally, pressure-sensitive and glue-applied label formats continued to meet the majority of labeling needs, with a combined market share of ±75 percent, supported by the strong growth of pressure-sensitive labels across the board.

Pressure-sensitive label volumes showed positive overall growth in 2021. The global market estimated to have grown by 4.9 percent in 2021: North America at 3.4 percent and Europe at 6.5 percent. Asian pressure-sensitive label market growth approximated 5.1 percent – a positive development compared to 2020. There was a relatively slow recovery in Asia compared to the

previous fast recovery forecast.

Growth in glue-applied label formats was stable compared to the previous year and with the hospitality sector opening up after experiencing another wave of infections caused by Omicron, glue-applied was expected to experience a relatively stable growth rate annually. Although the format reached maturity across the developed regions, growth markets are in China, India and, to a lesser extent, Eastern Europe. The South American market had shown promise, but, in recent years, volumes stagnated as a consequence of poor economic performance in the region.

Overall, global growth in cold (wet) glue-applied labels in 2021 was estimated at 2.4 percent, supported by a 3.1 percent growth in wraparound glue-applied formats, together delivering overall glue-applied growth labels at 2.7 percent. Sleeving technologies (heat shrink TD; stretch; RFS/ROSOTM MD) accounted for around 19 percent of global label volumes.

Food, beverage and household chemicals represented highest market shares in the sleeve label market, and these three end-use segments accounted for a market share of 90 percent in 2021. Recovery of Asian sleeve labeling contributed to volume growth in the market, whereas regional markets like Europe and North America experienced a stable growth rate.

Heat shrink TD sleeve volumes continued to increasingly compete with pressure-sensitive labels in most markets and showed a healthy global growth rate of 4.3 percent. Combining this growth rate for the dominant sleeve label format with those of the smaller stretch sleeve and RFS/ROSOTM MD formats resulted in an overall global volume increase for sleeve labels of 4.1 percent.

In-mold label applications showed growth for the year at 4.2 percent, primarily driven by emerging markets such as South America and Asia. Whereas, the established markets (North American and Europe) also experienced an increase compared to the previous year. ■

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There's More than One Way to Treat a Film

By **Ted Lightfoot**, casting, coating, drying and laminating film consultant

To most people, surface treatment means corona treatment. Corona treatment is the most popular surface treatment for good reasons, but it isn't the only choice. Table 1 lists 10 other ways to improve wetting and adhesion. But, before getting into the "how," you need to establish the "why" … Are you looking for better wetting or better adhesion?

Printers need to control dot size, so they have to control wetting. Usually that means "surface energy" although liquids can be pinned by roughening the surface. Abrasion to enhance roughness is not common, but buying rougher film is.

Most people use "dyne pens" containing mixtures of 2-ethoxyethanol and formamide (specified in ASTM D-2578-04a) to see which wet (for three seconds) and which bead up. Contaminated dyne pens can give false reading, so be careful what they touch.

The ASTM method (drops of liquid on clean swabs) is a better choice if contamination is an issue. D-2578 was written for polyethylene and polypropylene. ASTM D7490-13 was written for more polar substrates (like polyester). There are small portable measuring devices for D7490 — but no pens.

Coaters need the liquid to wet the surface, but they also need adhesion. The most robust mode of adhesion is covalent bonding, so they try to introduce reactive groups on the surface (which, coincidentally raise the surface energy). Most techniques listed in Table 1 are aimed at improving adhesion through introducing reactive groups.

One exception to that is "flash blasting" — developed for polyester. It is hard to stick to crystalline materials. Exposing the film to a "flash" of intense light quickly melts the surface leaving an amorphous adhesion promoting layer.

TECHNIQUE	PRINCIPLE	CHEMISTRY	AVAILABILITY
Corona	Electric discharge ionizes air	Oxygen compounds	Most common
"Atmospheric plasma"	Electric discharge in gas other than air	Customizable including nitrogen groups	Increasingly common
Traditional plasma	"Fourth state" = electrons / ions	Wide range	Well known. Off-line
Plasma polymerization	Polymerization of monomers in a plasma	Variable	Uncommon
Abrasion	Increases surface roughness / pinning	None	Rare
Flash blasting	Rapid heating /cooling gives amorphous layer	None	Two recent entrants
Flame treatment	Pass web under flame	Oxidative/ reductive	Common for polyolefins, Mostly off-line
Chemical etching	Pass web through reactive bath	Customizable, Sodium / naphthalene most common	Common in fluoropolymers
Ozonation	Ozone chamber	Oxidation of melt	Polyolefin melts
Priming	Coat "tie layer"	Customizable	Common for film lines
Coextrusion	Extrude adherable surface layer	Customizable	Common for film lines

Table 1 – Ways to enhance wetting /adhesion

In both corona and atmospheric plasma treating, the web passes between a grounded roller and an electrode driven at a high frequency and voltage. This produces a glow discharge over the film.

In air, this discharge produces reactive oxygen species (including ozone — that you have to decompose before venting). Either the electrode or the grounding roller must be insulated to prevent arcing. Before corona, people used "spark treatment" or "electronic discharge" to enhance wetting and adhesion. The great innovation for corona treatment was increasing the AC frequency from 50-60 Hz to 20-80 kHz[1] (although most corona treaters run between 15 and 25 kHz).

Atmospheric plasma frequencies usually run between 40 and 100 kHz although some use 13.56 MHz or 2.45 GHz. The advantages of higher frequency are "depth" of the treatment (for plasma, that can include removing a weak boundary), minimization of the possibility of "lightning bolts" (point discharges that leave pinholes in the film) and back side treatment (generating a plasma on the back side of the film under a wrinkle).

Atmospheric plasma treaters use gases other than air and can produce many types of surface chemistry (e.g., nitrogen groups) as well as the oxygen containing groups generated by corona.[2]

There is a lot of confusing marketing for atmospheric plasma and "plasma ready" corona treaters. If you are considering atmospheric plasma, be clear what you are getting: Is this just a corona treater with gas seals; How high is the frequency? How much of the web path is covered by the plasma? What gases can it handle? How effective is it for surface cleaning, etc. Engineers tend to favor the highest performance system, but the least expensive one may satisfy your needs.

It has been known since the late 19th century that low pressure plasmas can react with surfaces and form new materials (including polymers).[3] Vacuum plasma is powerful, but not an on-line option. Reactive atmospheric plasma treaters[4] became available around 2000. These can create a wide range of chemistries and substrates — at a cost.

Another off-line option, very effective for halogenated polymers, is chemical etching (running film

through a bath of metallic sodium in naphthalene).

Flame treatment involves passing the film (quickly) under a flame with a controlled chemistry. Like plasma treating, flame treating can clean off weak boundary layers. Flames can be run oxygen rich, or fuel rich to adjust the surface chemistry for the application. Flame treatment is usually run off-line; however, on-line flame treatment is common for BOPP lines. It is not cheap to install and it presents safety challenges, but it is very effective and often produces longer treatment life than corona.

The last three techniques in Table 1 are not exactly surface treatments of the film: ozonation involves exposing the melt in an extrusion coater to ozone to introduce reactive groups on the melt. Priming and coextrusion are usually practiced before the film comes to the converter.

If done as an add-on, priming is expensive. But many film manufacturers use coextrusion and on line-priming to produce a more wettable and adherable base (quite economically). Sometimes the cheapest option is to get someone else to do it.

Which surface treatment is "best?" Usually, the cheapest one that works for your application. On-line corona treatment is usually the lowest cost option and works for most systems. It is hardly surprising that corona is the most common method. Corona does not work for all systems but if it doesn't, remember: You have other options. ■

[1] US Patent 3,514,393

[2] US Patent 3,274,091 predates the term "atmospheric plasma" by some decades, but describes many atmospheric plasma systems.

[3] The Foundations of Vacuum Coating Technology, Donald M. Mattox Berlin Heidelberg: Springer Verlag (2003)

[4] US Patent 6,118,218

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Ted Lightfoot has worked in coating, drying, laminating and film casting for more than 35 years. He has experience in R&D, plant support, as a Six Sigma Black Belt for Growth, and application development (helping customers develop processes and structured products). He is a consultant, writer, speaker and gives short courses. He can be reached at TedlLightfootLLC@gmail.com.

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